Dŵr Cymru
Welsh Water

Enhanced Investment Case: WSH68-PE05 – Removing Phosphorus and Sanitary Determinands to Improve River Water Quality

Contents

Executive Summary

Need: This investment will improve effluent discharge performance of wastewater treatment sites to achieve regulatory compliance against Natural Resources Wales National Environment Programme (NRW NEP), the Environment Agency Water Industry National Environment Programme (EA WINEP) and ultimately the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD Regs), including The Conservation of Habitats and Species Regulations 2017 (Habitats Regs) and the associated requirements to improve and protect Special Areas of Conservation (SAC), and bring WFD waterbodies to Good Ecological Status. These regulations are part of UK law and are used to set the legally required standards to be achieved in the environment and provide the basis under which quality limits of our discharges to the environment are set under the Environmental Permitting (England and Wales) Regulations 2016 (EPR).

The interventions will improve or implement control of total phosphorus (P) and sanitary determinands, known as ammonia (AmmN), biological oxygen demand (BOD) and suspended solids (SS) in our Wastewater Treatment Works (WwTW) final effluent discharges to rivers. The programmes have been developed collaboratively with our regulators, NRW and EA, and contain investigations and actions required across our wastewater estate to meet these new regulatory requirements outlined under the legislation noted above to meet water quality targets under both WFD (new evidence of reasons for not achieving good) and Habitats Regs (new targets).

We will invest in phosphorus improvements at 149 sites (some of these sites also having amendments to their sanitary determinands) and in amending sanitary determinands only, at 19 sites. Included within the 149 sites requiring phosphorus improvements are 92 NRW sites which require a backstop (5 mg/l) P limit. Many of the 92 sites requiring these backstop limits are currently regulated by descriptive permits, and these permits will now be amended from a written description as to how the WwTW should be operated and the impact it can have on the watercourse, to a permit that will have numeric sanitary determinand limits imposed.

The principle of ‘Fair share’ or ‘Polluter Pays Principle’ follows the notion that polluters are responsible for removing or reducing their impact on the environment, as detailed in the WFD Regulations and Environment Act 2021. To support this, we used independently verified Source Apportionment Geographical Information System (SAGIS) modelling to determine our phosphorus contribution to freshwater SAC catchments and identify appropriate P limits to enable us to meet our fair share of removal in each catchment. This approach is the preferred tool by all UK Regulators to set up investment scenarios for phosphorus schemes to meet appropriate water quality targets. Phosphorus limits on WFD waterbodies are determined either using SAGIS models where they are available or using River Quality Planning (RQP) modelling which is an NRW accepted approach and takes less time and specialist technical resources to deliver. NRW are comfortable with both methods.

Sanitary determinands on WFD water bodies were determined for planning purposes using River Quality Planning (RQP) modelling as the accepted approach by NRW for this purpose.

Uniquely in Wales, NRW have identified sites where default phosphorus backstop limits should be applied to prevent deterioration from future housing development at sites that would not normally have them applied. This change will lead to numeric limits being applied at sites for the first time. The introduction of these new limits in combination with other improvements planned to be delivered in the SAC catchments are designed by NRW to enable Local Planning Authorities to restart planning approvals for new development in Welsh SAC catchments areas.

At the time of submission, NRW are still refining the sites under the Habitats driver with the potential for new ammonia permits and additional backstop ammonia limits to be required. The investment required to meet these additional requirements is not included in the submission due to a mismatch in the timing of the two regulatory processes. Should it be determined that these are required, we would propose that these be dealt with under a change control process prior to, or after, Final Determination.

In addition to physical investment on sites, we also plan to undertake investigations in SAC and WFD water bodies to determine how nutrient levels in Transitional and Coastal water (TraC) SACs can be better managed to support environmental quality objectives. These investigations are focused on TraC SACs where Welsh Water's assets have known, but unquantified, impacts and will potentially lead to new permit limits to be delivered in future AMPs.

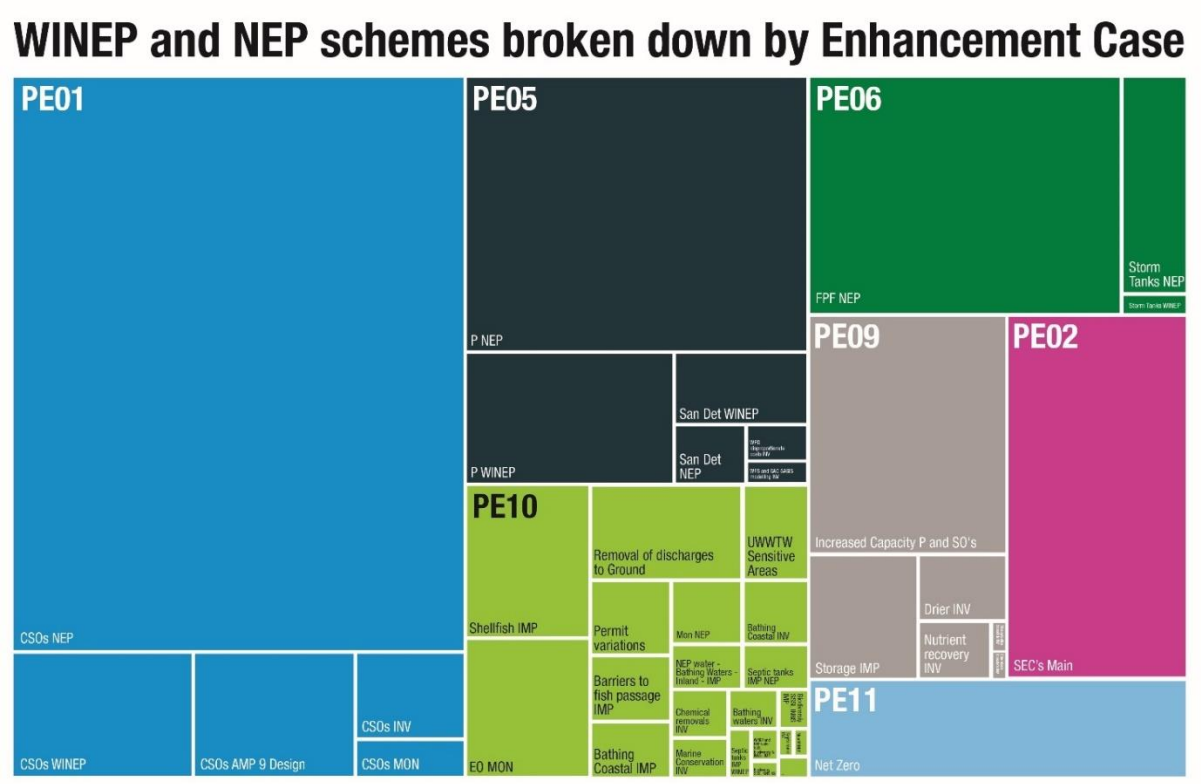
There are also 45 sites that did not meet NRW's standard cost benefit assessment which have been included for investigation. These investigations aim to establish if a broader assessment of benefits, in line with Welsh Government's policy on the sustainable management of natural resources, would make investment cost beneficial and provide evidence for this to be included in AMP9.

Number of interventions required.

Investment Objectives	Regulatory Programme	Number of Sites	CapEx	OpEx	TotEx
Phosphorus removal	NEP/WINEP	149	£132.513M	£5.673M	£138.186M
Sanitary determinand reductions	NEP/WINEP	19	£14.131M	£0.749M	£14.880M
WFD disproportionate costs Investigations	NEP	45	£1.696M	N/A	£1.696M
WFD and SAC SAGIS Investigations	NEP	N/A	£1.055M	N/A	£1.055M

This programme of work has been assessed and approved by the Wales PR24 Forum.

We have several other documents which cover related environmental investments. The diagram below sets out our NEP and WINEP enhancement documents and their subject area.



WINEP and NEP schemes broken down by Enhancement Case.

Options: We have considered a range of options to reduce phosphorus and improve sanitary determinand levels to meet discharge limits. Our approach took into consideration current performance, known operational issues, and future growth. Our options were constrained using screening criteria (using methods set out by our regulators) to understand their efficacy for treatment, impacts on the environment, and financial costs. The five screening criteria, and sub criteria, were attributed weighting thus enabling the viable options to be chosen.

What We Will Deliver: This Enhancement Case will deliver WwTW improvements to meet new or tightened limits in the numeric compliances of.

