SRN-DDR-043: WINEP Nutrients Phosphorus (P) and Nitrogen (N) Schemes Enhancement Cost Evidence Case

28th August 2024

Version 1.0

from Southern Water

Contents

1. Introduction

Ofwat's draft determination has applied substantial cost challenges to our WINEP nutrient removal programme. Some of the challenge is based on econometric modelling and some due to Ofwat finding insufficient evidence where benchmarking models were not applicable.

This document provides our response to these challenges, critiques the enhancement cost modelling approach Ofwat has used, and presents evidence which enables Ofwat to make the full requested cost allowance for our nutrient removal programme.

The challenges we are responding to are:

- the efficiency of our phosphorus (P) removal proposals according to Ofwat's modelling approach, and
- The evidence to support our nitrogen (N) removal proposals.

Our WINEP proposals for enhancing wastewater treatment have continued to evolve since we submitted our business plan to Ofwat in October 2023 and since we provided a separate set of data tables to Ofwat in February 2024 showing our understanding of the scope of the WINEP at that time. Our representation on the draft determination presents an opportunity to update the scope of the WINEP which has been agreed with our regulators and was provided to us by the EA on 5th July 2024. The key changes to our WINEP relate to:

- phosphorus removal, and
- nitrogen removal.

The changes are due to developments in the detailed requirements including:

- Revision of iron permits where phosphorus removal is provided through ferric dosing through discussions with the EA.
- Approval from Defra on our proposal for N catchment permitting to meet the nutrient neutrality requirements of the Levelling Up and Regeneration Act 2023 (LURA).

These two key revisions have material impacts on our proposals and are likely to affect the apparent efficiency of our costs when benchmarked with similar programmes of investment across the sector.

Changes to solutions for nutrient removal have knock-on impacts to business plan costs in other areas of investment such as improvements for sanitary parameters at sites where there are multiple drivers of WINEP investment, and at descriptive sites which are moving to numerical permits due to requiring phosphorus removal. We describe those changes in this document.

In addition, our June 2024 investigation into the improvements needed to prevent deterioration to Portsmouth Harbour shellfish waters have concluded that an improvement is needed to the continuous discharge from Southwick WTW which we also explain here.

2. Issue

2.1 Nitrogen removal

Ofwat does not appear to have used all the business plan information we provided in its deep dive assessment of our N removal proposals. Ofwat states that there was insufficient evidence of both options appraisal and cost efficiency but does not refer to either the WINEP technical annex (SRN38) nor the options appraisal and cost methodology technical annex (SRN15) in its deep dive assessment.

As a result of its deep dive assessment, Ofwat made large efficiency challenges to our nitrogen removal proposals, based on its assessment of insufficient evidence of a robust options appraisal process and cost efficiency. As well as pointing out the additional evidence we provided with our business plan we are expanding on it in this document to reinforce the evidence of detailed options appraisal and evidence of our cost efficiency. Ofwat's assessment failed to reference the detailed cost benchmarking and options appraisal methodology which underpinned our WINEP approach and which informed all our enhancement proposals. We consider that this demonstrated both an efficient scope and efficient costs were proposed in our business plan. We are not changing our approach to costings, but presenting and explaining our options appraisal and costing approach to aid Ofwat's understanding.

Ofwat's draft determination does not take into account the changes in scope and permit levels that result from the discussions with Defra and the EA since we submitted the February 2024 version of the data tables.

This revised scope of regulatory requirements is now represented on the WINEP. The changes to nitrogen removal are not significant but reflect an altered catchment permitting approach. We propose an efficient scope for N removal, using stretch permits at some sites to avoid the need to invest to meet Technically Achievable Limit (TAL) at other sites, saving customers money. This will avoid the need for £67 million of investment in AMP8 – a more efficient scope than following the standard upgrade duty. However, we are taking on additional compliance risk in using a catchment permitting approach by stretching below what is understood to be the limit of reliably technically achievable levels. The EA's innovative permitting WINEP guidance makes it clear that catchment permitting is applied on a trial basis initially to assess its efficacy. Should the trial be unsuccessful, then to meet the prescriptive TAL permit levels at all nutrient significant plants we will need to request funding from customers in a future period for the sites where our catchment permitting avoids the need for investment in AMP8.

2.2 Phosphorus removal

Ofwat's draft determination concludes our costs are inefficient as its modelled allowance is less than the costs in our February data tables. Firstly, we explained in our business plan that we had specific sites where costly solutions were driven by the need to meet tight iron permits rather than the phosphorus permit level itself. Ofwat did not take our evidence into account in its assessment, but as a result of a change to the approach to setting iron permits our business plan assertion is demonstrably the case. Changed scope of investment at sites where there is no longer a tight iron permit reduces our costs on a comparable basis by £68 million which substantially closes the £70 million gap between Ofwat's view of efficient costs in the draft determination and our business plan costs. Our representation on the draft determination provides an opportunity to update our costs at the sites where iron permit levels have changed since those assumed in February 2024.

Nevertheless, we are not persuaded that the phosphorus removal modelling approach Ofwat has taken is a robust way of making a cost allowance for these activities, in particular the models based on outturn costs in the APR are poorly specified.

We have assessed our revised costs and demonstrate that, just as in our business plan, we are proposing efficient P removal costs, which we show to be efficient when benchmarked against those of the rest of the industry. We used the data provided by companies in February 2024 versions of business plan data tables and our reduced costs for P removal for the benchmarking activity. As anticipated, the relaxation of iron permits in particular closes the efficiency gap found by Ofwat's draft determination modelling approach.

3. Our response

This representation document includes:

- Additional evidence in response to the deep dive challenges from Ofwat on our N removal proposals
- Details of our N removal schemes following Defra's decision to designate the Solent catchment as a catchment permitting area under the Levelling-up and Regeneration Act, 2023.
- Details of our P removal schemes with revised solutions to meet altered iron permits.
- We provide evidence of benchmarking we have carried out which demonstrates our revised P removal proposals are efficient.
- The impacts on associated investments at the affected treatment works. In some cases the change of solution for P removal has impacted on the solution and costs for sanitary parameters, N removal or growth investment at the same site. The changes to the scope and costs of growth schemes are provided in a separate document.

4. Supporting Evidence

4.1 Nitrogen removal

Nutrient Neutrality scope and catchment permitting approach

Our October 2023 business plan proposed phasing some N removal schemes to AMP9. Our February response to query OFW-OBQ-SRN-205, brought all required N removal forward to complete in AMP8, but made an assumption that our proposed catchment permitting approach to meet the Levelling Up and Regeneration Act (LURA) N load reduction in the Solent catchment would be approved by Defra. We outlined our proposed catchment permitting approach for nutrient neutrality under LURA in our response to the query, which reduced AMP8 costs by £68 million compared to the standard upgrade duty requirements of TAL at all nutrient significant sites. The document explaining the changes was the Addendum to SRN39, the WINEP Treatment Works enhancement business case.

Since writing the Addendum to SRN39, we have continued to engage with Defra to discuss our Nutrient Neutrality catchment permitting proposal. These discussions led to revisions to take account of sites currently operating to permits set below TAL within the baseline calculations, rather than assuming they operate at TAL.

Our revised proposal is for an additional stretch permit at Budds Farm WTW of 9.3 mg/l total N and removing the Arun and Western Streams sub-catchment from our catchment permitting proposal altogether. This will result in the standard upgrade duty to TAL at Lavant WTW, alongside the current permit levels at Bosham WTW (10mg/l), Chichester WTW (9mg/l) and Thornham WTW (10mg/l).

In our draft representation data tables we include the costs of N removal to TAL at Lavant WTW, and the additional opex requirements for increased methanol dosing to meet the stretch permit level at Budds Farm WTW.

The other notable change to N removal scope is the removal of the need for N removal at Newnham Valley Preston WTW.

We had applied to Defra for an extension to completion dates due to engineering constraints on the N removal programme. We have received written confirmation that our proposed extensions are not being allowed, meaning all N permits have 31/03/2030 regulatory completion dates.

Revised costs of WINEP N removal proposal

There are changes to our N removal costs due to the scope changes described above, as well as updated cost information through more detailed Level 2 costing. We provide these updated costs by site in data table CWW19.

Table 4-1: Changes to N removal costs between February and DD representation

	February data table totex allocated to total nitrogen removal (chemical) in CWW3, £m	DD representation totex allocated to total nitrogen removal in CWW3, £m
Total N removal AMP8 costs	**266.671**	**262.013**

The net change in N removal costs since the February 2024 query 205 response is a reduction of £4.7m.

Improved confidence in our costs

Since the submission of our business plan we have continued to gain improved confidence in our costs through carrying out level 2 costings for another 8 of the more material treatment works WINEP schemes. We have updated the costs of the specific schemes in our representation version of the business plan data tables.

These level 2 costings have impacted the costs for P removal, N removal and treatment for sanitary parameters. The variation in costs at the site level are wider, but the overall variance between Level 1 and Level 2 costs for the 8 sites is within 6% of Level 1 totex. This provides assurance that our Level 1 costs are reliable for business planning purposes and that our treatment works WINEP schemes are costed appropriately at the programme level. This approach to increasing confidence in our most material scheme costs provides additional confidence that our revised costs are robust and efficient.

The additional schemes we have undertaken level 2 costings for are:

- Canterbury WTW – N and P removal
- Ashlett Creek Fawley WTW – N removal
- May Street Herne Bay WTW – N and P removal
- Morestead Road Winchester WTW – N and P removal
- Newnham Valley Preston WTW – treatment for sanitary parameters
- Portswood WTW – N removal
- Tenterden WTW – P removal
- Tonbridge WTW – P removal

We discuss in the section on cost efficiency for nitrogen removal below the benchmarking we have carried out of some of these level 2 costings against other UK water companies.

4.2 Additional evidence in response to Ofwat's deep dive of our N removal proposals: Best option for customers

We explained our approach to options appraisal in our October 2023 business plan in an Options and Costing Methodology technical appendix, SRN15. For N removal we also followed the WINEP methodology where we compiled options appraisal reports which we submitted in the Environment Agency, as explained in our WINEP Technical Annex, SRN38. From the deep dive assessment it is not clear that Ofwat reviewed these two documents when assessing evidence on options appraisal and cost efficiency, as the only document referred to is SRN39. We request that Ofwat reviews the evidence we provided in the business plan to explain our options appraisal and cost benchmarking approaches which will demonstrate we used robust processes in developing our business plan submission.

In addition, we provide more detail below of the options appraisal and cost efficiency evidence that is specific to the N removal schemes that are within our Draft Determination representation data tables.
As set out in SRN39 in our business plan, we considered a range of options to meet our N removal WINEP requirements. However, the unconstrained list of process options to meet total nitrogen permit levels is limited, once novel and mostly untried processes are discounted. The process options available for removing nitrogen from wastewater can be found described in academic papers, with a link to an example provided below.[1]

The main options available that have been tried in full scale in the UK revolve around conventional biological treatment processes which perform two steps in treating the incoming nitrogen which is mostly in the form of ammonia:

- nitrify (convert the ammonia to nitrate), followed by
- denitrify (convert nitrate to nitrogen gas).

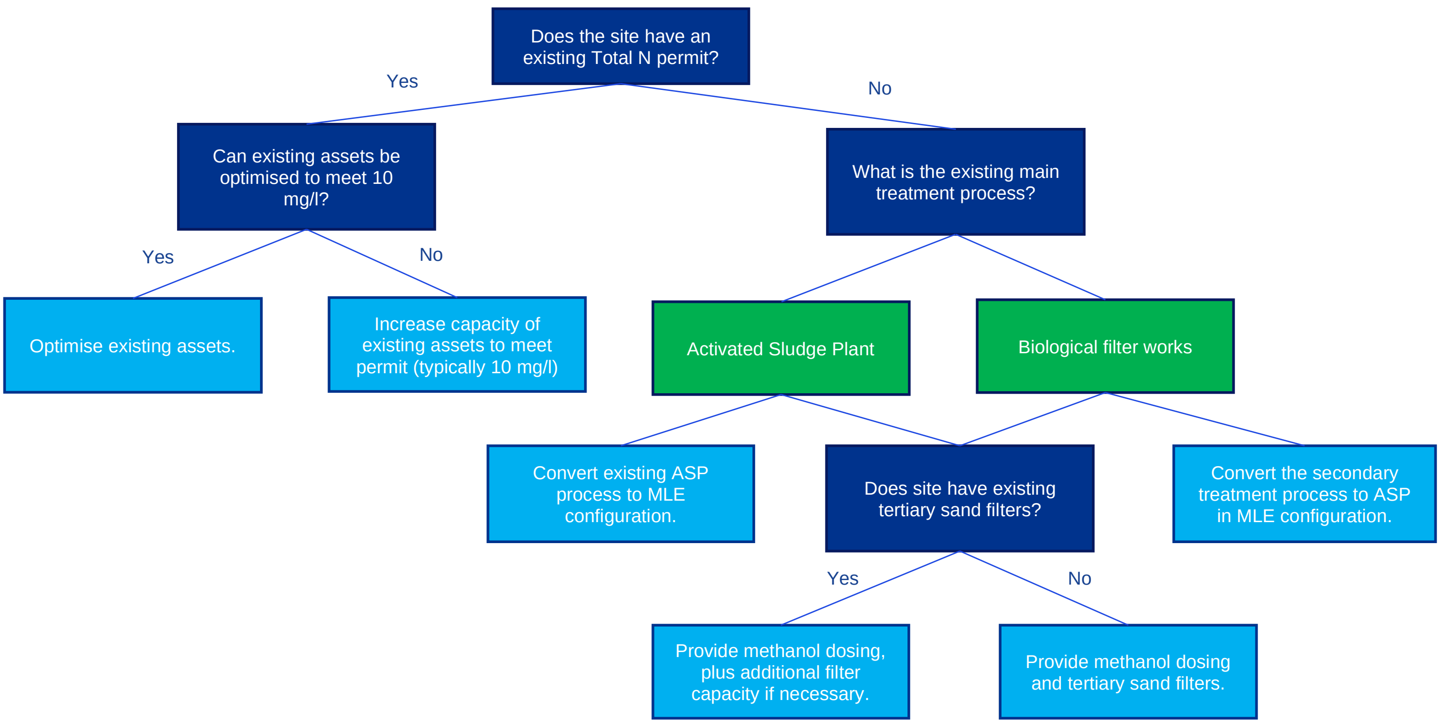
[1] Nitrogen | Free Full-Text | Technologies for Biological and Bioelectrochemical Removal of Inorganic Nitrogen from Wastewater: A Review (mdpi.com), 2022

The one more novel process that has been successfully implemented in the UK is ANAMMOX. However, it is typically applied to and most cost effective for treating highly concentrated wastewaters, such as sludge liquors generated from dewatering digested sludge which can contain many times the concentration of ammonia seen in inlet wastewater.

