SRN39 WINEP Enhancing Wastewater Treatment Enhancement Business Case

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from Southern Water

Contents

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Glossary

Acronym	Term
ASP	Activated sludge plant
BOD	Biological oxygen demand
DO	Dissolved oxygen
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
EPA	Environmental Performance Assessment carried out annually by the EA
MBBR	Moving bed biofilm reactor
N	Nitrogen
NE	Natural England
NPV	Net present value
NSAF	Nitrifying submerged aerated filter
ODI	Outcome delivery incentive
P	Phosphorus
PC	Performance commitment
PCD	Price control deliverable
PCL	Performance commitment level
PE	Population equivalent
R&V	Risk and Value
SSSI	Site of special scientific interest
TAL	Technically achievable limit
UV	Ultraviolet light
WFD	Water framework directive
WINEP	Water Industry National Environment Programme

Executive summary

Our business plan includes extensive proposals to make improvements to our treatment works in order to meet tight permit conditions. These investments will help play our part in making improvements to our local river, estuary and coastal environments.

The improvements we propose are statutory requirements to meet new tighter effluent permit limits. We have assessed the current performance of each site against the new permit requirements, and undertaken systematic and comprehensive options appraisal processes to consider a full range of nature-based and traditional solutions where upgrades are needed.

We have benchmarked our costs against Ofwat's PR19 enhancement models, where applicable, and used a rigorous process to derive efficient costs for our treatment works improvements applying standardised allowances based on analysis of historical data for indirect costs, risks and overheads for delivered projects of a similar scope and scale. The cost libraries are benchmarked internally and externally by our Cost Intelligence Team to understand relative cost efficiency.

Summary of Enhancement Case	
Name of Enhancement Case	WINEP – enhancing wastewater treatment
Summary of Case	We propose improvements at treatment works to meet tighter permit levels in: • Sanitary determinands (BOD and ammonia) • Phosphorus • Nitrogen • Microbiological quality
Expected Benefits	Our treatment works investments will help us play our part in meeting important targets and measures, including: • Water Framework Directive water body status improvements • The Government's Environmental Improvement Plan • The Environment Act phosphorus load reduction • Nutrient Neutrality requirements • Protecting local designated habitats • Shellfish and bathing water standards They will also deliver wider environmental outcomes particularly where we are able to install nature-based solutions.
Associated Price Control	Wastewater network plus
Enhancement TOTEX	£611 million
Enhancement CAPEX	£579 million
Enhancement OPEX	£16.3 million
Is this enhancement proposed for a direct procurement for customer (DPC)?	No. There are no individual schemes that are greater than £200m whole life totex, and the investment needed is varied and dispersed throughout our area.

1. Introduction and Background

Protecting and enhancing the environment is important to our customers and ourselves, as outlined in SRN38 Water Industry National Environment Programme (WINEP) Technical Annex. Improvements to our wastewater treatment processes can make a significant contribution to enhancing the local environment. Customers in principle support these improvements. However, they are statutory in nature and are not subject to needing evidence of customer support to proceed.

We have assessed the impact of our wastewater treatment activities on the environment through monitoring, the AMP7 statutory WINEP investigations and modelling across a wide range of quality parameters. From this, and the application of AMP8 WINEP guidance, we have developed an extensive programme of improvements at wastewater treatment works to meet statutory requirements. Our AMP8 WINEP actions will deliver improved effluent quality with respect to sanitary determinands (BOD and ammonia), nutrients (phosphorus and nitrogen), chemicals (e.g. cypermethrin) and microbiological contamination. Such needs are driven by environmental regulations, meaning the need to invest is outside management control.

There is a large scale of proposed investment particularly in nutrient removal, driven in the main by the Habitats Directive, SSSI protection, Water Framework Directive good ecological status ambitions, the Environment Act and Nutrient Neutrality regulations. Our DWMP includes long term planning objectives to progressively reduce risks to the environment but the regulatory drivers, in particular the Nutrient Neutrality requirements and WFD requirements mean a front-end loaded programme of improvements is necessary leading to an unprecedented large AMP8 programme. As a result, we propose to phase targeted investment beyond AMP8, rather than complete it all by 2030.

We will use nature-based solutions such as wetlands and reed beds to reduce pollutant loads from our sites where regulations and permit levels allow, and they represent best value for our customers. We are doing so where these solutions were the most cost beneficial, using the monetary valuation of wider environmental benefits provided by such schemes.