1) 133 NRW sites and 16 EA sites for phosphorous permits,
2) 17 NRW sites and 2 EA sites for sanitary determinand reductions.
Site specific solutions include chemical dosing, nature-based solutions (including reedbeds), an increase in biological capacity, and tertiary solids removal processes. Some sites have been identified as no build options as they already comply with the new permits with minimal investment.

Efficient Costs: We will invest £153M (improvements) and £3M (investigations) enhancement TotEx (post efficiency) to enable us to meet these requirements. This is in 22/23 price base. These costs have been determined through undertaking a long listing and short-listing process. The short-listed options were then costed using our Carbon and Costing Estimating Tool (CET). Each option was then put through a Risk and Value scoring exercise – see WSH50-IP00 Our Approach to Investment Planning (Section 7) – whereby a Cost Benefit Analysis was undertaken. The scheme with the highest benefit to cost ratio was chosen as the most cost-effective option for each category.

Customer Protection: This enhancement has oversight from NRW and the EA through requirements set out in the NEP and the WINEP. Progress will be monitored and reported to NRW and the EA as appropriate to the investment.

Benefits: We will deliver better water quality and improve the environment.

Note on document structure.

We have structured this document using the enhancement assessment criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A1. The enhancement assessment criteria are divided into four criteria groupings:

- Need for enhancement investment (5 sections).
- Best option for customers (4 sections).
- Cost efficiency (2 sections).
- Customer protection

1. Introduction

This investment will improve effluent discharge performance of wastewater treatment sites to achieve regulatory compliance against Natural Resources Wales National Environment Programme (NRW NEP), the Environment Agency Water Industry National Environment Programme (EA WINEP) and ultimately the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD Regs) including The Conservation of Habitats and Species Regulations 2017 (Habitats Regs) and the associated requirements to improve and protect Special Areas of Conservation (SAC) and bring WFD waterbodies to Good Ecological Status. These regulations are part of UK law and are used to set the legally required standards to be achieved in the environment and provide the basis under which quality limits of our discharges to the environment are set under the Environmental Permitting (England and Wales) Regulations 2016 (EPR).

The interventions will enhance existing, or implement new, controls of total phosphorus (P) and sanitary determinands, known as ammonia (AmmN), biological oxygen demand (BOD) and suspended solids (SS) in our Wastewater Treatment Works (WwTW) final effluent discharges to rivers.

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Improvement programmes have been developed collaboratively with our regulators, NRW and EA, and contain investigations and actions required across our wastewater estate to meet new regulatory requirements outlined under the legislation noted above to meet water quality targets under both WFD (new evidence of reasons for not achieving good) and Habitats Regs (new targets). These requirements are delivered through the EA WINEP and NRW NEP in a programme which broadly aligns to our price review periods – 5-year cycles.

The improvements needed to ensure that Welsh Water contributes to WFD water quality objectives, including those needed to support the conservation objectives in SACs, are set out in the following complementary plans:

- Natural Resources Wales (NRW) – National Environment Programme (NEP).
    - This programme covers our sites in Wales.
- Environment Agency (EA) - Water Industry National Environment Programme (WINEP).
    - This programme covers our sites in England.

Phosphorous reduction forms a large part of our NEP programme, in particular under the Habitats Regs. In 2016 the Joint Nature Conservancy Council recommended tightened phosphorus levels in freshwater SACs to support the conservation objectives in those water bodies across England and Wales. These new limits are generally tighter than the existing standard required to meet Good Ecological Status (GES) under WFD. In response to the tightened standards, NRW commenced a 3-year programme of monitoring in 2017 and published their report on phosphorus compliance of Welsh freshwater SACs in Jan 2021[1]. This showed 60% of SAC water bodies in Wales were not compliant with the new targets. This has also resulted in new planning guidance which has effectively limited planning application determinations in many areas of Wales.

Uniquely, in Wales, NRW has identified sites where default phosphorus “backstop” limits should be applied to prevent deterioration caused by future housing development at sites that would not normally have numeric conditions for phosphorus applied at them. This change will lead to numeric limits being applied at a number of sites for the first time. These changes, when viewed in combination with other improvements we are planning to deliver in SAC catchments, are designed by NRW to enable Local Planning Authorities to restart planning approvals for new developments in Welsh SAC catchments areas. NRW has confirmed their intention to adopt this approach through their planning guidance[2] and in their formal correspondence with Welsh Water.

[1] Compliance Assessment of Welsh River SACs against Phosphorus Targets: Report No 489, January 2021, NRW.
[2] Advice to planning authorities for planning applications affecting phosphorus sensitive river Special Areas of Conservation v3.1, August 2023, NRW.

Separately, NRW and EA monitoring programmes continue to show that other water bodies do not meet GES due to phosphorus concentrations for which Welsh Water's assets are identified as the reason for not achieving the required standard. A number of these sites, where the improvements are determined by NRW or the EA to be cost beneficial, have been included in the plan. Others, where they have failed our regulators' cost benefit assessment, have been identified for investigation in AMP 8. The aim of this is to establish if they might be cost beneficial under an enhanced economic assessment of benefits, in line with Welsh Government's policy on Sustainable Management of Natural Resources (SMNR), and where there is customer support to progress schemes despite their cost benefit ratio. Any improvements would be delivered in AMP9. See document WSH71-PE10[3] for more detail on this and other Investigations. It is worth noting that NRW have also included drivers[4] for improving these sites (33 no.) failing the cost benefit assessment in their NEP. These schemes are currently not costed in our plan as negotiations on how these could be considered before the investigation is complete are still underway. We hope to conclude these discussions before the draft determination. If all these improvement conditions were to remain in NRW's NEP it would have a significant cost impact on our business plan in the order, we estimate, of between £50M to £60M.

1.1 Strategic Position

Our improvement plans for SAC catchments and other freshwater bodies have been presented to Welsh Government, SAC River Oversite Group (SACROG), the Welsh Government's First Minister's pollution summits, and to the PR24 Forum.

For SAC rivers, modelling has shown that we are, on average, contributing 26% of the total phosphorus that is entering these sensitive waterbodies. These models have also identified the load that Welsh Water need to remove, in combination with reductions from others, to achieve the stringent targets. Welsh Ministers and the Forum have issued a Strategic Steer to Welsh Water in relation to Phosphorous removal, which requires us to achieve 90% (estimated at 89.6kg/day) of the Phosphorus reduction required on a 'fair share' by the end of AMP 8, and to complete the remaining 10% (estimated at 10.0 kg/day) in AMP 9, by the end of 2032. Post 2032, there will be a number of remaining WwTWs required to meet backstop limits (5 mg/l) in the 4 water bodies that currently meet the Joint Nature Conservation Committee (JNCC) targets. The estimated effect of our programme on phosphorus discharged from our WwTW's by the end of the programme is shown in Figure 1 below.

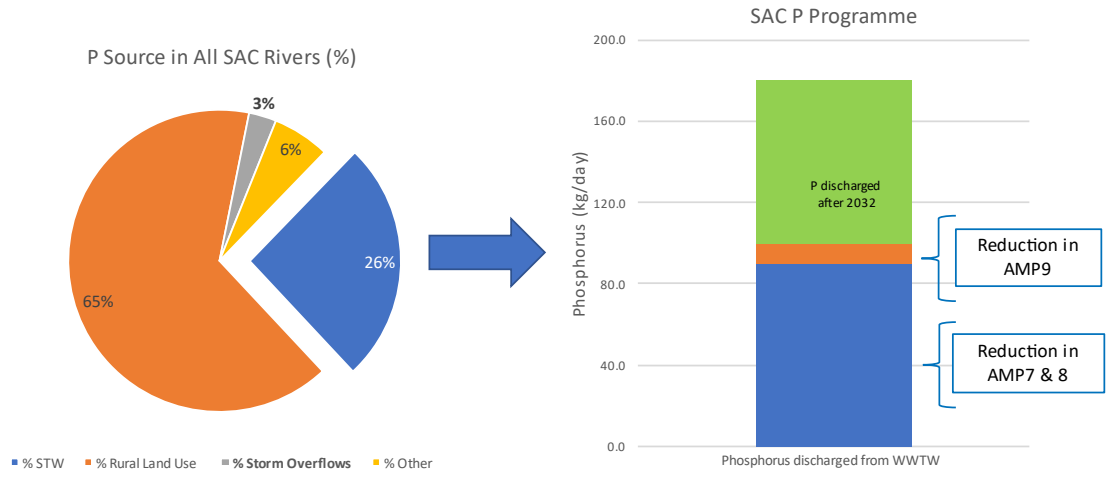

Figure 1*: Overview of the SAC P programme*

[3] WSH71-PE10 - Enhancing the Environment through WINEP and NEP Investigations and Programmes
[4] Added under driver code W_DP_IMP, although there is no driver paper for this code that has been issued to Welsh Water.