From our experience, the options we are confident can meet TAL permit levels are all conventional biological treatment processes. The detail of which options are feasible at each site are then very dependent on the existing assets and their performance. We considered a complete change of secondary treatment process as one of the unconstrained options but this is a very high cost solution, quickly screened out through our qualitative appraisal described below.

Decision flow chart for N removal options appraisal

We show in the figure below the decision process for considering which options may be feasible which takes into account the current site's assets and performance. This means there are typically very few feasible options at each site, which consider different configurations of the same processes.



Qualitative assessment of the unconstrained and constrained options list

For developing our WINEP treatment works schemes, our options appraisal process was undertaken for each site, taking into consideration all permit tightening. The starting point for our options assessment is a full unconstrained list of all options.

The first step is a qualitative assessment of whether the option would meet a number of criteria which informs the choice of which options are taken forward for more detailed quantitative assessment.

The qualitative approach is used in five different areas, with each area given a numerical score based on expert judgement made by process engineering staff with knowledge of the current site's operation and performance, as well as knowledge of the processes needed to meet the new permit requirements. The five areas are:

A. Cost and delivery
B. Natural capital benefits
C. Social capital benefits
D. Carbon impact
E. Commercial consideration

A. Cost and delivery
The criteria are given a score as follows:

Not acceptable	score 1
Unlikely to meet criteria	score 2
Likely to meet criteria	score 3
Will meet criteria	score 4

The criteria considered and scored for each option are:

1. Business needs: How well does it meet the need?
2. Business needs: How well does it minimise environmental and third part impact risks (e.g. full planning application, risk of EIA and land purchase.
3. Maintenance and operability: How well does it meet maintenance and operational goals?
4. Potential achievability: Can the solution be delivered well and on time?
5. Potential affordability: How well does the option fit within the budget?

All options are considered in the unconstrained list.

For any sites that score above 1 on the first question in the cost and delivery section proceed to the constrained options list and go on for further qualitative assessment with yes/no type responses which are converted into a score.

B. Natural capital benefits
B1. Water Framework Directive
1. Does the option affect waterbodies regulated by the WFD?
2. If yes, what is the current WFD status?
3. If yes, is the option expected to improve certain elements of WFD status, reasons for failure, or overall WFD status, following the implementation of the option?

B2 Bathing waters
1. Does the option affect designated bathing waters regulated by the revised Bathing Water Directive? If yes, what is the current level of bathing water quality?
2. If yes, what is the expected level of bathing water quality following the implementation of the option

B3 Land use change
1. Thinking of the land footprint (i.e. the area of land) the option will require, what is the main land type you will be starting with prior to implementing the option?
2. Thinking of the land footprint (i.e. the area of land) the option will require, what is the main land type you expect to end up with after implementing the option? For example, if you are creating natural solutions such as wetlands, then select the appropriate habitat type.

B4 Carbon sequestration
Likelihood of increase or decrease of carbon sequestration.

B5 Natural hazard regulation (flooding or erosion)
Likelihood of increase or decrease in protection against flooding and erosion

B6 Impact on biodiversity
Likelihood of enhancing biodiversity within the option's land footprint

C Social capital benefits
C1 Public trust
How does the option affect the level of public trust / institutional support in Southern Water? This relates to the level of confidence that stakeholders including customers, regulators and others have in Southern Water given our reputation and operating environment.

C2 Engagement and networks
How does the option affect the level of engagement and networks between Southern Water and potential delivery partners? This relates to extent to which the option facilitates engagement and partnerships, including with landowners and NGOs.

D Carbon impact
Both embodied and operational carbon are considered qualitatively and scored as follows:

KEY: Capital carbon impact		KEY: Operational carbon impact	
1	**High:** BAU solution involving large amounts of in situ civil construction resources (concrete and steel) and/or materials with high carbon intensity. Little or no opportunity for savings	1	**Large increase:** more than 20% increase in power or chemicals use
2	**Medium:** Solution involves 'building smarter' - by employing lean design, compact footprint and/or low carbon materials/products. Opportunities for more efficient construction (e.g. offsite manufacture or no/low dig approaches)	2	**Small increase:** less than 20% increase in power or chemicals use
3	**Low:** Build less - e.g. maximise asset reuse and reduced scale of build, and/or green infrastructure (nature-based) solution adopted instead of conventional grey infrastructure	3	**No change**
4	**None:** Build nothing - construction of new infrastructure avoided (e.g. by reducing demand or wider catchment solution) - capital carbon emissions expected to be zero or near zero	4	**Decrease**

E Commercial considerations
Both capex and opex are scored between 1 - high cost and 4 - low cost

From this qualitative assessment each constrained option has an overall score out of 64 which is used to inform the decision to shortlist the option and include in the feasible options list that go forward to full quantified costs and benefits assessment. Typically the two highest scoring options proceed and a rationale is documented. In addition, where at all viable we progressed a nature-based solution to the quantitative assessment, even if it was not one of the top two scoring options.

Quantitative options appraisal of the feasible options

For each feasible option, Level 1 costing tools were used to estimate:

- capex
- opex
- embedded carbon, and
- operational carbon

The costing approach is described in document SRN15 of our October business plan.

To calculate the benefits values of natural and social capital, we used the quantification provided by the Environment Agency, as described in Section 5 of SRN38 in our business plan, “Through work we commissioned from AECOM, we developed a tool to assess natural and social capital impacts of our proposals, including WINEP. For the WINEP, the tool used EA metrics across a full range of natural capital measures which we applied to our constrained options appraisal to allow us to understand which are best-value compared to least cost solutions. The tool provided monetary valuations of benefits of the different solution options across categories of natural and social capital such as provision of water supply, renewable energy and food; regulating air or water quality; regulation of natural hazards and local climate; supporting biodiversity; recreation and amenity; and volunteering opportunities. The tool also provides levels of confidence around those metrics and valuations to support decision-making use of the tool.”

Table 4-2 lists the wider environmental benefits we take into consideration when quantifying the benefits of feasible options. Quantities of the impacts, such as hectares of habitat or length of river are used to provide quantified benefits values. Typically we found the highest valued benefits came from a change in WFD status of a river, followed by the benefits of providing improved habitats when using nature-based solutions.

Table 4-2 Wider environmental benefits quantified through our options appraisal tool

Habitat	Sub-habitat
Coastal margins	Estuary
	Intertidal mudflats
	Saltmarsh
	Other sub-habitat
Enclosed farmlands	Intensively managed grassland (for agricultural use)
	Other sub-habitat e.g. cereal cropland
Freshwaters, wetlands and floodplains	Lake
	Marshland
	Peatland in actively eroding condition
	Peatland in drained condition
	Peatland in modified condition
	Peatland in near natural condition
	Peatland in unknown condition
	River
	Ditches including dry ditches
	Other sub-habitat e.g. pond, reedbed, reservoir
Marine environment	Other sub-habitat e.g. maritime cliff, maritime slopes, etc.
Mountains moors and heaths	Hedgerows

	Other sub-habitat e.g. inland rock, inland cliff, heathland, shrub, sparsely vegetated land
Semi-natural grasslands	Undisturbed grassland e.g. neutral grassland, acid grassland, calcareous grassland
	Other sub-habitat e.g. semi-improved grassland
Urban	Greenspace
	Other sub-habitat e.g. green walls, green roofs, bare ground, built-up areas, caravans, sea wall (artificial materials), building, fence, wall
Woodland	Broadleaved woodland
	Coniferous woodland
	Mixed woodland
	Recently felled woodland

Biodiversity
Biodiversity - area-based habitat units
Biodiversity - hedgerow units
Biodiversity - river units

Other impacts	
A. Water supply	Does the option involve **water abstraction**?
	If yes, enter the **current annual volume of water abstracted** under each option in m3
	If yes, enter the **expected annual volume of water abstracted** after implementing each option in m3
B. Water quality - rivers	Does the option affect **rivers** regulated by the Water Framework Directive (WFD)?
	If yes, what is the **length of the rivers** affected in km?
	If yes, what **management catchment** are these rivers located in?
	If yes, what is the **current status** of the rivers i.e. before implementing the option?
	If yes, what is the **expected status** of the rivers after implementing the option?
C. Water quality - lakes	Does the option affect **lakes** regulated by the Water Framework Directive (WFD)?
	If yes, what is the **area of the lakes** affected in hectares?
	If yes, what is the **current status** of the rivers i.e. before implementing the option?
	If yes, what is the **expected status** of the rivers after implementing the option?
D. Water quality - estuaries	Does the option affect **estuaries** regulated by the Water Framework Directive (WFD)?
	If yes, what is the **area of the estuaries** affected in hectares?
	If yes, what **river basin district** are these estuaries located in?

	If yes, what is the **current status** of the rivers i.e. before implementing the option? Note the highest possible status here is Good, so if the waterbody status is High, it is recommended that you select Good status
	If yes, what is the **expected status** of the rivers after implementing the option?
E. Food - shellfish production	Does the option impact upon shellfish production within designated Shellfish Protected Areas, under the WFD?
	If yes, select the **most prominent species of shellfish** produced from the coastal area i.e. before implementing the option. Select from the available options
	What is the **current volume of shellfish production for this species** within the coastal area?
	What is the **expected percentage (%) change** in the volume of shellfish production after implementing the option?
	If there is more than one species present, select the **second most prominent species of shellfish produced** within the coastal area i.e. before implementing the option
	What is the **current volume of shellfish production for this species** within the coastal area?
	What is the **expected percentage (%) change** in the volume of shellfish production after implementing the option?
	If there is more than one species present, select the **third most prominent species of shellfish** produced within the coastal area i.e. before implementing the option
	What is the **current volume of shellfish production for this species** within the coastal area?
	What is the **expected percentage (%) change** in the volume of shellfish production after implementing the option?
F. Recreation	Does the option impact upon **sites that are publicly accessible for recreational use**?
	What is the current annual value of recreational benefits under each option in £, for all affected sites?
	What is the expected annual value of recreational benefits after implementing each option in £, for all affected sites?
G. Freshwater recreational angling	Does the option affect **recreational anglers at freshwaters**?
	If yes, what is the **current number of anglers** who visit these freshwater bodies per year i.e. before implementing the option
	If yes, what is the **current average size of fish** within the affected freshwater bodies i.e. before implementing the option?
	If yes, what is the **current average quantity of fish** within the affected freshwater bodies i.e. before implementing the option?
	If yes, what is the **expected number of anglers** who would visit these freshwater bodies per year after implementing the option?
	If yes, what is the **expected size of fish** within the affected freshwater bodies after implementing the option?

	If yes, what is the **expected average quantity of fish** within the affected freshwater bodies after implementing the option?
H. Nature-based volunteering	Does the option involve **opportunities for nature-based volunteering**?
	If yes, enter the **current number of annual volunteering hours** under each option in hours.
	If yes, enter the **expected number of annual volunteering hours after implementing** each option in hours.
I. Nature-based educational visits	Does the option involve **opportunities for educational visits to nature reserves by school children**?
	If yes, enter the **current number of annual visits per pupil** under each option
	If yes, enter the **expected number of annual visits per pupil** after implementing each option

Cost benefit assessment

Following quantification of both costs and benefits, these were converted into whole life costs using a 30-year NPV calculation which enabled us to compare costs and benefits on the same basis. From this we were able to derive the lowest cost and the best value solutions for submitting to the EA in the WINEP Options Appraisal Reports.

Example of Options appraisal: Charing WTW

The current process at the site is biological filtration with single stage ferric dosing and a moving bed sand filter for tertiary treatment. The site will finish AMP7 with a total P permit level of 0.5 mg/l and no total N permit level.

The AMP8 WINEP requires it to meet TAL in both N (10mg/l) and P (0.25mg/l) by 2030, driven by Habitats Directive requirements (not nutrient neutrality requirements).

The options that were taken through the qualitative assessment were:

1. Converting the existing sand filters to denitrifying sand filters (with methanol Dosing) and expansion of the existing ferric dosing to dual point dosing with the provision of alkalinity dosing and a Lamella Settler.
2. Providing MBBR with methanol dosing and expansion of the existing ferric dosing to dual point dosing (possibly with the provision of alkalinity dosing)
3. Permit trading
4. Optimisation of site
5. Pump away.

The qualitative assessment screened out options 3 and 4 as not able to meet the permit requirements or not being permitted by the Environment Agency due to our low EPA score.