All of the AMP8 investments described in this document are enhancements to meet tighter permit levels. On sites with multiple drivers, we have developed separate solutions and costs for each driver. Where there is any overlap in scope, we have allocated the scope and associated cost to the most appropriate driver that is driving that cost, whether that is between enhancement cost categories or between enhancement and base. We have considered treatment works holistically for all investment needs in AMP8 to ensure there is no double counting of costs.

Our options assessment considers the existing assets and looks at the technical options available to us to meet the tighter standards set in the AMP8 WINEP. This technical detail was not suitable to explore with customers to determine their preferences above and beyond their clear preference to improve our local environment. Customers do not engage readily with solution choices we make within the boundary of our treatment works unless it has the potential to directly affect their neighbourhood.

Our customers have limited understanding of natural capital and nature-based solutions, as outlined in our SRN38 Water Industry National Environment Programme (WINEP) Technical Annex. But our future customers consider nature-based should be the primary approach and they would not support a solution that has not explored natural options first. Larger businesses, planning authorities and developers tend to favour certainty and stability that may come from end of pipe solutions, so they know our systems have the right capacity and right treatment by a known date.

Customers want us to focus on solutions that deliver environmental benefits. In particular they want us to use solutions that benefit habitats, wildlife, and ecosystems, followed by benefits to the local community and wider wellbeing.

The need and sites impacted for different wastewater improvement categories are provided below. We also set out the options appraisal process we went through to develop our preferred programme and demonstrate how our costs are efficient.

Links to data table lines		
Wastewater WINEP costs	CWW3	• Treatment for chemical removal (WINEP/NEP) • Treatment for total nitrogen removal (chemical) (WINEP/NEP) • Treatment for total nitrogen removal (biological) (WINEP/NEP) • Treatment for phosphorus removal (chemical) (WINEP/NEP) • Treatment for phosphorus removal (biological) (WINEP/NEP) • Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution (WINEP/NEP) • Treatment for tightening of sanitary parameters (WINEP/NEP) • Microbiological treatment - bathing waters, coastal and inland (WINEP/NEP) • Septic tank replacements - treatment solution; (WINEP/NEP) • Septic tank replacements - flow diversion; (WINEP/NEP)
Phosphorus and nitrogen removal WINEP scheme costs and site information	CWW19	All rows
WINEP related cost drivers	CWW20	All rows apart from 9 (current PE served by STWs)

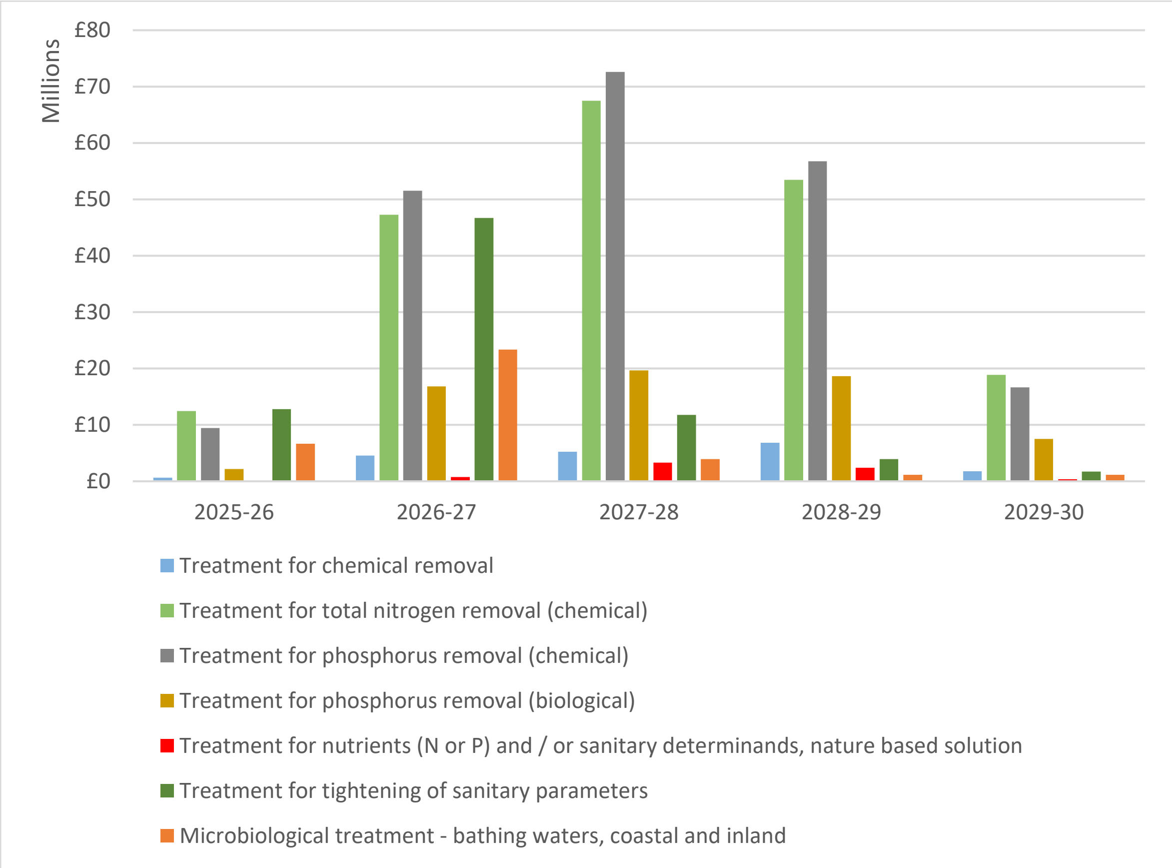
Our WINEP requires improvements at a large number of our treatment works. There are new quality permit conditions that apply to over 130 of our treatment works in AMP8.