For some non-SAC freshwater catchments (WFD waterbodies), our nutrient contribution can be even greater than has been observed in SAC catchments. It is important that, whilst the political focus is on removing phosphorus from the WwTW discharges in SAC catchments due to the halting of development, the WFD waterbodies are also addressed within AMP8 to remove them from being a reason for water bodies not achieving Good Ecological Status (GES) (known as RNAG) and meet the deadline of 2027[5]. In these WFD catchments, the regulators will have determined that there is a cost beneficial case for improving our WwTW discharges of phosphorus and/or sanitary determinands and delivery will remove them from the RNAG.

1.2 PR24 Programme

We will invest in phosphorus improvements at 149 sites (some of these sites also having amendments to their sanitary determinands) and in amending sanitary determinands only at 19 sites. As part of the 149 phosphorus sites, NRW have identified 92 sites which require a backstop (5 mg/l) P limit to provide certainty that there will be no deterioration as a result of future developments in those catchments. These include various sites which are currently controlled under descriptive permits and now require new sanitary determinand limits as well.

At the time of submission, the NRW are refining the sites under the Habitats driver with the potential for new ammonia permits and additional backstop ammonia limits being required. These additions are not included in the submission due to a mismatch in the timing of the two regulatory processes. Should it be determined that these are required, we would propose that these be dealt with under a change control process prior to or after Final Determination.

1.3 Structure of this Document

We have structured this investment case using the enhancement assessment criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A1.1:

ID from Appendix 9		Abbreviated Assessment Criterion	Addressed in
A1.1.1 Need for enhancement investment	a	Is there evidence that the proposed investment is required?	Section 2.1
	b	Is the scale and timing of the investment fully justified?	Section 2.1
	c	Does the proposed investment overlap with base activities?	Section 2.2
	d	Does the need and/or proposed investment overlap/duplicate with previously funded activities or service levels?	Section 2.3
	e	Does the need clearly align to a robust long term delivery strategy within a defined core adaptive pathway?	Section 2.4
	f	Do customers support the need for investment?	Section 2.1
	g	Have steps been taken to control costs, including potential cost savings?	Section 2.5
A1.1.2 Best option for customers	a	Have a variety of options with a range of intervention types been explored?	Section 3.1
	b	Has a robust cost-benefit appraisal been undertaken to select the proposed option?	Section 3.1

[5] Under WFD, the objectives set within the River Basin Management plan are to improve waterbodies to GES by 2027. Our delivery dates are aligned to these objectives.

ID from Appendix 9		Abbreviated Assessment Criterion	Addressed in
	c	Has the carbon impact, natural capital and other benefits that the options can deliver been assessed?	Section 3.2
	d	Has the impact of the proposed option on the identified need been quantified?	Section 3.2
	e	Have the uncertainties relating to costs and benefit delivery been explored and mitigated?	Section 3.3
	f	Where required, has any forecast third party funding been shown to be reliable and appropriate?	Section 3.4
	g	Has Direct Procurement for Customers (DPC) delivery been considered?	Please refer to WSH50-IP00 Our Approach to Investment Planning (Section 3.4.1)
	h	Have customer views informed the selection of the proposed solution?	Please refer to Stepping up to the Challenge: Business Plan 2025-30 (Section 2.2)
A1.1.3 Cost efficiency	a	Is it clear how the company has arrived at its option costs?	Section 4.1
	b	Is there evidence that the cost estimates are efficient?	Section 4.2
	c	Does the company provide third party assurance for the robustness of the cost estimates?	Section 4.1
A1.1.4 Customer protection	a	Are customers protected if the investment is cancelled, delayed or reduced in scope?	Section 5.1
	b	Does the protection cover all the benefits proposed to be delivered and funded?	Section 5.1
	c	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments?	Not applicable for this case

2. Need for Enhancement Investment

This section will set out the drivers behind the Enhancement Case and describe the context within which it has arisen.

The proposed investment aligns with our Long Term Delivery Strategy – responding to the need for long term stewardship and improvement in service. The five sub-sections below correspond to the seven criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), A.1.1.1.

2.1 Evidence that Enhancement is Needed

> ***Is there evidence that the proposed enhancement investment is required? Where appropriate, is there evidence that customers support the need for investment?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.1a and A1.1.1f*

This investment will improve effluent discharge performance of wastewater treatment sites to achieve regulatory compliance against the NRW NEP, the EA WINEP and ultimately the WFD and Habitats Regs requirements. These regulations are part of UK law and are used to set the legally required standards to be achieved in the environment and provide the basis under which enforceable permitted limits of specified substances in our discharges are determined under the EPR. The programmes have been developed collaboratively with our regulators, NRW and the EA, and contain investigations and actions required across our wastewater estate to meet new regulatory requirements outlined under the legislation noted above to meet water quality targets under both WFD (new evidence of reasons for not achieving good) and Habitats Regs (new targets).

The PR24 Forum also confirmed our WFD programme need. They directed Welsh Water to deliver improvements that were identified as contributing to reasons for not achieving good ecological status (RNAGs) – following the prioritisation approach to address environmental harm.

We would be in breach of legal compliance if the discharge levels rise above the new permitted limits.

There are several regulatory drivers for this enhancement:

- SAC rivers – These are defined in the NRW PR24 Habitats Regulation Driver paper and encompass backstop P limits and defined P limits on SAC rivers, depending upon the SAGIS analysis undertaken. SAC schemes are NRW only.
    - Driver codes:
        - W_HR_P_NDIMP1
        - W_HR_P_IMP1
- WFD – these schemes define both P permits and sanitary determinands for river improvements, based on preventing deterioration or under a "pathway to good" ecological status. WFD schemes have been specified in NRW PR24 WFD Surface Waters Driver paper and EA 's PR24 WINEP driver guidance – Nutrients and sanitary determinands (surface waters driver paper).
    - Driver codes:
        - W_WFD_PG_IMP1
        - W_WFD_Minor_IMP
        - W_WFD_BOD_NDIMP1
        - W_WFD_AMM_NDIMP1
        - W_WFD_P_NDIMP1
        - WFD_IMPg (EA).

- Investigation – We also have several water quality investigation drivers. The WFD driver is looking at 45 sites which have been given a 1 mg/l P permit by the NRW but at disproportionate cost. The SAGIS investigation will continue the current scrutiny on water quality drivers and further the understanding of the different sources of nutrients and pollution within the NRW Welsh Water catchments. The SAC_INV driver is for ensuring that the impact of changes to SAC rivers is also reflected in the water quality modelling in TraC waters affected by these rivers.

    - Driver codes:
        - W_WFD_DC_INV

NRW published the results of their comparison between measured phosphorus concentrations in SAC rivers and the 2016 JNCC compliance targets[6] which NRW adopted into their core management plans for those water bodies. At the same time other water body compliance assessments by NRW[7] and the EA[8] were reviewed to begin developing the investment plans required to protect river water quality supported by, where necessary, water quality modelling.

For SAC water bodies NRW commenced a review of permits (due to complete in July 2024) which is introducing a number of measures unique to Wales including:

1. The introduction of phosphorus backstop limits designed to provide certainty that future housing development will not lead to deterioration of river water quality.
2. Default sanitary limits will be added for sites covered by backstop limits that had previously been regulated as descriptive permitted sites.

The EA will not be introducing similar approaches as the policy for supporting development in the English parts of our SAC catchments differs from Wales. On the River Dee no such planning embargo is in force. In the Wye catchment, which includes areas that have been included under Natural England's (NE) Nutrient Neutrality rules, mitigation measures continue to be developed in partnership with Herefordshire Council after NE clarified that investment to meet WINEP requirements on its own would not satisfy the requirements to prevent deterioration and confirmation that regulations on meeting technically achievable limits (if they become law) for WwTW's > 2000pe would not apply to Welsh Water.

Our approach to customer engagement is set out in Stepping up to the Challenge: Business Plan 2025-30 (Section 2.2).

Customers are supportive of investment in environmental improvements. In terms of importance and concern, reducing pollution and improving river water quality came second in customers' investment priorities in our Phase 1 research (2021).

2.1.1 Scale and Timing of Investment

Is the scale and timing of the investment justified?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.1b

With respect to regulatory compliance, the NEP and WINEP sets the regulatory outputs to be delivered by 30th April 2027 (25 sites) and 31st March 2030 (143 sites) for the sites that fall under the WFD and SAC schemes respectively (this includes both P and sanitary determinand schemes).