Option 5 was considered through the full qualitative risk assessment process since the boundary of Ashford WTW catchment is within 2km of the site. However, on the qualitative approach it scored third highest and only the top two were assessed quantitatively. Options 1 and 2 were taken forward for full evaluation of costs and benefits as the remaining feasible options, and option 2 is the preferred option, being both best value and least cost option.

The results of the qualitative and quantitative options appraisal for Charing WTW are shown in Table 4-3.

Table 4-3 Charing WTW options appraisal results

Option number	Qualitative score (out of 64)	NPV of costs (2020/21 prices)	NPV of benefits (2020/21 prices)	Net cost benefit	Best value option	Least cost option
1	40.7	£10.52m	-£0.35m	£10.87m	No	No
2	40.7	£7.55m	-£0.56m	£8.01m	Yes	Yes
3	38.1	N/A Screened out at qualitative assessment stage				
4	1	N/A Screened out at qualitative assessment stage				
5	36.1	N/A Screened out at qualitative assessment stage				

The wider environmental benefits assessment for Charing WTW which informed the options appraisal revealed limited natural and social benefits from the solution, since it is an "end-of pipe" solution within the fence of our treatment works that we are required to install. We will deliver the required biodiversity net gain which will be a requirement for gaining planning permission. We have not taken this into consideration in the valuation since it will be required of all options. Due to being a "grey" solution there are no related social benefits such as recreation or volunteering opportunities. Although there will be benefits to river water quality, there is no anticipated change in WFD status of a stretch of river as a result of the investment, so there are no WFD-associated environmental benefits. The key benefits (disbenefits) which we could value arise from a change in habitat caused by building new assets on the site, The change is similar for both options and is set out below.

Table 4-4 Charing environmental and social benefits valuations

Option number	Habitat - agricultural	Habitat - urban	30-year net present value of habitat change
1	-1 hectare	+1 hectare	-£9k
2	-1 hectare	+1 hectare	-£9k

Results of quantified options appraisal

Figures given are where full quantification of costs and benefits were undertaken on feasible options. The values are 30-year NPV of costs minus NPV of benefits. These are level 1 costs, in 2020-21 prices and pre-efficiency assumed in our business plan. These are the figures we presented to the EA in the OAR documents supporting our WINEP proposals. Green cells show preferred option taken into the business plan.

Table 4-5 Results of options appraisal

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Ashford WTW (N and P removal)	£114,691k	Not feasible – no existing N permit and P permit needs investment	Not feasible (too large)	£96,887k	N/A		
Ashlett Creek Fawley WTW (N removal)	£26,095k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		Part of Solent catchment permitting approach
Budds Farm WTW (N removal)	N/A	Taken forward as preferred option. Stretch permit 9.3mg/l)	Not feasible (too large)	N/A	N/A	N/A	Part of Solent catchment permitting approach

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Canterbury WTW (N and P removal)	£82,060k	Not feasible – no existing N permit.	Not feasible (too large)			£63,780k	
Charing WTW (N and P removal)	£10,870k	Not feasible – no existing N permit	Screened out through qualitative assessment	£8,010k			
Chartham WTW (N and P removal)	Two options considered: A) NSAF (£14,227k) B) MBBR (£10,183k)	Not feasible – no existing N permit	Screened out through qualitative assessment		Screened out through qualitative assessment as high cost		
Chickenhall Eastleigh WTW (N removal)		Not feasible – no existing N permit	Not feasible (too large)	£18,235k	Screened out through qualitative assessment as high cost		

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Chilham WTW (N removal)	£8,170k (MBBR)	Not feasible – no existing N permit	Screened out through qualitative assessment as high cost		£6,206k		
Coldwaltham WTW (N and P removal)	£8,436k	Not feasible – no existing N permit	Screened out through qualitative assessment		Screened out through qualitative assessment		MBBR: £9,795k
East End WTW (N removal)	Screened out through qualitative assessment	Not feasible – no existing N permit	Two locations considered. £4,262k		Screened out through qualitative assessment		Wetland in catchment: £2,363k, rejected through lack of land
Flexford Lane Sway WTW (N removal)	£8,397k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Fullerton WTW (N removal)	£7,628k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		Part of Solent catchment permitting approach
Harestock WTW (N removal)	£8,056k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		Part of Solent catchment permitting approach
Kings Somborne WTW (N removal)	£8,367k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		Part of Solent catchment permitting approach
Lavant WTW (N removal)	£9,107k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Lenham WTW (N removal)	£12,013k	Not feasible – no existing N permit	Screened out through qualitative assessment		£11,406k		Part of Solent catchment permitting approach
Lyndhurst WTW (N removal)	Screened out through qualitative assessment as high cost	Not feasible – no existing N permit	Not feasible (too large)		£11,506k (existing ASP)		Part of Solent catchment permitting approach
May Street Herne Bay WTW- (N and P removal)	Screened out through qualitative assessment as high cost alongside P removal needs	Not feasible – no existing N permit	Not feasible (too large)			£27,928k	
Milford Road Pennington WTW (N removal)	N/A	Taken forward as preferred option. (Stretch permit)	Not feasible (too large)	N/A	N/A	N/A	Part of Solent catchment permitting approach

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Millbrook WTW (N removal)	N/A	Taken forward as preferred option. (Stretch permit)	Not feasible (too large)	N/A	N/A	N/A	Part of Solent catchment permitting approach
Morestead Road Winchester WTW (N and P removal)	Screened out through qualitative assessment as high cost	Not feasible – no existing N permit	Not feasible (too large)			£30,674k	Part of Solent catchment permitting approach
Overton WTW (N removal)	£9,654k	Not feasible – no existing N permit	Not feasible (too large)		Screened out through qualitative assessment as high cost		Part of Solent catchment permitting approach
Portswood WTW (N removal)	Screened out through qualitative assessment as no room on site or nearby	Not feasible – no existing N permit	Not feasible (too large)			£67,540k	Part of Solent catchment permitting approach

	(Additional biological treatment capacity and) new denitrifying tertiary filter	Optimisation of site	Pump away	Expansion of the existing tertiary filter and converting it for denitrification.	Convert to denitrifying ASP with methanol dosing	Expanding/ converting ASP to Denitrify, Chemical Dosing for P removal and New TSR	Permit trading/ other
Romsey WTW (N removal)	Screened out through qualitative assessment	Not feasible – no existing N permit	Not feasible (too large)	Screened out through qualitative assessment		£12,696k	Part of Solent catchment permitting approach
Sellindge WTW (N removal)	£13,315k	Not feasible – no existing N permit	Screened out through qualitative assessment				
Slowhill Copse Marchwood WTW (N removal)		Not feasible – no existing N permit	Not feasible (too large)				Part of Solent catchment permitting approach
Summer Lane Pagham WTW (N and P removal)	N/A	Taken forward as preferred option. (No change to permit level)	Not feasible (too large)	N/A	N/A	N/A	
Westbere WTW (N removal)	Denitrifying sand filter: £14,907k MBBR: £15,161k	Not feasible – no existing N permit	Screened out through qualitative assessment				Part of Solent catchment permitting approach

4.3 Additional evidence in response to Ofwat's deep dive of our N removal proposals: Robust and efficient costs

Many of the assets we propose to install to meet N removal requirements are similar in scope to those required for P removal or sanitary parameter tightening, such as additional biological capacity to ensure full nitrification and tertiary solids removal. In addition, a number of our sites with N removal requirements also have P removal requirements. With our revised P removal costs being demonstrably efficient according to Ofwat's draft determination enhancement modelling approach, we consider this provides some consequential evidence that our N removal costs are also efficient.

However, we carried out benchmarking to assure ourselves that our costs are efficient by comparing our costs to those of others in the sector.

The specific assets we use only for N removal and for no other driver relate to methanol dosing. Methanol is a more difficult chemical to handle and store than ferric sulphate used for P removal because it requires explosion proofing installation and protection against static build up during transfer, for example through earthing tanks and equipment.

Methanol dosing is not commonly applied at wastewater treatment works. According to Defra's data, of the 9,000 wastewater treatment works in the UK, there are 35 of them with total N permits reported against the Urban Wastewater Treatment Regulations. We operate 10 of them, 19 are operated by Anglian Water, 4 by South West Water, 1 by Wessex Water, and 1 by Severn Trent Water.[2] This indicates that we are one of few companies experienced in delivering nitrogen removal schemes.

Where nitrogen limits apply, the Urban Wastewater Regulations require treatment works sized between 10,000 and 100,000 population equivalent to meet a 15mg/l total Nitrogen standard, and sites greater than 100,000 population equivalent to meet a 10 mg/l total N standard. At least 7 of our sites have total N permit levels at or below 10mg/l meaning we have experience in meeting the newly defined TAL levels, which typically require methanol dosing.

This all illustrates why benchmarking of nitrogen removal-specific solutions is not as easy to do as for other assets due to the limited installation experience. In addition, methanol dosing is not always required to meet an Urban Wastewater 15mg/l permit level. However, we have found it necessary for reliably meeting TAL permit levels. All our AMP8 installations are to meet 10mg/l permit levels or below. Comparative benchmarking data for methanol dosing equipment is therefore particularly sparse.

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[2] See Defra's website for 2022 data: https://s3.eu-west-1.amazonaws.com/data.defra.gov.uk/Urban+Waste+Water+Treatment+Directive/Article15_13Dec2022.ods

Benchmarking approach

We explained our costing approach in the technical annex, SRN15 that we provided as part of our business plan. There we explain, "[Cost capture] is managed and maintained by a dedicated Cost Intelligence Team (CIT) formed of cost estimators and data modellers. They ensure our cost tools align with our historical experience of delivery. To challenge the efficiency of our costs we compare these cost models to benchmarks sourced by our CIT team and adjust where we deem necessary to ensure our models reflect efficient delivery." (SRN15, p.18)

"Our AMP8 plan means we will be delivering work which we have not delivered at a similar scale before. It has therefore been necessary to collect and model wider industry (non-SWS) sources of data to form our cost models; either to blend with our existing data where it may be scarce or to form new models where we do not have any data. This process is managed by our CIT, supported by engineering consultancy Mott MacDonald. Mott MacDonald have access to a wide array of data from the wider UK water sector as well as other sectors and international projects. However, wherever possible, we have prioritised use of our own data in-line with recognised good practice and relied upon external data as benchmarks to assure costs represent efficient delivery." (SRN15, page 21).

Level 1 Benchmarking

We have carried out benchmarking to assess our costs against others in the sector. Our provider developed a tool to help optioneering using cost curves to generate high level costs for the schemes. To determine an appropriate benchmark, the tool cost curves were sourced to examine their design level and inclusions and exclusions. Cost element definitions were aligned to those from comparable water companies to gain an industry standard benchmark. See below for the detail of the number of independent sources used to benchmark our costs against.

We analysed the cost curves to determine their applicability across a reasonable range of sizes and costs representing our investment programmes for P removal, N removal and growth. The high-level benchmarking is deemed a reliable representation of the programme. However, scheme-specific analysis allowed us to pin-point any schemes which required further investigation or development to L2 costing.

Table 4-6: Number of Sources in L1 Benchmark

Asset	Number of Benchmark Sources
Wet Well Pumping Station	2
Methanol Dosing	3
Alkalinity Dosing	3
Moving Bed Sand Filter	2
Moving Bed Biofilm Reactor	2
Nitrifying Submerged Aerated Filter	2
Deep Bed Filter	4
Aeration Plant	2
Activated Sludge Plant	2
Trickling Filter	2
Ferric Dosing – Front End	3
Ferric Dosing – Back End	3
Primary Settlement Tank	3
Final Settlement Tank	1
Inlet Works	3
Sludge Holding Tank	2
Storm Tank	3
Humus Tank	2

Level 2 Benchmarking
To support our response to the draft determination we commissioned level 2 benchmarking, particularly where we had produced level 2 costings which have adjusted our submitted costs from those in the February data tables. This is more granular than the Level 1 approach and uses industry curves and rates to generate a comparable cost based on the same design inputs e.g., tank sizes. The scope cost curves are typically at equipment and asset level, and align to an increased scope definition, we would expect from a level 2 design.

Benchmarking results

Benchmarking results
We provide the full level 2 benchmarking report as an appendix to this document.

Our initial level 1 benchmarking across asset types used in P and N removal showed our costs to be on average 8.1% above the benchmark. This led us to carefully review our costs and carry out more detailed scoping and bottom up costing for the most costly schemes. The level 2 results which benchmarked five of our largest sites against similar scope from up to five UK water companies show the overall variation between our estimated total net direct costs and the total benchmark equivalent was 1%, with our costs being lower than the benchmark. The coverage of the benchmarking was no less than 82% in all projects apart from the Portswood project, which has some specific and atypical characteristics due to the constrained nature of the site. This high coverage adds weight to the results and robustness of the Level 2 benchmark study. However, as set out above, few companies have experience of installing nitrogen removal processes, and of those even fewer installations have needed to install methanol dosing and its associated real time control as part of that process, so the benchmarks available for methanol dosing equipment are extremely limited.