[6] Compliance Assessment of Welsh River SACs against Phosphorus Targets: Report No 489, January 2021, NRW.
[7] See https://waterwatchwales.naturalresourceswales.gov.uk/en/ and Reasons for Not Achieving Good assessments issued to Welsh Water.
[8] See https://environment.data.gov.uk/portalstg/home/item.html?id=bcec2775501841d7a4dacef57e291b61

These dates can be found in the published version of the WINEP, and we expect NRW to issue their NEPV6.1 to coincide with this submission.

This regulatory timeline means that Welsh Water is required to identify appropriate solutions, create detailed designs, and construct or adapt assets to meet these obligations within the stipulated timeframes. We are aiming to deliver improvements at all 25 No. 2027 sites by the end of 2026 and at the latest March 2027. We are starting the design for the schemes in 2023 so that construction can occur as soon as the AMP starts. Due to the scale of the investment, we are also going to apportion a certain amount of 2030 schemes earlier in the AMP, so we are not constructing 143 schemes in 2028-2030. We will be working with NRW and the Nutrient Management Boards on the priorities of these to balance deliverability and development pressure.

The sites requiring investment vary significantly in size. Of the 168 sites, 2 are below 20 m^3/d flow and 3 are above 10,000 m^3/d. The minimum flow is 11 m^3/d, the maximum 69,638 m^3/d, and the average is 1,258 m^3/d.

We will follow the strategic steer from the PR24 Forum that confirms that the regulatory improvement programme for phosphorus in SAC rivers will continue into AMP 9 (to 2032) and there are a number of sites under the Habitats drivers that are within the NEP with 2032 delivery dates.

For the two investigations detailed in this Enhancement Case we aim to start these at the beginning of the AMP. The SAGIS modelling will contribute to our plans for PR29 so it is essential it is undertaken early to enable the correct level of consent adaptations to meet the river quality improvement targets going forward. The WFD disproportionate cost investigation will feed costs and feasibility into discussions with the NRW on whether these schemes are cost feasible going forward.

2.2 Overlap with Activities to be Delivered through Base

> ***Does the proposed enhancement investment overlap with activities to be delivered through base?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.1c*

We have a standard approach for assessing overlap between base and enhancement, this is set out in WSH50-IP00 Our Approach to Investment Planning (Section 3.4.2).

The cost estimates produced for the 149 sites include scope for new assets or enhancing existing assets for P-removal and any associated water quality improvements on those sites. The same applies to the 19 sites which only require improvements to meet new sanitary limits. Any costs associated with refurbishing our existing assets are not included within this investment case and will be addressed under Base Maintenance. This investment is not being used to address any existing maintenance needs at these assets. Although it will be necessary to utilise Base allowance to bring assets being retained up to good condition to ensure a successful output.

The operational expenses (OpEx) component of the costings is only for the delta i.e., the increase beyond Base Maintenance already present on site which is being introduced as a result of these investments.

The CapEx costs for the enhanced assets in this business case are therefore separate from any maintenance drivers. The OpEx costs only apply to new OpEx arising from the construction of the new assets. There are, therefore, no overlaps within the business case with any activities to be delivered through Base Maintenance.

2.3 Overlap with Funding from Previous Price Reviews

Does the need and/or proposed enhancement investment overlap with activities or service levels already funded at previous price reviews?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.1d

This enhancement investment is a response to the new P level discharge requirements and any associated sanitary limits at 149 sites across our network. It also covers 19 further sites which are required to meet new sanitary determinands only. These standards have been introduced in the current NEP and WINEP for completion in AMP 8 and as such have not been part of a previous funding request.

Some of the sites may have had investment in a previous AMP to achieve a particular phosphorus or sanitary permit condition, but if included in this PR24 investment programme it is because the required new and further work is required to meet a tighter standard. For example, Dyffryn Isaf WwTW has a current permit of 2 mg/l but in PR24 has a new permit of 0.25 mg/l. At this site, whilst chemical dosing had already been installed at the site to achieve the limit of 2 mg/l, additional process units now need to be constructed to enable compliance with the new permit. In contrast at Five Fords WwTW, which has a current permit of 1 mg/l and now has an AMP 8 permit of 0.7 mg/l, investment is not required as we are already compliant with the tightened permit. A similar approach has been taken on sites which only require sanitary determinand improvements.

There are no overlaps in funding for these schemes with other categories defined in our PR24 plan. For example, Llwyncelyn is specified as a no build option for sanitary determinands, as it has been identified in growth and so has spend in this category. We have some schemes also identified in other NEP and WINEP drivers and where this has occurred, we have made sure that the solutions are specific to the driver and no overlap in costs or scheme solutions occur, e.g., Talybont is in both the P and the U_IMP5 drivers.

2.4 Alignment with the Long Term Delivery Strategy

Is the need clearly identified in the context of a robust long term delivery strategy within a defined core adaptive pathway?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.1e

Welsh Water has a long term strategy focused on improvements to river water quality and coastal water quality towards which this investment is a direct contributor.

Welsh Water 2050 states "With increasing pressure on the natural environment from population growth, changing land use, climate change and new sources of pollution we will improve our wastewater assets to do our part to help achieve 'good' ecological status for our rivers, lakes and coastal waters".

Although the Long Term Delivery Strategy does not show the NEP or WINEP going beyond AMP 9 (and therefore we cannot define this at this point), we are sure there will be further schemes to protect the environment and achieve good ecological status in all Welsh waterbodies, with further tightening of determinands.

We have developed a core pathway related to water quality improvements, in line with NEP & WINEP legislative requirements. The schemes outlined in this Enhancement Case form a key element of achieving our long term ambitions. Welsh Water has assessed the core pathway against a range of scenarios and has developed an alternative pathway looking at the opportunities associated with market mechanisms. An additional pathway has been developed associated with legislative changes with respect to wastewater discharge standards in line with Welsh Government remaining closely

aligned with future EU water quality directives such as the proposed revision to the UWWTD. Further details can be seen in WSH01 Long Term Delivery Strategy.

2.5 Management Control of Costs

> ***Is the investment driven by factors outside of management control? Is it clear that steps been taken to control costs and have potential cost savings been accounted for?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.1g*

This work is driven by changes in environmental legislation, policy, or new environmental water quality evidence with regards to the impact of discharge quality from wastewater treatment works on the environment. Our existing approach has been permissible but will no longer be appropriate because of the requirement to ensure Welsh Water is delivering its "fair share" of pollutant load in line with the "Polluter Pays" principle.

The tightening of P and other sanitary determinand permit limits is a response to evolving environmental, technological, and regulatory factors identified either by our regulators or through our investigations and modelling. It aims to improve water quality, protect ecosystems and public health, and ensure that sewage treatment facilities can be operated to meet their new regulatory requirements.

Further investigations have been included in the NEP for investigating water quality with a view to providing evidence for necessary investment in AMP9. These include those sites where NRW's standard approach has previously determined that improvements are not cost beneficial, but a broader value assessment is now needed to establish if they might be cost beneficial under an enhanced economic assessment of benefits, in line with Welsh governments policy on Sustainable Management of Natural Resources (SMNR).

We have provided an example in Table 1 below of our default approach to tackling tightening of quality limits at our WwTW's, which is to meet the new limit without the need for capital investment if possible. Using this approach, we have ensured that any costs set out in this document are those required to achieve compliance.

Table *1: Example of our approach to controlling costs.*

Example: Five Fords	
Current P permit	1 mg/l
AMP 8 P permit	0.7 mg/l
2022 average total P in final effluent	0.55 mg/l
Conclusion	
Due to the current compliance, we decided that there was no expenditure required in AMP 8 for the decreased P permit and the plant could be maintained and optimized to meet the new permit requirement.	

3. Best Option for Customer

In this section we will describe how we have developed options for addressing the need identified above.

We have identified the investments to achieve the improvement (IMP) and investigation (INV) drivers identified in the WINEP and NEP, and accordingly enhance the environment.

The four sub sections below correspond to the eight criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A.1.1.2.

Due to the large number of investments contained within this Enhancement Case we will detail the optioneering of a few examples to represent the Enhancement Case and thus provide examples of the process we have implemented which is also described in our investment narrative.