The conclusions of the Level 2 benchmarking report state the following:

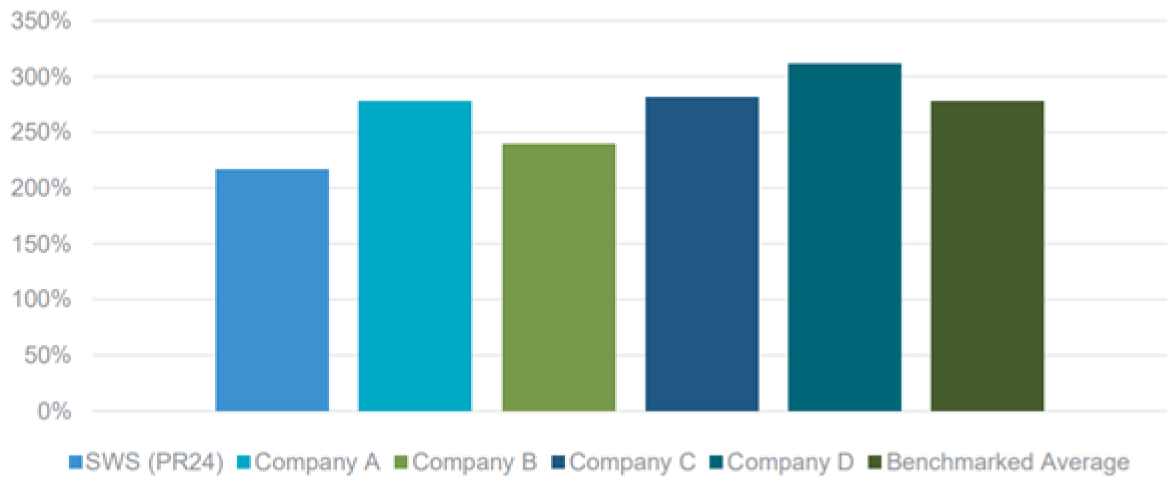
> "The primary purpose of this study is to bolster confidence in the PR24 N&P-Removal programme. To achieve this Mott MacDonald's CIT team completed a level 2 benchmarking study on the five project estimates which constitute part of the N-Removal programme. The study has achieved overall 82% coverage, and the total variance is -1%. The total variance means that SWS total benchmarked scope is 1% lower than the total benchmark cost.
>
> The projects with the greatest variances are Ashlett Creek. The former is driven by the SBR cost item, specifically SWS's estimated cost is 45.1% lower than Mott MacDonald's benchmark cost.
>
> Only one comparable source was available for the costed item 'Methanol Dosing', that highlights the difficulty to cost this item."

Responding to the benchmarking results

Ahead of the submission our business plan and in response to the level 1 benchmarking results we challenged our costs prior to submission of our business plan. In particular we challenged our overhead multipliers and checked them through further benchmarking. Again, we set this out in our costing technical annex provided with our business plan in October 2023, SRN15. In it we explain, "Benchmarking our non-infrastructure aggregate multiplier of 216% indicates that our enhancement costs are efficient because it is the lowest of the 4 comparators. The aggregate multiplier compounds non-infrastructure Indirect Costs, Risk and Corporate Overhead multipliers to provide one value that is indicative of the entire uplift that has been applied to Direct Costs within the full plan".

We are showing the comparison of the multipliers which demonstrates we have put efficient costs in our business plan using a chart extracted from our business plan document below.

Figure 26 – Non-infrastructure aggregate multipliers industry comparison



Efficient scope of N removal investment

An important point to note and as explained in more detail below, our draft determination representation assumes an efficient scope of N removal investment. Defra has designated the Solent catchment as a catchment permitting area. Our draft determination response takes into account our catchment permitting approach where we commit to operate some treatment works at stretch permits below TAL and thereby avoid investing at nine treatment works in the Solent catchment. This has reduced the costs to customers by £68.6 million. We show in Table 4-7 the impact of our catchment permitting proposal by comparing the costs of carrying out the standard upgrade duty compared with our catchment permitting proposal in the sub-catchments where we propose to apply the catchment permitting solution. (For clarity, please note this table does not list all our N removal investments or the full requirements for meeting the Nutrient Neutrality cost driver.) There are additional operating costs for increased methanol dosing at the sites where we are proposing stretch permit levels below TAL.

Table 4-7: Totex savings from Nutrient Neutrality catchment permitting proposals

Site	N permit level under standard upgrade requirements (TAL), mg/l	AMP8 totex for standard upgrade to TAL, £m	N (stretch) permit level under catchment permitting approach mg/l	AMP8 totex for catchment permitting approach, £m
Ashlett Creek Fawley WTW	10	17.0	9	17.0
Barton Stacey WTW	10	8.2	N/A	0
Bishops Waltham WTW	10	9.3	15 (current level)	0
Brockenhurst WTW	10	6.4	N/A	0
Budds Farm WTW	9.7	0	9.3	0.02
Chickenhall Eastleigh WTW	10	9.7	9	9.7
East Grimstead WTW	10	8	N/A	0
Flexford Lane Sway WTW	10	7.7	9	7.7
Fullerton WTW	10	6.7	9	6.7
Harestock WTW	10	7.0	10	7.0
Ivy Down Lane Oakley WTW	10	9.3	N/A	0
Kings Somborne WTW	10	7.6	10	7.6
Ludgersgall WTW	10	9.4	N/A	0
Lyndhurst WTW	10	9	9	9.02
Millbrook WTW	10	0	9	0.01
Morestead Road Winchester WTW	10	11.2	10	11.2
New Alresford WTW	10	4.7	N/A	0
Overton WTW	10	8.8	10	8.8
Peel Common WTW	9	0	9	0

Pennington WTW	9.5	0	9	0
Portswood WTW	10	43.5	9	43.6
Romsey WTW	10	6.1	10	6.1
Slowhill Copse Marchwood WTW	10	14.8	10	14.8
West Wellow WTW	10	5.4	N/A	0
Whitchurch WTW	10	6.8	10	6.8
Wickham WTW	10	7.9	N/A	0
Woolston WTW	10	12.1	10	12.1
TOTAL		**236.6**		**167.9**

4.4. Phosphorus removal

Changes in scope

Our February 2024 submission in response to query OFW-OBQ-SRN-205 of a set of PR24 data tables took account of all P removal requirements on the WINEP with regulatory completion dates between 01/04/2025 and 31/03/2030. The number of P removal schemes has reduced by one since this submission. Newnham Valley Preston WTW had been initially included in the draft list of Nutrient Significant Plants under the Levelling Up and Regeneration Act (LURA) within the Stour area. However, Defra in May 2024 confirmed the site's removal from the list. This means the driver to reduce P to TAL at the site by 2030 has fallen away.

The removal of Newnham Valley Preston WTW from the list of P removal investments in AMP8 reduces slightly the forecast load reduction we will achieve in AMP8 for the river water quality performance commitment level forecast. But investment is still required at this site to meet a tight new BOD permit.

Other than Newnham Valley Preston WTW our internal review found we had in error removed New Alresford WTW from the costs of our P removal programme (along with the N removal investment not required in our nutrient neutrality catchment permitting approach). We have therefore added the costs of this scheme into the data for CWW3. In our February 2024 unassured submission, we included the New Alresford P removal requirements in table CWW19 but in error removed the related costs from table CWW3.

There are no other changes to the P removal requirements. However, there have been changes to the solutions we propose at some sites. This is because of revised iron permits which have been agreed through discussions with the EA which concluded in May 2024.

In the October 2023 business plan, we assumed precautionary iron permit levels which were produced through SAGIS water quality modelling. On 30 January 2024, the EA provided to us its internal guidance for setting iron permits when iron compounds are used to remove P. This takes a less precautionary approach than the SAGIS modelling methods we used. The EA also confirmed that where there are sites with existing P and iron permits, the iron permit level will remain unchanged even if the P permit level is being tightened.

We followed the EA's updated guidance to calculate revised iron permits for all the AMP8 sites with first time P removal and reviewed the impact of the revised iron permits on the choice of P removal solution. Our approach and the results were accepted by the EA in May 2024.

The 12 sites where we have made changes to the solutions as a result of more relaxed iron permit levels are shown in Table 4-8 below. The twelfth site in the table below is Westbere WTW which has a tighter iron permit than we had a previously assumed due to its location within a protected area. The costs of P removal at this site have therefore increased as a result of having to change the site from a filter works to an activated sludge plant to meet a 1mg/l iron permit.

Table 4-8 sites and solutions which have changed as a result of revised iron permit levels

Site	February 2024 data table – solution	Revised preferred solution following iron permit changes
Coxheath WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Forest Row WTW	Chemical dosing for P removal and tertiary solids removal	Chemical dosing for P removal, tertiary solids removal – reduced specification of tertiary solids removal process
Leeds WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Lydd WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Nutley WTW	Chemical dosing for P removal and tertiary solids removal	Chemical dosing for P removal, tertiary solids removal – reduced specification of tertiary solids removal process
Paddock Wood WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Pembury WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Redgate Mill Crowborough WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
St Johns Crowborough WTW	Chemical dosing for P removal and tertiary solids removal	Chemical dosing for P removal, tertiary solids removal – reduced specification of tertiary solids removal process
Staplecross WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Stubbs Lane Brede WTW	Convert site to ASP and use Biological P removal	Chemical dosing and tertiary solids removal
Westbere WTW	Chemical dosing and tertiary solids removal	Convert site to ASP and use Biological P removal

Revised cost proposal

The total change in costs of the P removal solutions at sites that are allocated to P removal cost categories is a reduction of £104.6 million.

The reduction arises due to:

- The change in iron permits at 13 sites (see table below),
- The removal of the need for P removal investment at Newnham Valley Preston through Defra's confirmation it is outside the nutrient neutrality area, and
- Refined costs from more detailed level 2 costing of our largest sites.

Table 4-9: P removal cost implications of the change in iron permits since the February 2024 data table submission

Site	February 2024 data table – solution totex allocated to P removal in CWW3, £m	DD representation solution totex allocated to P removal in CWW3, £m
Coxheath WTW	11.170	3.252
Forest Row WTW	9.892	4.069
Leeds WTW	8.938	2.984
Lydd WTW	8.140	3.581
Nutley WTW	4.531	3.051
Paddock Wood WTW	9.652	7.458
Pembury WTW	11.811	2.608
Redgate Mill Crowborough WTW	27.430	8.305
St Johns Crowborough WTW	9.933	4.720
Staplecross WTW	9.253	3.125
Stubbs Lane Brede WTW	11.172	5.895
Wallcrouch WTW	2.662	1.331
Westbere WTW	7.342	13.289
Sub-total of changed P removal costs	**131.926**	**63.668**

The net change in P removal costs since the February data table submission from the reduction in scope brought about by the relaxation of most iron permits is a reduction of £68.3m.

We expand on the changes relating to Newnham Valley Preston WTW in section 0 below and the changes relating to Wallcrouch in section 4.4.2.

Revised cost drivers

These changes in P removal solution type also impact the split of proposed expenditure between biological and chemical dosing categorisations from those in our business plan and February data tables. We have reflected the relevant changes such as population equivalent in data table CWW20 and made alterations to CWW19 to show the P removal costs and drivers by site.

Benchmarks/ Cost modelling

Ofwat has set an allowance for P removal at the Draft Determination using a modelling approach which provided an allowance against our requested costs (pre-frontier shift and RPE) as shown in the table below.

Table 4-10 Ofwat's Draft Determination assessment of P removal costs

	Amount Assessed (£m)	Enhancement Allowance (£m)	Cost Gap (£m)
P Removal	450.20	380.04	-70.16

Prior to Ofwat publishing its approach to setting allowances for P removal in the draft determination we carried out top-down benchmarking assessment of our revised P removal costs, with key data changes to our February submission outlined in Table 4-9 above. We benchmarked our revised proposed costs with those submitted in February 2024 data tables provided by each of the other wastewater companies, prior to the publication of the draft determinations.

We reviewed and tested all of Ofwat's PR19 models, the CMA's models at PR19 and looked at alternatives using the available data, but could find few statistically robust alternative approaches. In our assessment of suitable econometric models we considered all the models and drivers using both company level and site level information. We attempted to derive different models for sites with biological removal and chemical removal options. At the company level the only model we found to be statistically robust was a logarithmic form model regressing AMP8 totex against population equivalent served by sites with tightened phosphorus permit limits. At the site level, the robust model was a logarithmic one regressing unit cost (£/population equivalent) against population equivalent served at the site.

The key findings of this benchmarking show:

- Our requested costs for phosphorus removal programme reduced by £83m when compared to our February 2024 submissions (including the impact of costing to a greater level of confidence at many of the larger schemes).
- Southern Water's efficient modelled allowance is 5% more than its requested cost. This assessment assumes a 10% efficiency is applied to the median allowance provided from the econometric models. This modelling outcome is a marked improvement on the -15% gap obtained when we compared all the February submissions, and illustrates in particular the impact on costs of the tight iron permits we understood to be required using the guidance available to us at the time.
- Our efficiency position increases, with an efficiency score of 0.95 and our ranking in the sector goes up from 8th position using the February 2024 data to 4th position out of 11 using our revised costs

Table 4-11: Summary of benchmarking analysis

	Feb 2024 query response	DD representation
Requested totex	£457m	£363m
Modelled allowance	£388m	£380m
Gap	-£69m (-15%)	+£17m (+4%)
Rank	8	4

An example of the model fit at the company level which demonstrates our efficiency is provided in **Error! Not a valid bookmark self-reference.**.

Figure 4-1: Company level P removal model

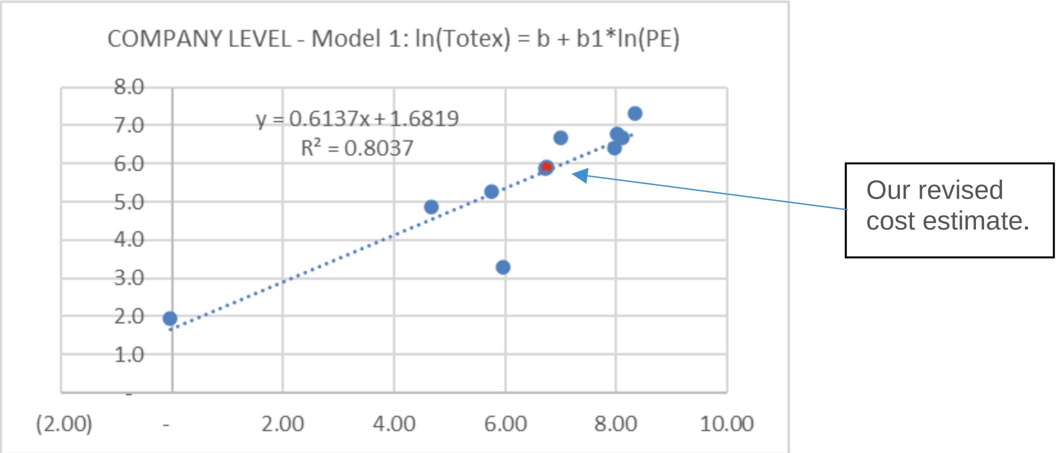
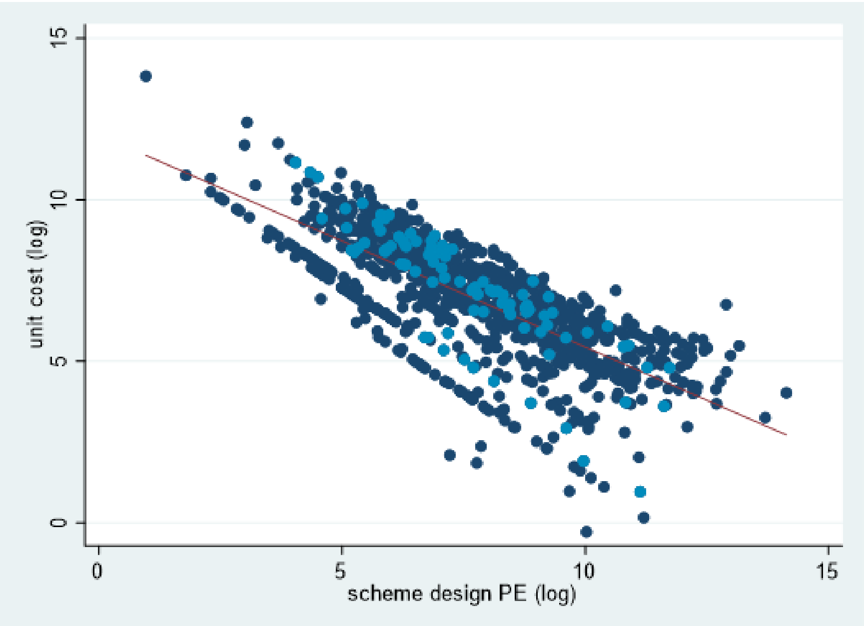


Figure 4-2 shows in light blue each of the individual schemes in the SW programme alongside the rest of the industry's scheme-specific data in dark blue, which again illustrates that although there are ranges of unit costs in our programme, our costs are similar to those of other companies, and efficient at the aggregate level.

Figure 4-2: Scheme level P removal model



In our October 2023 business plan we discussed the impact of iron permits on the costs of our P removal solutions. Table 4-9 illustrates the point by site and in aggregate. The relaxation of most of the iron permits has reduced our proposed P removal costs by £77m. This demonstrates that the points we were making in our October enhancement business case were valid reasons accounting for differences between companies' costs in Ofwat's modelling approach. However, following the change in approach to setting iron permit levels, the need to control P removal costs for tight iron permits has potentially fallen away.

We have one site, Westbere WTW, where we recommend Ofwat makes an off-model adjustment to account for the additional costs of meeting a 1mg/l iron permit. Westbere WTW may appear as an outlier in costs wholly due to the tightness of the iron permit driving the solution being a change from a filter works to an activated sludge plant. Our recommendation is that Ofwat uses a modelled approach to estimate the costs of efficient P removal and then uplifts the costs by our calculation of the difference in costs between the solution to meet the same phosphorus permit limit with a 4mg/l iron permit (£7.3m) and the solution to meet a 1mg/l iron permit (£13.3m). This is the only remaining site on the WINEP where the reason for potentially atypical costs is due to the tightness of the iron permit.

There is one other site, Wallcrouch WTW, where we have reduced the costs allocated to P removal. There is a new driver for the site moving to a numerical permit from a descriptive permit. The solution we had costed and previously fully allocated to P removal in CWW19 will also provide the improvements needed to improve sanitary parameter performance. We are therefore splitting the costs between phosphorus and sanitary parameters as shown in the scheme listed costs in CWW19 and ADD17. However, there is no change in CWW3 because the costs are allocated to the line with combined nutrient and sanitary parameter improvements made through nature-based solutions.

Impact of revised P removal costs on Ofwat's shallow dive efficiency challenge

Our revised costs are demonstrably efficient in the cost modelling approach Ofwat has adopted in the draft determination. The draft determination considered the scope of investment in the draft WINEP version of the data tables we submitted in February 2024. The gap between our costs in the February submission and Ofwat's modelled allowance are around £70m. We have removed £4.7m scope at Newnham Valley Preston, and in total our costs for P removal are £83m lower in our representation than in February. We consider this shows that our revised costs are demonstrably efficient, in line with Ofwat's modelling approach.

Our evidence of cost-efficient P removal proposals means that Ofwat should not apply a shallow dive efficiency challenge to our wastewater costs because in the areas Ofwat considers when calculating the shallow dive efficiency challenge we are demonstrably efficient. We anticipate this will add £7m to our wastewater cost allowance.

4.5 Subsequent impact on other costs and cost drivers

Descriptive permits

During the discussions with the EA on iron permits for P removal, it was noted that some sites with AMP8 P removal requirements currently have descriptive permits. As a result of the P numerical permit, the EA asked us to include Urban Wastewater improvement drivers (U_IMP1) on the WINEP at these sites to allow for a dry weather flow (DWF) permit to be set as well as BOD, Suspended Solids and potentially Ammonia numerical permits.

The sites affected by the new U_IMP1 requirements added to the WINEP are:

- Itchingfield WTW,
- Lurgashall WTW
- Shipley WTW,
- Slaugham WTW.
- Wallcrouch WTW,
- Westwell WTW, and
- Wilmington WTW

We will assess the permit levels needed at the sites during AMP8 so that all numerical parameters can be incorporated into the sites' permits by 31/03/2030 when the P removal requirement comes into force.

The typical numerical permit levels that are set when moving from descriptive to numerical permits are 40mg/l BOD and 60mg/l Suspended Solids on a 95%ile basis. We have reviewed performance on a calendar year basis for the last 5 years, against a 40 mg/l BOD and 60 mg/l Suspended Solids permit limit to mimic how treatment works compliance would be assessed. Our findings and consideration of whether investment is needed to secure sanitary parameter performance are shown in Table 4-12 below.

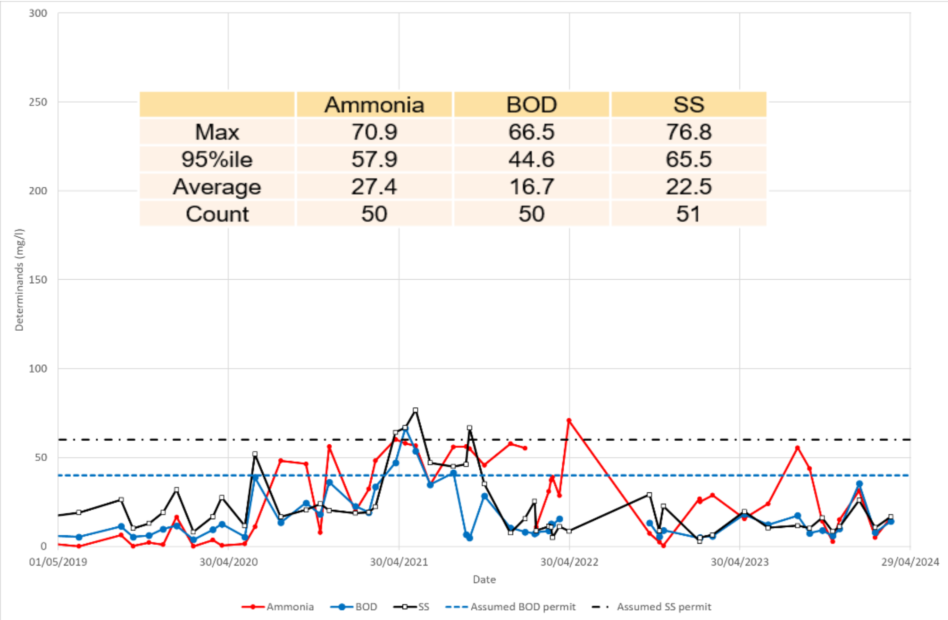
Table 4-12: Assessment of compliance risk

Site name	Years of potential works non-compliance with 40 mg/l BOD and 60mg/l SS, 2019-2024	P removal solution	Need for investment to secure sanitary parameter performance	Notes
Itchingfield WTW	2019 (atypical spike)	Chemical dosing and wetland	No	Wetland will bolster sanitary performance
Lurgashall WTW	2021	Chemical dosing	Yes	
Shipley WTW	2021, 2023	Chemical dosing	Yes	
Slaugham WTW	none	Chemical dosing	No	Site performs consistently well.
Wallcrouch WTW	2019	Chemical dosing and wetland	No	Investment will allow site to meet both P removal and new sanitary parameters.
Westwell WTW	2019 2020	Pump away	No	Pump away solution mitigates sanitary compliance risk
Wilmington WTW	None (one sample failure on BOD)	ASP and FST expansion and chemical dosing	No	P removal solution will mitigate sanitary compliance risk.

We show the below the performance of the two sites where we propose investing to secure sanitary parameter performance. The figures demonstrate that on a long term 95% percentile basis, performance is above the 40mg/l BOD and 60mg/l Suspended Solids levels. Since we have certainty over the need to invest at these sites to improve secondary treatment, we have included investment proposals for a new secondary treatment package plant (SAFF) for the two sites particularly impacted, even though we do not have confirmed sanitary parameter permit limits for any of the seven sites.

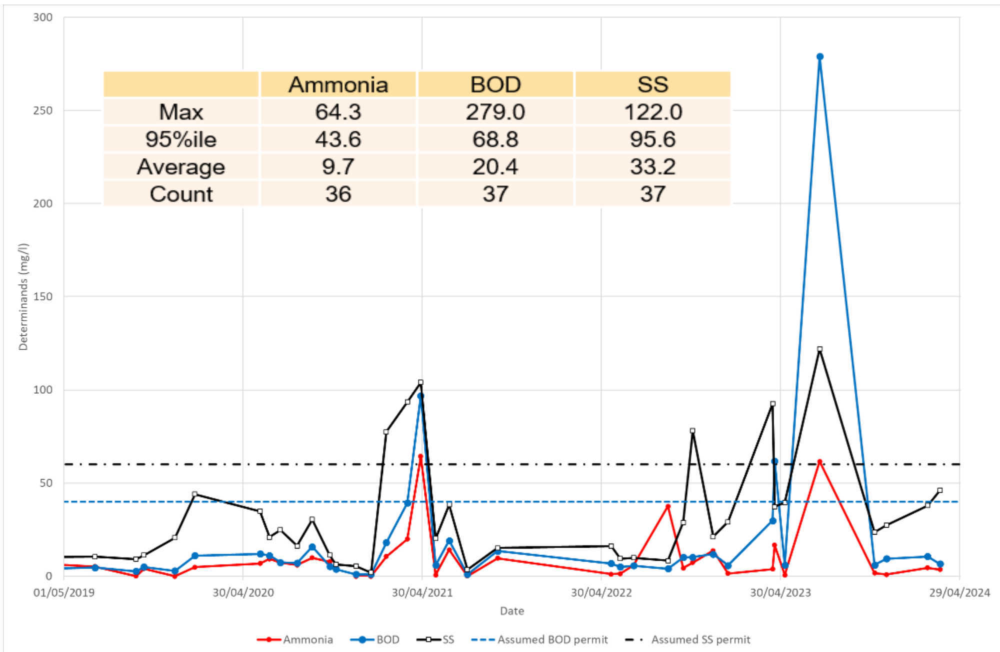
As mentioned above, at Wallcrouch the solution for P removal is relatively costly, in that it includes the provision of a new final settlement tank. In the light of the risk to sanitary parameter compliance, we are now splitting the costs of the solution evenly between P removal cost categories and sanitary parameter improvements in the disaggregated, scheme level data tables.

Figure 4-3: Lurgashall WTW Final effluent samples 2019-2024 and calculated 95 percentile performance



	Ammonia	BOD	SS
Max	70.9	66.5	76.8
95%ile	57.9	44.6	65.5
Average	27.4	16.7	22.5
Count	50	50	51

Figure 4-4: Shipley WTW Final effluent samples 2019-2024 and calculated 95 percentile performance



	Ammonia	BOD	SS
Max	64.3	279.0	122.0
95%ile	43.6	68.8	95.6
Average	9.7	20.4	33.2
Count	36	37	37

Flow and Event Duration Monitoring

For any of the sites with new numerical permits which have DWF permitted flows greater than 50 m^3/d the EA requires us to consider fitting an EDM and an MCERT flow monitor to measure incoming flows to demonstrate FFT permit compliance, all as part of the U_IMP1 driver.