3.1 Identification of Solution Options

> ***Has the company considered an appropriate number of options over a range of intervention types to meet the identified need?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.2a*

- We, or our regulators, undertook water quality modelling which looked at various parameters that may need to be improved.
- For nutrients this produced an assessment of the impact of our discharges in the context of the principal sources in the catchment. This evidence was provided to our regulators.
- Regulators issued driver papers and reviewed water body status and modelling evidence against Welsh Government and Defra policy.
- Through engagement with the NRW and EA we produced an agreed NEP and WINEP scheme list.
- We then developed different options aimed at providing best value for customers and the environment. (Note – the differences in regulatory positions between Wales and England mean that some of the options that could be assessed for English sites were not available in Wales, for example catchment offsetting).

Our phosphorus contribution to freshwater SAC catchments has been established through our own Source Apportionment Geographical Information System (SAGIS) modelling that was subsequently audited by the EA for the cross-border SAC rivers or NRW's independent consultants for Welsh SAC rivers. The audit process confirmed that the results were suitable for our investment planning and allowed us to identify appropriate P limits for WwTW's (>20m3/d) in these catchments that were sufficient to ensure we are delivering our fair share of the phosphorus removal required to achieve the targets in each catchment. NRW also identified sites where default backstop limits (defined at 5 mg/l P limits by the NRW) will be applied to prevent deterioration as a result of future development so that planning approvals can restart in Wales.

Phosphorus limits on other water bodies (WFD) were determined for planning purposes using a combination of SAGIS models and River Quality Planning (RQP) modelling. NRW support both methods for determining appropriate limits for Phosphorus. Whilst SAGIS is the preferred method to set up investment scenarios for phosphorus schemes, the tool takes considerably more time, resources and technical skills than the RQP tool. Therefore, given NRW also accept the RQP too for indicative permit limits, our water quality strategy focussed on delivering the detailed models for the most critical and political riverine environments – namely SAC rivers and a small number of WFD waterbodies. Our long term ambitions, supported by investigation expenditure in AMP8, will be to expand our SAGIS model coverage to more waterbodies.

In developing schemes, we have utilised a P solution development matrix which considers different options for different sizes of works and varying P permits. We have benchmarked the costs developed through our Unit Cost Database (UCD), against other water companies.
For Sanitary determinands, NRW have a different position to both England and Scotland and only accept the use of RQP for evidence for appropriate sanitary limits and this has been the approach for PR24.

Costing of the options allowed for the identification of a preferred solution for each site and also, least cost and alternative solutions via the application of a Risk and Value (R&V) process (set out in WSH50-IP00 Our Approach to Investment Planning (Section 7). This was applied to all viable costed options to identify, measure and report on both financial and non-financial impacts and dependencies to enable holistic investment decision making.

For this Enhancement Case we have considered a range of options to reduce phosphorus and sanitary determinand levels across all the sites to meet the varying discharge limits. Our approach took into consideration site performance data, insight from our process scientists on site issues, and future growth. Examples of the types of the unconstrained options considered are set out in Table 2 below. The list of options considered includes traditional options and some less traditional options.

Table *2* Options considered across sites for P removal.

Option	Description	Viability
Maintain the effective risk controls already in place. Do nothing	Continue to use and maintain the existing assets without intervention as the site is meeting the required new discharge permit.	Only viable if current assets have capacity to work harder and discharge permits, and growth are unlikely to change significantly in the future.
Maintain the effective risk controls already in place. Monitor	Spot sampling, or installation of devices to measure permit determinands.	Only suitable for sites that are performing close to the new discharge permit.
Maintain the effective risk controls already in place. Optimisation	Optimisation of the existing site units to remove P through solids removal.	Only viable if existing assets are in sufficient condition and the majority of the influent P is not ortho-phosphorus. Optimisation is then achievable through solids removal and if the P permit limit is above 4 mg/l.
Enhance existing resources or add new resources. Pump away	Redirect flows to a neighbouring site with adequate capacity for flow to treat the incoming wastewaters, or where upgrades already planned could accommodate, or where upgrades would be easier/more cost effective.	Only applicable to small sites with low P permit. Infrastructure for pump away will take significant planning and civil works. Requires environmental analysis, planning permission, and suitably sized pumping station.
Enhance existing resources or add new resources. New settlement tanks	New conical or radial primary settlement tanks (PSTs) and humus settlement tanks (HSTs) are required to replace Dortmund, rectangular and square and/or existing assets that are underperforming.	Radial/conical PSTs improves settleability and solids removal, especially with chemical dosing.

Option	Description	Viability
Enhance existing resources or add new resources. Chemical dosing	Process of treating wastewater with chemicals such as iron and aluminium to remove the high levels of chemicals present in it.	Single, double- and three- stage chemical dosing is suitable for low phosphorous permits and as a stand-alone solution. Higher carbon footprint.
Enhance existing resources or add new resources. Biological Phosphate removal	Designed to substantially degrade the biological content of the waste through aerobic/anaerobic biological processes. This step removes the dissolved organic matter using biological agents. Such technologies and suppliers include: Nereda, EBPR, HYBACS, SAF, RBC.	Solution efficacy depends on many variables such as: influent wastewater quality, flow, operator knowledge, climate, land availability and existing assets.
Enhance existing resources or add new resources. Algae	Using plant biomass that allows aerobic bacteria to breakdown organic contaminants in the wastewater whilst taking up excess nitrogen and phosphorus in the process.	Currently a largely untested method with variable pilot plant results. The disposal route of spent algae is yet to be determined.
Enhance existing resources or add new resources. Tertiary solids removal	Tertiary treatment designed to remove solids that have been carried over from a secondary settlement process. Such technologies and suppliers include: sand filters, Mecana, Filter clear, Actiflo.	Only suitable for sites where the ortho P level is below permit and only the total P related to solids is required to be removed.
Enhance existing resources or add new resources. Reedbed	A green alternative solution can be aerated, modular or conventional types. Low carbon footprint.	Suitable for phosphorus permits of 4 mg/l and above. Only removes solids. Any dissolved P will not be removed. Will need monitoring to ensure compliance. Little to no power requirement. However, requires suitable land footprint.
Enhance existing resources or add new resources. Wetland	A nature-based solution increasing biodiversity. Potentially partially funded through an Environmental Non-Government Organisation (ENGO).	Potential to be the least cost option, however uncertainty around the feasibility and cost of land purchase means there is low confidence in the final cost. Wetland solutions will be investigated further in the detailed design phase.
Enhance existing resources or add new resources. Mixture of solutions	To achieve site permit, several technologies will need to be deployed together.	Depending on the size of the works, including existing assets and permit limits, a multi technology approach will need to be taken. Complexity and time to build are significant considerations.

Table *3.* Options considered across sites for Sanitary determinands removal.

Option	Description	Viability
Maintain the effective risk controls already in place. Do nothing	Continue to use and maintain the existing assets without intervention as the site is meeting the required new discharge permit.	Only viable if current assets have capacity to work harder and discharge permits, and growth are unlikely to change significantly in the future.
Maintain the effective risk controls already in place. Monitor	Spot sampling, or installation of devices to measure permit determinands.	Only suitable for sites that are performing close to the new discharge permit.
Maintain the effective risk controls already in place. Optimisation	Optimisation of the existing site units to remove additional BOD, TSS or ammonia.	Only viable if existing assets are in good condition and there is additional headroom in the system.
Enhance existing resources or add new resources. Additional biological process units	The construction of additional biological and/or ammoniacal treatment units to meet the new BOD and/or ammonia permit limit. Example: Additional ASP Lane, new biofilters, tertiary SAF plant.	Viable if there is a lack of headroom for additional treatment capacity at the site.
Enhance existing resources or add new resources. Additional solids removal units	The construction of additional final tanks or tertiary solids removal (TSR) processes to meet the new solids permit.	Viable if there is a lack of headroom for additional treatment capacity at the site.
Enhance existing resources or add new resources. Reedbeds or wetlands	New reedbeds or wetlands on site for solids removal. May also enhance ammonia removal.	Viable where solids removal required is small (compared to the existing permit) and there is sufficient land available for the reedbeds or wetland.
Enhance existing resources or add new resources. Chemical dosing	Dosing of chemical into the existing Primary Settlement Tanks (PSTs) or elsewhere in the process to remove phosphorus and, if required, aid solids settlement. This can remove additional BOD as well.	Only suitable if no other options are viable but would suit a treatment works with a new TSS permit.