We have assessed the locations and network configurations at the seven sites listed above, and only one of them, Lurgashall WTW, has a storm overflow at the inlet to the site. The current permitted Dry Weather Flow at Lurgashall WTW is 41 m^3/d, which is below the 50 m^3/d threshold for requiring EDM and flow monitoring. However, we will be reassessing the DWF permit as part of the conversion of the site from descriptive quality to numerical quality parameters, and any measured and forecast growth in the catchment since the DWF permit was set is likely to lead to an increased permitted DWF. We have therefore added the site to the WINEP for EDM and flow monitor installation in anticipation that the site's DWF will be at or over 50m^3/d by the end of AMP8.

Revised cost drivers

We have added the seven sites to the list of WINEP actions with new sanitary parameters in the new representation data table ADD17 Wastewater network+ - WINEP / NEP Sanitary parameters scheme costs and cost drivers. We have also reflected the overall changes in the representation data table CWW20.

Impact on costs for sanitary parameter improvements

Newnham Valley Preston WTW

In May 2024 Defra confirmed that Newnham Valley Preston WTW is no longer designated a nutrient significant plant. The investments to meet TAL in both P and N are therefore no longer required. However, the site remains on the WINEP with a WFD_IMP driver to meet a BOD of 5mg/l. In order to meet such a tight permit level the lowest cost solution is to convert the site from a filter works to an activated sludge process. The costs of the conversion were previously included in our AMP8 business plan costs, but were allocated between sanitary parameters and nutrient removal, since the activated sludge process would support meeting all the requirements. However, now the nutrient removal requirements have fallen away, the remaining costs of converting the site to an activated sludge plant (ASP) fall entirely within the WINEP – treatment for sanitary parameter cost lines. This has changed the costs of the sanitary parameter solution at the site.

We also carried out level 2 costing for the ASP solution at Newnham Valley Preston WTW to gain further confidence in the solution costs, as described in section **Error! Reference source not found.** below.

Other sites

There are similar but less material cost allocation changes that impact one other site, Paddock Wood WTW, where the iron permit has changed the P removal solution but additional investment requirements to meet new sanitary parameter permits remain.

The changes to sanitary parameters costs are summarised in Table 4-13.

Table 4-13: Sites with changed sanitary parameter costs

Site	February data table – solution totex allocated to treatment for sanitary parameters (grey and nature based solutions) in CWW3, £m	DD representation solution totex allocated to treatment for sanitary parameters (grey and nature based solutions) in CWW3, £m
Lurgashall WTW	0	1.740
Newnham Valley Preston WTW	16.364	14.621
Paddock Wood WTW	10.570	6.932
Shipley WTW	0	1.330
Wallcrouch	0	1.331
Sub-total of changed sanitary parameter costs	**26.934**	**25.954**

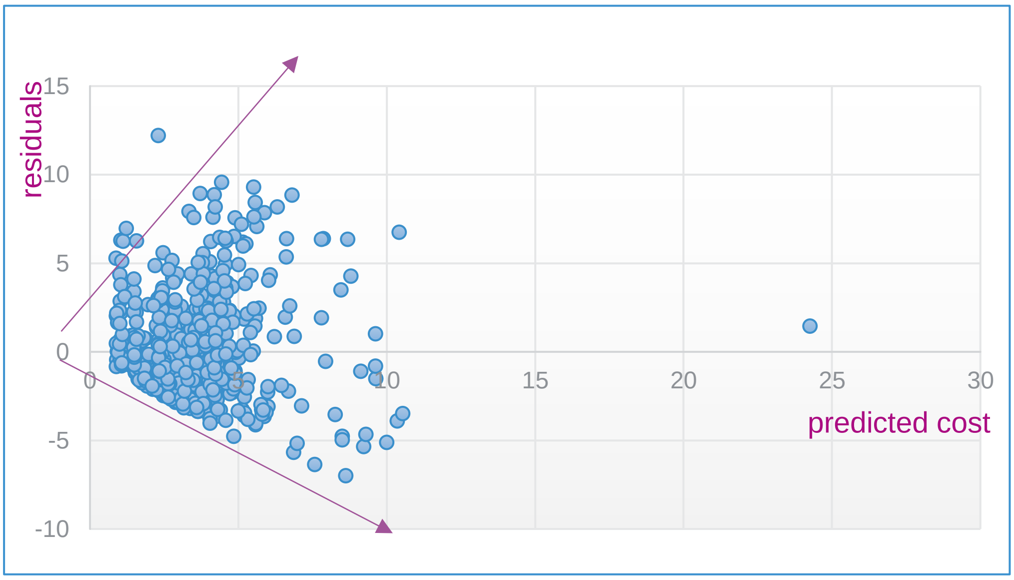
4.6 Assessment of Ofwat's approach to setting cost allowances for P removal

We have reviewed the approach Ofwat has taken to setting allowances for P removal in the draft determination. We are concerned over the robustness of the models it has used which it is using to make material adjustments to companies' proposed costs. In particular, we do not support the use of the models based on APR data to set cost allowances.

Ofwat has used four equally weighted models to determine its view of efficiency costs for P removal in AMP8. These include two models based on companies' business plan forecast costs, and two based on a mixture of outturn and forecast data within the Annual Performance Report (APR). According to Ofwat's own analysis, the models based on historical PR19 APR data explain only 32% of the historical phosphorus removal costs. It is implausible that companies' inefficiency accounts for the remaining 68% variation in phosphorus costs. In addition, there is a much weaker correlation between P removal costs and PE served in the APR data than in forecast data. A correlation of 0.48, as is the case with Ofwat's model PR3 is relatively low for a scale driver, and notably different to that of PR1 where the correlation is 0.77. Unsurprisingly, the p-values for the Ramsey RESET Test for model PR3 is 0. This is a clear indication that the model is mis-specified and not suitable to explain the P removal costs incurred by companies in PR19. We do not support its inclusion in the PR24 suite.

An assumption of Ordinary Least Squares (OLS) estimators is that the errors are homoscedastic, that is, the errors have a constant variance and do not change for each observation. This assumption plays an important role in the reliance on, and validity of, the statistical inference. An easy way to confirm this assumption is to create a simple plot of the residuals of the historic model (in this case model PR3) against the estimated P removal costs obtained from that model. We show this in Figure 4-5. The plot reveals a cone-shaped pattern in the residuals, indicating an increase in the vertical range of the predicted P removal costs as the residuals increase. In the presence of non-constant variance of the residuals, the OLS estimators are no longer efficient and the predicted values of P removal costs based on this model are not reliable.

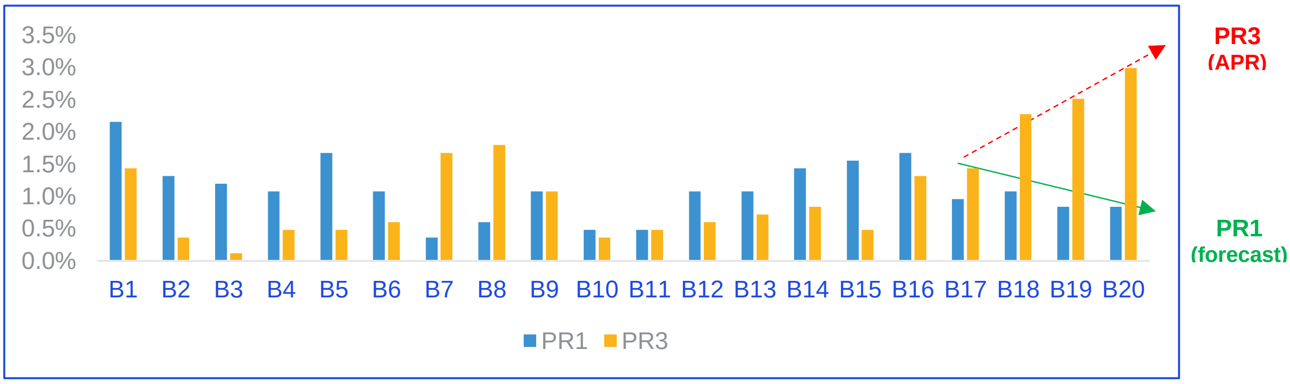
Figure 4-5 Residual plot – predicted costs versus residuals, model PR3



The impact of this homoscedasticity violation is particularly evident in larger sites where increasingly large differences in the residuals are identified between the models based on forecast data (PR1) and those based on APR data (PR3). We have assessed residuals for all schemes greater than 10,000 population equivalent. These make up 22% of the number of sites in Ofwat's model but 84% of the costs.

We have split the data from PR1 and PR3 models into twenty equal cohorts, each based on the size of the residual gap (difference between company costs and model estimates). Our analysis indicates that when model PR3 is used, the company forecast costs are much higher than the PR24 estimates from the model. This was not the case for PR1, the model based on forecast costs, which is a better representation of the data. The forecast cost model (PR1) appears to be more stable with an even spread of residual gaps . That is, the estimated PR24 costs from this model are equally likely to be higher and lower than company forecast costs. We illustrate this in Figure 4-6, where B1-B20 are the different residual gap cohorts. B1 represents the top 5% of the sample, with the largest negative gap (company forecast costs are much smaller than PR24 estimates) while B12 represents the bottom 5% of the sample with the largest positive gap (company forecasts are much higher than the PR24 model estimates).

Figure 4-6 - Residual differences between Ofwat's P removal models PR1 and PR3



We conclude that the models PR3 and PR4 which are based on APR data, are biased and incapable of explaining companies' proposed P removal costs in AMP8. They should not be included in the suite of benchmarking models at Final Determination.

4.7 Shellfish Waters - preventing deterioration

The WINEP requires both investigation and action to prevent deterioration of shellfish waters in Portsmouth Harbour, with the actions to be completed by 2027. We concluded the first phase of the investigation to assess impact of SW assets and activities on the shellfish water microbiological quality in July 2024. Our draft assessment found that there is one wastewater treatment works where a reduction in the microbiological load in the continuous discharge from the site is needed, which is Southwick WTW. We have not made a full assessment of the solution but it is likely to be either a wetland or UV disinfection. We have added the action to the WINEP and costed a solution assuming UV disinfection. We will confirm the scope of investment needed, whether wetland or UV disinfection, through detailed design.

All other actions for preventing deterioration of the Portsmouth Harbour shellfish waters relate to storm overflows and are described in the storm overflows representation document.

5. Protection for customers – WINEP PCD

Ofwat proposes specific PCDs for our WINEP treatment works improvements programme. We are requesting that Ofwat reconsiders its approach to customer protection and uses instead our wastewater WINEP PCD, which we set out below. The principles we applied to our PCD proposals are set out in SRN-DDR-052 Price Control Deliverables.

The details of the PCD are subject to our AMP8 WINEP being finalised.

Table 5-1 Wastewater WINEP PCD

Component	Output based on WINEP action completion
Description	Completion of AMP8 WINEP actions as submitted in our business plan (including Delivery Mechanism and DPC), and are within the scope of the WINEP drivers listed in Table 5-2 below. We will return funding to customers on a unit cost basis for non-delivery of AMP8 WINEP actions within the scope of the drivers listed in Table 5-2 below that are not completed by 31st March 2030.
Output - WINEP actions	Output: The total number of actions in scope of PCD is 1,419
Total Cost	£2,187 million
Unit cost	£1.541 million per action (total cost / number of actions)
Penalty rate	£1.541 million per action not completed (no cost sharing assumed)
Materiality of future scope alterations	£21.872 million

Component	Output based on WINEP action completion
Output delivery date with current scope	31 March 2030
Gated dates	Assurance of the WINEP actions being forecast for completion by 31 March 2030 will be provided by 31st of March 2028 to support draft reconciliation for performance during PR29.
Conditions on allowance	Should we receive confirmation from a regulator of a necessary change to the timing or scope of a scheme, or in fact the change of scheme to address the core issue, which either changes the benefit delivered or the solution being more expensive, the implication of this change would be reflected in the PCD. Where this change leads to a material variance greater than 1% of the original enhancement investment, then the PCD would symmetrically account for this change in a reconciliation at the end of the AMP.
Assessment of PCD	In the event of not delivering an output by the end of AMP8 (i.e., by 31 March 2030), but the need for the action still being required, this PCD remains in place until the end of AMP9 (i.e., 31 March 2035). Ofwat will assess the completion of the full scope of this PCD by 31 March 2035 as part of the PR34 process.
Late penalty	Not required as being late would mean non-compliance with WINEP statutory requirements.
Measurement	Progress and performance will be reported in our annual performance report (APR) We will report progress on number of in scope WINEP actions completed by 31 March each year.
ODIs to be netted off in the event of non-delivery	Storm Overflows Discharge Permit Compliance (part) Operational Greenhouse gases (part)
Assurance	Third party APR assurer will assure that the output and conditions have been met.