3.1.1 Assessment and Selection of Solution Options

Is there evidence that the proposed solution represents best value for customers, communities, and the environment over the long term?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.2b

The unconstrained options were constrained via assessment and scoring against five screening criteria to understand their efficacy for treatment, impacts to the environment and financial costs. The five screening criteria, sub criteria and attributed weighting for constraining the options can be seen in the associated option development reports. Table 4 and Figure 2 below explain the scoring, screening and weighting criteria, which were based on the requirements defined in the WINEP options development guidance.

Table *4* Scoring, screening and weighting criteria for long listing to short-listing evaluation.

Criteria	Sub Criteria	Description	Score			Weighting
			1	3	5	
Ability to meet S or NS obligations	**Regulatory Complexity**	How complex will this option be to regulate as a solution? (e.g., will there be a complex licence/permit).	Low	Medium	High	35%
	Problem Resolution	Will the option address the obligation identified? How much certainty is there that the option will deliver the benefits required?	Very Certain	Certain	Not Certain	
	Failure Risk	Is the option resilient to a range of future external factors/pressures, such as climate change and political and legislative changes?	Very Resilient	Resilient	Not Resilient	
Contribute to the WINEP wider environmental outcomes	**Natural Environment**	Will the option impact on biodiversity, shellfish cultivation and air quality?	Positive Impact	No Impact	Negative Impact	15%
	Net Zero	Will the option impact on GHG emissions during construction and/or operation, i.e., change in land-use, restoration, or enhancement of ecosystems.	Positive Impact	No Impact	Negative Impact	

Criteria	Sub Criteria	Description	Score			Weighting
			1	3	5	
	Catchment resilience	Will the option impact on flood risk (fluvial, groundwater or surface run-off), area of wetland or riparian habitants and river water quality? Will the option provide a more resilient and flexible water supply for the environment and public and private abstractions?	Positive Impact	No Impact	Negative Impact	
	Access, amenity and engagement	Will the option impact on recreational value of local green spaces, and provide educational opportunities to the local community? Will the option provide environmental volunteering opportunities to the local community?	Positive Impact	No Impact	Negative Impact	
Technical feasibility	**Technology Development Status**	What is the maturity of the technology	Well Proven	Some Installations	Trial Stage	15%
	Construction/ Buildability	What level of confidence is there that the scheme can feasibly be constructed?	High Confidence	Moderate Confidence	Low Confidence	
	Operability	Would the option require an on-going level of management and maintenance?	Low Level	Moderate Level	High Level	
Deliverability	**Client Acceptability**	Operational Experience of technology within Welsh Water	Positive Experience	Moderate Experience	Negative Experience	15%
	Resourcing	Is the labour/resource available to manage and maintain this option?	Highly Likely	Possible	Unlikely	

Criteria	Sub Criteria	Description	Score			Weighting
			1	3	5	
	Complexity	Could the option be delivered without the need for extensive feasibility studies, trials, investigations or infrastructure modifications?	Low Complexity	Moderate Complexity	High Complexity	
Cost	**Cost band**	What is the relative scale of expenditure (CapEx and OpEx) anticipated with the option?	Low TotEx	Moderate TotEx	High TotEx	20%
	Co-funding	Can the option be co-funded?	Highly Likely	Possible	Unlikely	

Site Name	EA WINEP Criteria	Ability to meet S or NS obligations			Contribute to the WINEP Wider Environmental Outcomes				Technically Feasibility			Deliverability			Cost		Total Weighted Score	Ranking	Selected for Constrained Solution?
	Sub Criteria	Regulatory Complexity	Problem Resolution	Failure Risk	Natural Environment	Net Zero	Catchment resilience	Access, amenity and engagement	Technology Development Status	Construction/Buildability	Operability	Client Acceptability	Resourcing	Complexity	Cost band	Co-funding			
	Option Description/ Weight	0.35			0.15				0.15			0.15			0.20				
PEN-Y-STRYT	Monitor Site	3.00	3.00	4.00	2.00	3.00	4.00	2.00	1.00	2.00	2.00	2.00	1.00	2.00	2.00	3.00	2.58	7	N
PEN-Y-STRYT	Pump away	1.00	3.00	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	2.00	2.00	3.00	2.00	2.00	1.86	5	N
PEN-Y-STRYT	Modular Reed Bed	1.00	2.00	2.00	1.00	2.00	1.00	1.00	2.00	2.00	1.00	2.00	1.00	2.00	2.00	1.00	1.57	2	Y
PEN-Y-STRYT	Wetland	1.00	3.00	3.00	1.00	1.00	1.00	1.00	1.00	4.00	1.00	1.00	1.00	2.00	2.00	1.00	1.77	4	Y
PEN-Y-STRYT	TSR (Actiflo, COUFs, Filter Clear, Mecana)	2.00	3.00	3.00	2.00	2.00	1.00	1.00	1.00	2.00	1.00	2.00	2.00	2.00	2.00	3.00	2.16	6	N
PEN-Y-STRYT	Single stage Chemical Dosing + New PSTs	1.00	2.00	2.00	2.00	1.00	2.00	1.00	1.00	1.00	1.00	2.00	1.00	2.00	2.00	3.00	1.71	3	Y
PEN-Y-STRYT	Single stage Chemical Dosing	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	2.00	2.00	2.00	1.49	1	Y

Figure *2*: Scoring and screening criteria example for Pen-Y-Stryt WwTW

The options are ranked according to their scores, with the most viable solutions advanced as short-listed options.

Weighting of the options facilitated the identification of options to progress in more detail. These options then had a cost benefit process applied to them to identify, measure and report on both financial and non-financial impacts and dependencies to enable holistic investment decision making.

Our approach to cost benefit appraisal and its role in decision making is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.3). This includes a cost benefit analysis (CBA) which comprises a detailed analysis of benefit to cost for all proposed options. The proposed solutions include quantification of risk and benefit over the long term via service measure framework (SMF) values, including valuation of the following criteria: natural capital; social capital; human, and intellectual properties.

The CBA tool was applied to for all 149 sites P sites and the 19 sanitary determinand sites.

An example of the CBA tool is presented in Table 5 and Table 6 for two sites Devauden and Clarbeston, which lists the progressed options and compares the benefit to cost ratios based on net present value (NPV) and total costs and whole life benefits values (All monetary values are expressed in 2022/23 prices and are prior to portfolio adjustments for corporate overheads and efficiency challenge. Welsh Water ref: SMF version 5).

Taking Devauden for example, the benefit to cost ratio for the modular reedbed option outweighs the other options of reducing P levels as it relieves both the risks of non-compliance and high expenditure

costs and benefits the environment over the long term due to its comparatively lower whole life carbon value.

Table 5. Example of benefit to cost ratio analysis (site: Devauden – 5 mg/l P permit).

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S1	1-point chemical dosing	£0.898M	£1.665M	£1.280M	0.769	-£0.384M
Option S2	Modular reedbed	£0.274M	£0.823M	£1.307M	1.588	£0.484M
Option S3	1-point chemical dosing + 2No new PSTs	£1.328M	£1.536M	£1.216M	0.791	-£0.320M

In the Clarbeston example, the EBPR (Enhanced Biological Phosphorous Removal) is almost double the CBA of a traditional chemical dosing option for complying with the 1.5 mg/l P limit. As the site is an activated sludge plant site already, adding the EBPR process onto this makes cost beneficial sense and is the best value for customers.

Table 6. Examples of benefit to cost ratio analysis (sites: Clarbeston 1.5 mg/l permit, and Penprys for Sanitary Determinands).

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S1	1-point Chemical dosing + Alkalinity dosing + 2No. New PSTs + COUF	£1.822M	£2.573M	£17.660M	6.87	£15.087M
Option S2	EBPR	£0.946M	£1.573M	£17.688M	11.25	£16.115M

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S1	Pump away to Llithfaen (linking in to the pentre Uchaf line), distance 213m	£0.373M	£0.503M	£1.123M	2.231	£0.620M
Option S2	Integrated RBC	£1.184M	£1.614M	£1.038M	0.643	-£0.576M

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S3	Wetlands	£0.219M	£0.689M	£1.059M	1.537	£0.370M

We have also included nature-based solutions (NBS) in the short list, specifically surface flow wetlands. Work is still being undertaken as to the feasibility of these WwTW's wetland processes to meet their new permit requirements, but most sites have had a desktop analysis to date to assess their suitability. This desktop analysis used static parametric tests (for example flow & load rate, trade effluent, PE) but did not include any ground investigations (soil samples, topography etc) to confirm suitability. Our next phase of work will include site specific assessment to conduct detailed ground assessment of potential wetland sites to advance our understanding of the buildability and effectiveness. The initial costs given are therefore estimates based on limited data. No wetland schemes have been promoted for AMP8 investment as the preferred option due to the level of uncertainty regarding this treatment technology at this stage. Should this subsequently be determined to provide a high confidence solution, Welsh Water would take advantage of the innovative permitting framework and a variable permitting scheme like that proposed by the EA for NBS solutions put forward. This is however, yet to be confirmed by NRW in Wales although we are currently in discussion with them over a trial site in North Wales.