Table 5-2 Drivers and number of wastewater WINEP actions and business plan costs within scope of the PCD as reported in table ADD15

WINEP driver	Number of actions	AMP8 totex, £m 2022/23 prices
U_IMP1	8	6.309
U_IMP2	2	0.1
U_IMP3	0	0
25YEP_IMP	0	0
25YEP_INV	1	0.41
WFD_INV_WRHMWB	0	0
WFD_NDINV_WRHMWB	0	0
WFD_ND_WRHMWB	0	0

WINEP driver	Number of actions	AMP8 totex, £m 2022/23 prices
WFD_IMP_WRHMWB	0	0
BW_IMP1	0	0
BW_IMP2	3	0
BW_IMP3	0	0
BW_IMP4	0	0
BW_INV1	0	0
BW_INV2	4	0.519
BW_INV3	0	0
BW_INV5	0	0.318
BW_ND	4	120.478
BW_NDINV	7	0.61
NERC_INV	0	0
NERC_IMP	0	0
WFD_NDLS_CHEM1	11	0.006
WFD_NDLS_CHEM2	23	3.827
WFD_ND_CHEM3	6	11.213
WFD_ND_CHEM4	5	0
WFD_IMP_CHEM	8	3.92
WFD_INV_CHEM	24	2.442
EnvAct_INV1	2	0.15
EnvAct_MON1	0	0
EnvAct_INV2	0	0
EnvAct_MON2	0	0
EnvAct_INV3	0	0
EnvAct_MON3	0	0
EnvAct_MON4	1	43
EnvAct_MON5	1	0
DrWPA_INV	0	0
DrWPA_ND	0	0
DrWPA_IMP	0	0
EE_INV	1	0.034
EE_IMP	1	1.836
U_MON6	3	39.707
HD_IMP	11	119.309
HD_ND	0	0
HD_INV	14	3.716
HD_IMP_NN	37	223.355
WFDGW_INV	7	2.138
WFDGW_NDINV	0	0

WINEP driver	Number of actions	AMP8 totex, £m 2022/23 prices
WFDGW_ND	0	0
WFDGW_IMP	0	0
U_IMP5	0	0
U_IMP6	0	0
INNS_INV	0	0
INNS_ND	0	0
INNS_IMP	0	0
INNS_MON	0	0
MCZ_ND	0	0
MCZ_IMP	0	0
MCZ_INV	14	2.618
WFD_INV_MP	3	0.589
U_MON3	260	8.323
U_MON4	255	66.508
EPR_MON1	0	0
WFD_INV_N-Tal	4	3.052
WFD_INV	37	8.804
WFD_IMP	59	227.869
EnvAct_IMP1	5	24.585
WFD_ND	29	73.844
SAFFA_IMP	0	0
SAFFA_INV	0	0
U_IMP7	0	0
SUiAR_IMP	2	51.069
SUiAR_ND	0	0
SW_IMP	6	63.529
SW_ND	56	419.421
SW_INV	3	0.362
SSSI_IMP	18	58.708
SSSI_ND	0	0
SSSI_INV	32	9.611
EnvAct_INV4	210	14.679
EnvAct_IMP2	212	417.122
EnvAct_IMP3	20	83.267
EnvAct_IMP4	6	67.257
EnvAct_IMP5	2	2.086
WFD_INV_MOD	0	0
WFD_IMP_MOD	2	0.548
Totals	**1,419**	**2,187.248**

6. Delivery mechanism proposals

We outline our delivery mechanism proposals in a separate document, SRN-DDR-028 Delivery Mechanisms. We provide below the detail of the WINEP treatment works proposals that form part of these delivery mechanisms.

We provide in data table ADD25 the following elements of the delivery mechanism that relate to WINEP treatment works improvements, with the relevant extract shown in Table 6-1.

Table 6-1 Delivery mechanism proposals relating to WINEP treatment works improvements

CWW3 table row	CWW3 description	Year scheme triggered	unit	DP	2025-26	2026-27	2027-28	2028-29	2029-30	**2025-30**
CWW3.66	Treatment for phosphorus removal (chemical)	2026	£m	3	0.000	14.294	28.242	36.313	10.737	**89.586**
CWW3.69	Treatment for phosphorus removal (biological)	2026	£m	3	0.000	4.514	7.899	7.899	2.573	**22.884**
CWW3.57	Treatment for total nitrogen removal (chemical)	2024	£m	3	8.530	32.461	50.108	52.179	18.667	**161.946**
CWW3.51	Treatment for chemical removal	2026	£m	3	0.000	2.236	3.912	3.912	1.151	**11.212**
CWW3.75	Treatment for tightening of sanitary parameters	2026	£m	3	0.000	6.438	11.267	11.267	3.617	**32.589**

The costs within the scope of the delivery mechanism relating to treatment works improvements relate to investment at 21 treatment works which are outlined in Table 6-2. These have been selected because they are the more complex and costly schemes to deliver, and/or there are multiple drivers of investment.

Table 6-2 Treatment works investment in scope of Delivery Mechanism

	Driver	Description	Totex for scheme in AMP8, £m
Ashford WTW	HD_IMP_NN	P and N removal	30.3
Ashlett Creek Fawley WTW	HD_IMP_NN	N removal	17.0
Bidborouth WTW	WFD_IMP	P removal	4.5
Canterbury WTW	HD_IMP	P and N removal	19.2
Chickenhall Eastleigh WTW	HD_IMP/ HD_IMP_NN	P removal N removal	13.7
Dambridge Wingham WTW	WFD_ND_CHEM3	Chemicals removal	11.2
Felbridge	WFD_IMP	Sanitary parameter	11.0
Fullerton WTW	SSSI_IMP/ HD_IMP_NN	P removal N removal	6.9
Luxfords Lane East Grinstead WTW	WFD_IMP	P removal	11.3
May Street Herne Bay WTW	HD_IMP_NN	P and N removal	21.0
Morestead Road Winchester WTW	HD_IMP_NN	P and N removal	22.5

Newnham Valley Preston WTW	WFD_IMP	Sanitary parameter	14.6
Paddock Wood WTW	WFD_ND WFD_IMP	Sanitary parameter P removal	14.4
Pembury WTW	WFD_IMP	P removal	2.6
Portswood WTW	HD_IMP_NN	N removal	43.5
Slowhill Copse Marchwood WTW	HD_IMP_NN	N removal	14.8
Tonbridge WTW	WFD_IMP	P removal	13.0
Tunbridge Wells North WTW	WFD_IMP	P removal	15.2
Westbere WTW	HD_IMP	P and N removal	16.6
Westfield WTW	WFD_IMP	P removal	2.9
Woolston WTW	HD_IMP_NN	N removal	12.1
TOTAL			**318.2**

All schemes apart from Portswood are due to commence detailed design and construction from 2026-27 onwards, so we anticipate a trigger decision for them in 2025-26, based on satisfactory progress with detailed design of the remainder of the wastewater treatment works improvements. For Portswood, we are assuming the spend up until 2026-27 will be allowed for in the final determination and a trigger decision used to release the remainder in 2025-26.

7. Conclusions

- We provide evidence that confirms our business plan scope and costs for nutrient removal were demonstrably efficient.
- We have signposted the additional documents we provided with our business plan in October where we explain our options appraisal and costing approaches for WINEP schemes.
- We have presented specific detailed evidence of the options appraisal and cost efficiency for our N removal programme which Ofwat assessed through a deep dive. The evidence for our approach to options appraisal and costing demonstrates efficient scope and costs for our N removal programme.
- On the basis of the evidence we request Ofwat makes the allowance of the costs in full for N removal programme that we have proposed.
- Our industry benchmarking evidence demonstrates our P removal costs are efficient and that what Ofwat in the draft determination assumed to be inefficiency was due to a factor not explained within the P removal benchmarking approach – that of tight iron permits.
- We have provided explanation of the changes to scope and costs of the WINEP investment required to enhance wastewater treatment since the February 2024 data tables were submitted.
- Our demonstrably efficient P removal costs reduces shallow dive efficiency challenge to our proposed costs elsewhere in our business plan.
- We recommend that, rather than controlling for iron permit within the models, Ofwat makes off-model adjustments to outlier sites with tight iron permit levels, such as Westbere WTW.
- Our on-going refinement of costs by costing to a more detailed level (L2) has confirmed our higher-level costing (L1) is sufficiently accurate and efficient for business planning purposes, but also found our costs to be efficient.
- We are concerned that Ofwat is using a modelling approach that is not sufficiently robust for setting material allowances for P removal investment.

8. Business Plan Dependencies

Chapters	
Business cases	
Technical annexes	SRN15, SRN38
Enhancement cases	SRN39. Addendum to SRN39 submitted with February 2024 data tables as part of query 205 response
Cost adjustment claims	
Ofwat test areas	
Assurance	We have had additional assurance carried out on changes to N and P scheme scope.
Other – please specify	

Data Tables impacted by the representation:

Table/s Impacted	Data Lines Impacted
CWW3	CWW3.55 to CWW3.57 CWW3.64 to CWW3.75 CWW3.153-CWW3.155
CWW19	Multiple lines
CWW20	CWW20.19-CWW20.22 CWW20.28-CWW20.30
ADD15 – PR24 Water Industry National Environment Programme (WINEP) – England, Costs and number of actions	All
ADD17 – Wastewater network+ - WINEP / NEP Sanitary parameters scheme costs and cost drivers	All

All documents and tables referenced above can be found on our website here: [Business Plan 2025-30 - Southern Water]

9. Appendices

9.1 Level 2 cost benchmarking report

MOTT MACDONALD

PR24 N&P-Removal Programme
Level 2 Benchmarking

Project:	N&P-Removal programme		
Our reference:	V3	**Your reference:**	NA
Prepared by:	[redacted]	**Date:**	01/08/2024
Approved by:	[redacted]	**Checked by:**	[redacted]
Subject:	Level 2 Benchmarking		

Executive Summary

Southern Water (SWS) commissioned Mott MacDonald to undertake a level 2 benchmarking exercise for the PR24 N&P- Removal Programme. Mott MacDonald was tasked to benchmark five of them.

Mott MacDonald achieved 82% benchmark coverage by the total cost of the five estimates. This provides a good level of confidence in the results.

Finally, the total variance was -1% indicating that SWS total benchmarked scope is 1% lower than the total benchmark cost.

1.1 Introduction

Mott MacDonald was engaged to undertake level 2(L2) benchmarking analysis to increase cost confidence on five project estimates which are part of the N&P-Removal programme for the PR24 submission. The study below presents the results of the benchmarking analysis.

1.2 Methodology

Benchmarking was carried out on the five cost estimates produced by the Cost Intelligence Team (CIT). The individual costed items of the five projects identified and benchmarked against Mott Macdonald's industry database where comparable data was available. The Mott Macdonald's database includes data from eight UK Water and Wastewater companies (WaSCs), of comparable scale and operating model to Southern Water (SWS). Companies have been selected as the closest peers to SWS and data normalised for location and date to ensure comparisons are appropriate.

To make like-for-like comparisons, the comparator data has been adjusted for inflation (and deflation) to 1Q2023 using the published CPIH figures.

To account for regional variations in the base cost of the resources needed for water projects, the location factors published by the BCIS were used to adjust comparator data to a SWS base. This adjustment seeks to remove any 'skewing' of the comparison due to data being sourced from companies across the UK, which experience local differences in resource cost due to factors including availability; the general local economy and average rates of pay; logistical or access constraints caused by the preponderance of urban or rural communities within their catchment areas; and variances in productivity.

Occasionally, costed items were factored to adjust costs to reflect market changes, replacement costs and additional assumptions. These factors have been used in the benchmark costs as well to make equal comparisons.

Every costed item is either referenced by a SWS cost curve or is referenced by the term “Custom Asset”. Custom Assets denoted to different construction works. The ’Custom Assets’ details were unavailable; therefore, these items have been excluded from the study. Particularly, the total cost of the Custom Assets is £6,514,074, this accounts for 14% of the total project costs.

1.3 Analysis and Results

This section of the report provides the results and analysis of the benchmarking process. Table 1 below presents the excluded ‘Custom Assets’ accompanied with their reference number as this presented in the corresponded project workbook, the associated cost and the available notes.

Table 1 Excluded Custom Assets.

Project	Ref in Estimate Workbook	Custom Asset Cost	Estimate Notes
Ashlett Creek	**12**	£1,382	Block existing 525mm dia concrete pipe to existing balancing tank to redirect flows to DBSF PS
Ashlett Creek	**15**	£1,123	Allow for 2 No. new standpipes in SBR area
Ashlett Creek	**20**	£100,000	2 no. decant arms with actuator. £50k each
Ashlett Creek	**55**	£1,123	Allow for 2 No. new standpipes in DBSFs area
Ashlett Creek	**76**	£1,000,000	RTC (Real Time Control) for Methonal Dosing. If unable to estimate use £1,000,000
Canterbury	**18**	£3,673	Connection to existing underground pipeline assumed 450mm dia to FST3
Canterbury	**28**	£0	Allow for 2 No. new standpipes in ASP area
Canterbury	**48**	£1,123,000	RTC (Real Time Control) for Methonal Dosing. If estimate available use £1,000,000
Canterbury	**71**	£16,500	System integration of new items of plant into telemetry and monitoring system - allow 2 weeks
May Street	**14**	£8,060	Block existing pipeline from PST Collection Chamber to Oxidation Ditch Distribution Chamber to divert flow to new Feed PS to Selector Tank
May Street	**24**	£3,032	Allow for 2 No. new standpipes in Anoxic Tank area
May Street	**43**	£1,123,000	RTC (Real Time Control) for Methonal Dosing. If unable to estimate use £1,000,000
May Street	**101**	£3,032	Allow for 2 No. new standpipes in DBSF area
Morestead	**14**	£17,058	Connections to existing pipelines 2 No. 700mm dia upstream of existing aeration tanks distribution chamber
Morestead	**24**	£3,032	Allow for 2 No. new standpipes in Anoxic Tank area
Morestead	**37**	£1,123,000	RTC (Real Time Control) for Methonal Dosing. If unable to estimate use £1,000,000
Morestead	**101**	£3,032	Allow for 2 No. new standpipes in DBSF area
Portswood	**9**	£7,800	Concrete Support Columns to Distribution Channel. 6 No. 500mm square

Portswood	**38**	£32,563	Allowance for coating concrete tanks with protection against corrosion. Length of walls approx 300m for a depth of 2m down the walls. Approx surface area 600m2
Portswood	**61**	£48,027	Remove existing PST scraper bridges and dispose off site. 4 No. 14.5m long over each rectangular concrete PST Tank. Refer to photo P1000231 PST Scraper Bridge
Portswood	**63**	£248,793	Benching to existing sludge hopper. Approx 57.6m x 4.8m x 4m deep. Triangular hopper with estimated benching volume required of 1,106m3
Portswood	**64**	£15,338	Remove metal weirs 4 No. each 14.5m long
Portswood	**65**	£211,526	Create concrete wall in existing tank to create Selector. Approx 57.6m long x 4m high x 0.5m thick
Portswood	**80**	£54,058	FBDA aeration system in the 4 lanes to replace surface aerators Remove existing surface aerators 16 No. in total (4 No. to 4 No. tanks)
Portswood	**90**	£18,221	Remove existing Outlet Boxes to 4 No. Aeration Tanks. Refer to Photo IMG_0872 Aeration Tank Outlet Box
Portswood	**107**	£212,625	Disposal of excavated material off site. Material likely to be contaminated but inert. Assuming Secondary Anoxic and Re-aeration tank is mainly buried in order to allow gravity flow from existing Aeration Tanks. Approx volume 54m x 15m x 3m deep from GL to Formation Level, total volume 2430m3. CIT to review not included in cost curve for Anoxic Tank
Portswood	**128**	£12,078	Decommission existing RAS PS comprising 4 No. screw pumps.
Portswood	**143**	1123000	RTC (Real Time Control) for Methonal Dosing. If estimate not available use £1,000,000
Total		£6,514,074	

Table 2 presents the coverage which reflects the % of the project cost that has been benchmarked and the variance which represents in percentage terms the cost difference between SWS cost for the scope benchmarked and the industry benchmark. For example, 13% variance implies that scope benchmarked is 13% more expensive than the benchmark.

Table 2 Project Coverage and Benchmark results per project.

Project Name	Project cost	Scope Benchmarked	Coverage	Benchmark	Variance	Comment
Ashlett Creek	£6,961,718	£5,705,596	82%	£7,000,177	-18%	Custom asset with no information £1,103,628
Canterbury	£7,775,208	£6,453,224	83%	£5,728,756	13%	Custom asset with no information £1,143,173

May Street	£8,585,050	£7,338,078	85%	£7,215,442	2%	Custom asset with no information £1,137,124
Morestead	£9,076,387	£7,721,369	85%	£7,282,177	6%	Custom asset with no information £1,146,122
Portswood	£15,480,118	£12,107,073	78%	£12,588,507	-4%	Custom asset with no information £1,984,028
Total	**£47,878,482**	**£39,325,340**	**82%**	**£39,853,728**	**-1%**	**£6,514,074**

The table above suggests that coverage is equal to or above 82% in all projects apart from the Portswood project. The overall achieved coverage of 82%, increases the robustness of the benchmark study.

Notably, the Ashlett Creek project presents variance of -18%. This is result of the 'Sequencing Batch Reactor (SBR)' item in which SWS's estimated cost is 45.1% lower than Mott MacDonald's industry data.

It is worth mentioning that for the cost item 'Methanol dosing' only one comparable source was available. The unrealist aspects to estimate cost for this item is underlined from the poverty of comparable sources.

1.4 Conclusion.

The primary purpose of this study is to bolster confidence in the PR24 N&P-Removal programme. To achieve this Mott MacDonald's CIT team completed a level 2 benchmarking study on the five project estimates which constitute part of the N-Removal programme.

The study has achieved overall 82% coverage, and the total variance is -1%. The total variance means that SWS total benchmarked scope is 1% lower than the total benchmark cost.

The projects with the greatest variances are Ashlett Creek. The former is driven by the SBR cost item, specifically SWS's estimated cost is 45.1% lower than Mott MacDonald's benchmark cost.

Only one comparable source was available for the costed item 'Methanol Dosing', that highlights the difficulty to cost this item.

9.2 Evidence of EA acceptance of revised iron permits

Department for Environment Food & Rural Affairs

Seacole Building,
2 Marsham St, London
SW1P 4DF

T: 03459 335577
helpline@defra.gov.uk
www.gov.uk/defra

By e-mail only

21 August 2024

Dear [redacted]

Nutrient neutrality and catchment permitting area designations

Defra have been considering proposals for meeting the new wastewater treatment work upgrade requirements in the Water Industry Act 1991 (as introduced by the Levelling-up and Regeneration Act 2023) using a catchment permitting approach.

Ministers have considered advice from the Environment Agency (EA) and Natural England (NE) on catchment permitting proposals and have designated the Solent, Avon and Teesmouth and Cleveland Coast catchments as catchment permitting areas.

In these catchments, the EA will review permits and agree and set new permit conditions with companies as appropriate, in line with its functions under section 96G(3) of the Water Industry Act 1991. Companies should note that catchment permitting approaches remain subject to the EA's normal permitting and approval processes and Defra expect companies to work collaboratively and in good faith with the EA to agree an Operating Techniques Agreement to progress the permitting process. Companies should additionally ensure their response to Ofwat's consultation on draft determinations reflects the cost profile associated with the catchment permitting proposal.

Whilst Defra are supportive of ensuring investment can be optimised to deliver the same, or improved, environmental outcomes in the most cost-effective way using nature-based and lower carbon solutions, companies are reminded that if a catchment permitting approach is not achieving the same or better overall effect on the habitats site than if upgrades to previously announced wastewater treatment works to the relevant nutrient pollution standard occurred (the 'standard upgrade duty'), then remedial and enforcement action will be taken as appropriate, in line with the EA's enforcement and sanctions policy. This includes enforcement action taken by the EA under new powers set out in the Environmental Damage Regulations. If, despite remedial action, a catchment permitting approach is not successful in securing the required level of nutrient load reductions across the catchment, Ministers may consider exercising the power to revoke a catchment permitting area designation and instead require the 'standard upgrade' duty to be followed.

Please do not hesitate to contact my officials [redacted] [redacted] [redacted] if you have any questions.

Yours sincerely

[redacted]

9.3 Evidence of Defra's acceptance of our catchment permitting approach.

From: [redacted]
To:
Cc:

Subject: RE: Southern Water Iron Permits Review
Date: 31 May 2024 11:57:22
Attachments: image001.png

Hi [redacted]

Many thanks for your email and apologies for my late response due to annual leave.

Firstly, thanks to everyone who has been involved with this work. I can confirm that we updated Defra and Ofwat colleagues yesterday on the outcome of this work to close this action. Please could Southern Water colleagues provide updated cost information to Ofwat in response to the draft determinations (or as otherwise agreed with Ofwat). To note, Defra colleagues are also keen to understand the cost savings resulting from this review, if this could be shared with Defra.

In terms of your query for the 5 sites below, we confirm that additional lines under the U_IMP1 driver is the correct process. I can see that these have been included as "Additional new actions" on the 'WINEP Changes' spreadsheet submitted by Southern Water colleagues, so these will be approved and added to the LIVE WINEP shortly.

Many Thanks,
[redacted]

From: [redacted]
Sent: Thursday, May 16, 2024 12:31 PM
To: [redacted]
Cc: [redacted]
Subject: RE: Southern Water Iron Permits Review

Hi [redacted]

This morning OCS and KSL/SSD IEP teams met up with SWS (Alison and Paul) to discuss their Iron limits for PR24. The meeting was successful, and we wanted to summarise the outcomes for you:

1. There are a total of 119 sites with phosphate limits in the WINEP for SWS; 66 should retain their current iron limits and 53 need a new FE limit. Last month SWS calculated Iron limits for the 53 sites that needed a new limit using the EA's chemical dosing coaching aid. OCS has reviewed this information and agree with the outcome that 4mg/l 95%ile with an 8mg/l upper tier max limits are needed at 52 out of the 53 sites. However, at

Westbere STW, which is hydrologically connected to Stodmarsh (habitats directive protected site) we requested that a **1mg/l 95%ile** with an 8mg/l upper tier max limit is implemented due to the potential impact on this protected site. We have made SWS aware that it is likely that this site will be subject to a HRA.

2. Through the review process OCS identified 5 of the sites (Wilmington, Shipley, Westwell, Itchingfield, Wallcrouch and Slaugham) that are currently descriptive (small sites with no DWF or sanitary limits) will need updating to numeric sites as part of the process of implementing WFD Phosphate limits. The agreed method for implementing this is to add an additional line to the WINEP for the site under the U_IMP1 driver code to fund the new sanitary limits (SS, BOD and potentially Ammonia) and to identify what the flows are (to calculate a DWF) at the site. **Can the price review team confirm that this is the correct process please?** During AMP8, SWS and their consultants will calculate new DWF/limits for these sites and OCS/IEP will review them.

3. As a result of the review that OCS carried out, 44 of the 119 sites that were in the original WINEP for iron limits will now either retain their current Iron limit (instead of needing a new more stringent limit) or need a less stringent first time Iron limit. This is a significant cost saving for SWS (in the region of ~£100 million – **SWS to confirm**).

Here is a table of the breakdown of all the 119 sites (**SWS to confirm the breakdown**):

Iron Limit	Before review	After review
4	75	109
3	20	5
2	19	4
1	5	1

Price review team - please can you inform DEFRA that this closes the actions in the email below regarding this subject.

Kind regards,

[redacted]

From: [redacted]
Sent: Wednesday, March 27, 2024 1:02 PM
To: Rol[redacted]
Cc: [redacted]

[redacted]
Subject: RE: Southern Water Iron Permits Review

Hi [redacted]

Further to the meeting on 30 January 2024 to discuss the iron permits, and the email with the actions below, we have now completed the iron permit analysis for first time iron permits for AMP8 WINEP phosphorus removal schemes. We have used the flow data extracted from our SAGIS modelling and applied the *chemical dosing coaching aid* you provided to us. Please find attached the results of our analysis.

We found 2 gaps in the flow data available to us, at New Alresford and at Westbere, as neither site was included in the SAGIS modelling our consultants carried out.

New Alresford
The site discharges to groundwater. Please could you advise how we should calculate the iron permit at this site?

Westbere
The P removal requirement came about from the Stodmarsh SSSI report but this did not provide an iron permit level for the site. To give an indicative permit level, we have used publicly available flow data from a gauging station on the Great Stour at Horton (NRFA Station Data for 40011 - Great Stour at Horton (ceh.ac.uk)) which is c.8 miles upstream of Westbere and compared it with our measured discharge flow from the treatment works. This shows considerable dilution is likely at Westbere, leading us to conclude a 4mg/l permit level is appropriate. We also note that Westbere is just downstream of Canterbury which has a 4mg/l iron permit. Please let us know if this is a sufficient basis on which to assume a 4mg/l permit level, and if not, please advise on any other data we can use.

Please can you confirm that you're happy with the approach we have taken and the resulting limits? We will then review the proposed solutions and update the costs for our business plan.

I understand that you had an action to consider the mechanics for updating the WINEP spreadsheet, as a block or via the alterations process. We have added these revised iron permits – both aligning with extant permits and any revisions to first time permits - in an offline version of the WINEP. We have created this version of the WINEP to capture and record all the requirements for AMP8 as discussed in the series of meetings with Defra, Ofwat and EA in December 2023 and January 2024. We expect to provide this offline version of the revised WINEP to you this week. It would then be helpful to discuss how we put these changes through the alteration process.

Kind regards
[redacted]

[redacted]

[redacted]

www.southernwater.co.uk
Southern House, Lewes Road,
Falmer, BN1 9PY

From: [redacted]
Sent: Tuesday, January 30, 2024 2:35 PM
To: [redacted]
Subject: RE: Fe permit limits

Hi all,

Good to catchup earlier.

Meeting notes as follows:

- The Sept 23 WINEP includes Fe permit conditions for assets that require new or enhanced P permits. These were calculated by SWS's consultants.

- As part of the series of deliverability/affordability meetings with DEFRA/EA/Ofwat, SWS submitted a paper asking the EA to reconsider a number of Fe limits highlighted in PR24 associated with P conditions.

- The method applied by SWS's consultants differs from the EA's standard approach as set out in the internal *chemical dosing coaching aid* based on river needs modelling.

Action EA to share coaching aid (attached)

- EA analysis of the programme found that **~66 PR24 P schemes** have extant Fe limits. Extant limits were set by the EA during previous AMP cycles and were based on the approaches set out in the coaching aid. The expectation is that these extant Fe limits should be retained, given that the permitted DWF is unchanged through the WINEP process. Extant limits are unable to be relaxed as are based on river needs assessments.

Action SWS to review PR24 programme alongside extant Fe limits.

- EA analysis found that ~**53 PR24 schemes** with first time P limits will require assessment for Fe conditions in line with the chemical coaching aid. It is acknowledged this will take some time (likely weeks); however, this is a priority for SWS.

Action SWS to re assess Fe limits for all first time P schemes in PR24. SWS will keep EA updated on progress once the company has reviewed the documentation.

- Updates to the Sept 23 WINEP will be necessary to reflect these changes (both extant and updated limits for first time P scheme).

Action EA to consider the mechanics for updating the spreadsheet, as a block or via the alterations process.

Please let me know if there are any edits or additions ASAP. I plan to send these to Defra by CoP tomorrow.

Many thanks
[redacted]

-----Original Appointment-----
From: [redacted]
Sent: Friday, January 26, 2024 3:52 PM
To: [redacted]
Subject: Fe permit limits
When: 30 January 2024 13:00-14:00 (UTC+00:00) Dublin, Edinburgh, Lisbon, London.
Where: Microsoft Teams Meeting

Hi all,

Chance to discuss WINEP Fe limits proposal and the wider methodology for calculating iron limits for sites proposed for P limits.

Southern's list of sites to discuss attached for reference.

Thanks
[redacted]

[redacted]

[redacted]

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