Due to the additional benefits wetlands can provide, where suitable we will maximise opportunities to work with other sectors, taking a multi-benefit, multi-sector approach. However, any additional third-party contributions to a scheme will only be to deliver betterment *beyond* Welsh Water's required statutory duty, and the benefit would be reportable for the third party only. This is how we will ensure that we avoid over reporting or double counting of benefits, and that we deliver our statutory duty as a standalone funded commitment. See Section 3.4 for more information on collaboration.

This wetland option has the potential to be the least cost option, however uncertainty around the feasibility and cost of land purchase means there is currently low confidence in the final cost.

Third-party technical assurance of cost–benefit appraisal has been completed by Economic Insight who have confirmed that our approach is robust and in line with Ofwat expectations. Full details are given in the WSH50-IP00 Our Approach to Investment Planning (Section 6).

3.2 Quantification of Benefits

> ***Has the company fully considered the carbon impact, natural capital and other benefits that the options can deliver?***
> ***Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?***
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.2c and A1.1.2d*

Our approach to best value analysis is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.3).

Table 7 below summarises the carbon, environmental impact and nutrient removal, and includes value benefits for the entire P removal programme.

Table 7: AMP 8 benefits

Scenario	Benefits from AMP8 Spend relative to baseline							
	Legal Compliance	Greenhouse Gas Emissions	Final Effluent Quality	Environmental Impact	Avoidable Costs	Nutrient Removal	Engagement	Total
Preferred –	10.0%	-1.0%	4.9%	78.8%	-0.1%	7.4%	-0.1%	100%

The values show that whilst whole life carbon increases due to embedded and operational processes (-1% of the benefit calculation) the environmental and societal monetary benefit lie with the increase in the quality of discharged water and length of rivers improved.

The valuation of benefits was calculated from Welsh Water's multi-capital service measure framework (SMF), which converts a unit of benefit to an equivalent financial value. In addition, the improvement schemes in England, covered by the WINEP, were assessed using the Environment Agency's Wider Environmental Outcomes (WEO) matrix, as required by WINEP Options Development Guidance.

Within our cost benefit process the impacts of each option on the need have been quantified. Our methodology is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.3). This work will ensure we maintain our performance against our discharge compliance performance commitment and is critical to ensuring we can improve and maintain our EPA score.

It will also contribute to the new river water quality performance commitment by increasing the percentage of phosphorus we are removing relative to the 2020 baseline. However, Welsh Water's removal may not be directly comparable with English WASCs as we are not covered by the requirements of S10 of the Environmental Targets (Water) (England) Regulations 2023 requiring 80% reduction of phosphorus discharged to freshwaters compared to a 2020 baseline. Neither will we be covered by any potential new regulations requiring WASCs to meet technically achievable phosphorus limits in areas designated by Natural England as "Nutrient Neutrality" areas. Instead, the target has been set through the Strategic Steer of the PR24 Forum to meet 90% of our share of phosphorus removal in failing SAC rivers by 2030 with the remaining 10% to be delivered by the end of 2032.

Finally, it will also contribute to our Length of River Improved (LoRI) or Protected. This metric is used to identify the length of a watercourse, area of lake, or other water-dependent habitat within the boundary of the designated site that will be improved by our investment. This is calculated by measuring the linear distance from the existing discharge (WwTW outfall pipe) to the next significant discharge or confluence downstream. This methodology is supported by our environmental regulators, to ensure consistency with all water companies and all drivers.

Using our Service Measure Framework, we have split the benefits that we have rolled up into Ofwat drivers. The split for this Enhancement Case is shown below.

The bulk of the benefit in this case is in the environmental impact section with nearly 80% of the benefit in this category.

3.3 Uncertainties relating to cost and benefit delivery.

Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?

– Ofwat's final methodology for PR24, Appendix 9, A1.1.2e

Our methodology is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.3). This includes commentary on our approach to optioneering, costing and cost benefit analysis.

For this Enhancement Case we have evaluated a range of options in line with our TotEx hierarchy approach, an example is shown in Table 43.

We have highlighted in Table *8* below, areas in which the calculation of costs or benefits are unusual or uncertain, and how we have mitigated for this in our evaluation. In the majority of cases the proposed solutions are well-established, and the costs are known. The benefits are controllable and are also well known for this specific activity and are therefore achievable.

Table *8*: Example: options considered for Devauden. requiring a P permit of 5mg/l

Option	Description	Risks associated with costing this option or valuing its benefits	Mitigation [of the risk associated with costing]
Enhance existing resources or add new resources. 1-point chemical dosing	Single stage chemical dosing suitable for phosphorous permits above 2 mg/l as a stand-alone solution.	Conventional approach. Tying into existing treatment processes. Where the current existing assets (e.g., PSTs etc) are aging this may impact performance of the solution.	Not applicable
Enhance existing resources or add new resources. Modular reedbed	An alternative and 'greener' technology solution that can meet the desired discharge permit.	Low risk, low-cost approach and modular solution.	In assessing this option within our appraisal process the delivery risk has been considered as part of our qualitative assessment. This option has only been applied to 5 mg/l P consent sites.
Enhance existing resources or add new resources. 1-point chemical dosing + 2 new primary settlement tanks	New radial/conical tanks to replace existing. Plus, single stage chemical dosing for effective removal of solids.	Comparatively higher initial costs, higher whole life carbon, and longer payback period.	Not applicable.

3.4 Third Party Funding

Has the scale of forecast third party funding to be secured (where appropriate) been shown to be reliable and appropriate to the activity and outcomes being proposed?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.2f

No third-party funding is involved in any of the projects included in this Enhancement Case.

Our AMP8 plan is exploring opportunities to maximise collaboration and co-funding with other sectors, to enable third parties to garner additional benefit and environmental improvement.

For example, where we are mobilised to deliver a P reduction solution at a wastewater treatment works, but there is the option for the P to be reduced further, we will work in partnership with the local planning authority to enable an additional river betterment or future housing offsetting credits.

In this sense, no third-party funding will be sought to deliver the regulatory benefit, but instead it can be sought to deliver greater environmental improvements for the benefit of communities and other sectors.

4. Costing Efficiency

In this section, we give specific details on our approach to costing and benchmarking. Our overarching approach to developing efficient costs is set out in WSH50-IP00 Our Approach to Investment Planning (Sections 4.10 and 7).

The two sub-sections below correspond to the three criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A.1.1.3.

4.1 Developing a cost for Phosphorus and sanitary determinand removal

> ***Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate?***
> ***Does the company provide third party assurance for the robustness of the cost estimates?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.3a and A1.1.3c*

Costing of the options for each site and the development of least cost and alternative solutions via the application of a Risk and Value (R&V) process allowed for the identification of a preferred solution. This was applied to all viable costed options to identify, measure and report on both financial and non-financial impacts and dependencies to enable holistic investment decision making.

Our approach has been independently assessed by Jacobs (Engineering and Costs) and Economic Insight (CBA).
Throughout much of the PR24 process, the programme has been in development with NRW and the EA, and as such, has changed significantly over the period of engagement.

Our approach to costing has reflected the iterative and evolving nature of the NEP and WINEP.

- In some areas we have been able to develop costs for specific sites.
- In others we have developed cost bandings based on cost drivers such as population equivalent (PE) and process type to address P removal. This involved grouping schemes by PE and P permits to assign similar solutions and costs. The benefits, however, were attributed to each scheme individually.
- We have listed the key assumptions we used in the reports to the NRW and EA. We have also utilised a P removal technology matrix which identifies technology options appropriate to the size of the works and the P permit that has to be achieved.

This enabled a like-for-like (top down) approach, as described Section 5 Costing Methodology of 'Overview: How we have developed our investment plan'.

We used our Unit Cost Database (UCD) Cost & Carbon Estimating Tool (C&CET) which holds cost models for process and component assets, which we use to cost the developed scope of works for each of the proposed options. Where costs were not available in the UCD, quotes from suppliers for proprietary equipment were used.

Much of the scope is for items of work which have been constructed throughout previous AMPs, and as such we have a rich source of historical cost data. For these items of work, we have developed cost models based on the dominant cost drivers, e.g., the most influential driver to cost for a tank is volume. This costing approach forms the direct works and site-specific costs. We apply construction indirect costs and project oncosts based on the work stream, in this instance this is Wastewater Non-Infrastructure, which applies modelled percentages to the cost of the direct works and site specifics.

The scope is aligned to our Work Breakdown Structure (WBS), which was developed to support our data capture process of historical project cost against delivered assets, into a scope input sheet. Within this, sizing of the assets based on the relevant yardstick, which is dictated by the WBS, is

provided following calculation in the previous engineering stages. Our costs models are developed in line with our WBS, and this allows us to input this information into the C&CET and generate a project estimate. WBS details the inclusions and exclusions of works under each cost model and the limitations of the model, so we can ensure all project costs are captured and there is also no over costing.

Key assumptions in the costing of the P and sanitary determinand schemes include:

- Linear growth up until 2040 (local development plans only give us surety of growth up until 2025).
- If primary chemical dosing is required into a Primary Settlement Tank (PST) and this is an existing Dortmond type tank, then it will be replaced with a radial or conical tank as per our design specifications (PS217).
- Assumption that all remaining assets on a site are performing adequately where there are no operational records to say otherwise.
- Land purchase requirements for reedbeds have been assumed based on average costs per hectare provided by our estates team.
- Assumption that if the biological process on site is performing within current permit parameters it needs no further upgrades other than conventional Base Maintenance.

The structure of our OpEx forecast is based on when schemes are due to be completed according to the NEP and WINEP latest compliance date requirements. However, as the majority of these are towards the end of the AMP, sites will be upgraded to meet the new permits prior to this regulatory date to smooth out the capital expenditure profile and enable a realistic delivery profile. This means that the increase in OpEx for some sites (use of power, chemicals, sampling etc) may not be aligned with our projections in this paper. There will be pressure from our stakeholders to try and deliver these schemes earlier than the 2030 deadline in the NEP. We will assess the OpEx implications of delivering these schemes early in the AMP but that will add extra running costs earlier in the AMP than planned which may challenge our operating efficiency plans.

Along with our overall costing strategy being reviewed and assured by Jacobs, we have also employed third party consultants to review single Enhancement Cases to provide confidence that the estimates within them are robust, efficient, and deliverable. Please refer to WSH50-IP00 Our Approach to Investment Planning (Section 6) for more information regarding the review and assurance undertaken.

4.2 Benchmarking our approach

> ***Is there evidence that the cost estimates are efficient (for example using similar scheme outturn data, industry and/or external cost benchmarking)?***
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.3b*

We have engaged independent consultants to carry out a benchmark exercise on a representative sample of our P Removal schemes. They benchmarked a like-for-like scope against our pre-efficiency estimates of the identified scope of works. They found that our CapEx estimates came in within the benchmark range, with our NRW schemes (where most of our investment is focused), within the upper quartile. Our OpEx estimates were below the benchmark range from the industry data held by Aqua Consultants.

Table 9 - Extract from Benchmark report on the NRW sample

Site and Option	Welsh Water PR24	Low Benchmark	Mean Benchmark	High Benchmark	Variance to Mean	% from Mean
Total of Sample	£9.528M	£8.898M	£12.203M	£15.684M	-£2.675M	-21.9%

5. Providing Customer Protection

The below corresponds to the three criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A.1.1.4. There is no third-party funding for this Enhancement Case.

5.1 Proposed Customer Protected

> ***Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.4a*

We have not proposed a price control deliverable for this investment case as the outputs are contained within the WINEP and NEP and therefore have existing oversight from another regulator (EA/NRW). Failure to deliver will result in prosecution.

In addition, the investment will be covered by two common performances commitments (PC) and our length or river improved metric (as also described in 3.2 above):

- This work will ensure we maintain our performance against our discharge permit compliance performance commitment[9] and is critical to ensuring we can improve and maintain our EPA score.
- It will also contribute to the new river water quality performance commitment by increasing the percentage of phosphorus we are removing relative to the 2020 baseline[10].
- Finally, it will also contribute to our metric for Length of River Improved (LoRI) or protected (see Section 3.2 for definition)[8].

Failure to comply with the new standards will result in failures against the PC.

5.1.1 Extent of Protection

> ***Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.4b*

The benefits from this work are focused on delivery of the phosphorus and sanitary permit compliance standards. No wider benefits have been identified for the chosen solutions.

[9] The definition of this metric can be found at https://www.ofwat.gov.uk/publication/discharge-permit-compliance-pc-definition/

[10] The definition of this metric can be found at https://www.ofwat.gov.uk/publication/river-water-quality-pc-definition/. However, Welsh Water's P removal may not be directly comparable with English WASCs as we are not covered by the requirements of S10 of the Environmental Targets (Water) (England) Regulations 2023 requiring 80% reduction of phosphorus discharged to freshwaters compared to a 2020 baseline. Neither will Welsh Water be covered by any potential new regulations requiring WASCs to meet technically achievable phosphorus limits in areas designated by Natural England as "Nutrient Neutrality" areas. Instead, the target has been set through the Strategic Steer of the PR24 Forum to meet 90% of our share of phosphorus removal in failing SAC rivers by 2030 with the remaining 10% to be delivered by the end of 2032.

[8] PR24 WINEP Supporting Guidance: Capturing Outcomes for Environmental Enhancement and Protection - version 0.3.

6. Appendix A

Improving phosphorus and sanitary determinands removal at sewage works

The Ofwat drivers this Enhancement Case maps to are:

- CWW3b.064 - Treatment for phosphorus removal (chemical) (WINEP/NEP) wastewater capex
- CWW3b.065 - Treatment for phosphorus removal (chemical) (WINEP/NEP) wastewater opex
- CWW3b.067 - Treatment for phosphorus removal (biological) (WINEP/NEP) wastewater capex
- CWW3b.068 - Treatment for phosphorus removal (biological) (WINEP/NEP) wastewater opex
- CWW3b.070 - Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution (WINEP/NEP) wastewater capex
- CWW3b.071 - Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution (WINEP/NEP) wastewater opex
- CWW3b.073 - Treatment for tightening of sanitary parameters (WINEP/NEP) wastewater capex
- CWW3b.074 - Treatment for tightening of sanitary parameters (WINEP/NEP) wastewater opex

- CWW3b.103 - Investigations, other (WINEP/NEP) - desk-based studies only wastewater capex
- CWW3b.106 - Investigations, other (WINEP/NEP) - survey, monitoring or simple modelling wastewater capex

Table 10 – Allocation of Costs in the Data Tables

Driver Ref	Year in AMP8					
	1	2	3	4	5	Grand Total
CWW3b.064 - CapEx	£10.835M	£26.475M	£26.135M	£26.575M	£16.575M	£106.595M
CWW3b.065 - OpEx	£0.100M	£0.200M	£0.216M	£0.754M	£1.277M	£2.547M
CWW3b.067 - CapEx	£0.000M	£0.000M	£0.506M	£1.279M	£0.798M	£2.583M
CWW3b.068 - OpEx	£0.000M	£0.000M	£0.000M	£0.016M	£0.032M	£0.048M
CWW3b.070 - CapEx	£5.958M	£9.045M	£7.444M	£6.241M	£3.892M	£32.580M
CWW3b.071 - OpEx	£0.172M	£0.344M	£0.641M	£1.179M	£1.424M	£3.760M
CWW3b.073 - CapEx	£1.988M	£1.943M	£0.955M	£0.000M	£0.000M	£4.886M
CWW3b.074 - OpEx	£0.000M	£0.000M	£0.013M	£0.027M	£0.027M	£0.067M
CWW3b.103 - CapEx	£0.858	£0.838	£0.000M	£0.000M	£0.000M	£1.696M
CWW3b.106 - CapEx	£0.533M	£0.522M	£0.000M	£0.000M	£0.000M	£1.055M
TotEx	**£20.444M**	**£39.367M**	**£35.910M**	**£36.071M**	**£24.025M**	**£155.817M**

No other Enhancement Cases contribute to these drivers.

What We Will Deliver: This Enhancement Case will deliver WwTW improvements to meet new or tightened limits in the numeric compliances of;

1) 133 NRW sites and 16 EA sites for phosphorous permits,
2) 17 NRW sites and 2 EA sites for sanitary determinand reductions.

Site specific solutions include chemical dosing, nature-based solutions (reedbeds), an increase in biological capacity, and tertiary solids removal processes. Some sites have been identified as no build options as they already comply with the new permits.