A summary of costs in our AMP8 WINEP for enhancing wastewater treatment are shown in Table 1-1 and Figure 1-1.

Table 1-1 Business plan expenditure in enhancing wastewater treatment

Expenditure category in business plan table CWW3	AMP8 totex, £m 2022/23 prices
Treatment for chemical removal (WINEP/NEP) wastewater	19.1
Treatment for total nitrogen removal (chemical) (WINEP/NEP) wastewater	199.6
Treatment for total nitrogen removal (biological) (WINEP/NEP) wastewater	0.0
Treatment for phosphorus removal (chemical) (WINEP/NEP) wastewater	207.0
Treatment for phosphorus removal (biological) (WINEP/NEP) wastewater	64.8
Treatment for nutrients (N or P) and / or sanitary determinands, nature based solution (WINEP/NEP) wastewater	6.8
Treatment for tightening of sanitary parameters (WINEP/NEP) wastewater	76.9
Microbiological treatment - bathing waters, coastal and inland (WINEP/NEP) wastewater	36.3
Septic tank replacements - treatment solution; (WINEP/NEP) wastewater	0
Septic tank replacements - flow diversion; (WINEP/NEP) wastewater	0
TOTAL	**610.6**

Figure 1-1: WINEP enhancing wastewater treatment totex by year of AMP8



1.1. Phasing our treatment works investment in response to deliverability and affordability concerns

We will play our part in improving the local environment. However, the scale of the proposals that have emerged through following the WINEP methodology and guidance from environmental regulators is so large that we are concerned about its deliverability and affordability to our customers. This is particularly at a time when the cost of living is affecting many customers' ability to meet their household expenses. We are continuing discussions with the Environment Agency, Defra and Ofwat to resolve these concerns. We have built our PR24 Enhancement Business Case based on our phased WINEP as shared with the regulators on 19 July 2023.

Our phased WINEP delivers the best value solutions to make sure our WINEP delivers the maximum benefits it can within the scope of the improvements we need to make. We will deliver the WINEP in full, but over a slightly longer period due to the constraints on deliverability and affordability.

2. Improvements in Sanitary Determinands

The quality of rivers, seas and protected areas can be impacted by levels of BOD and ammonia in our wastewater effluents. We have assessed the risks to the environment caused from the sanitary determinand concentrations in our effluents and propose an AMP8 programme of improvements at our sites to mitigate risks of deterioration as well as improvements needed.

2.1. Needs case for enhancement

Modelling for WFD and ensuring there is no deterioration due to population growth mean we need to increase the treatment capacity for sanitary determinands at several sites. There are some additional sites with WFD improvements required to contribute to meeting the river status objectives. In total there are 21 sites with WFD drivers for sanitary determinand permit tightening and a further two sites with WFD drivers requiring solutions that improve DO in the river.

We also have three SSSI locations that require us to reduce levels of sanitary determinands in the wastewater effluent. These needs result from detailed AMP7 investigations and water quality sampling.

In total we have 26 sites needing investment to meet tighter sanitary determinand or DO permit levels.

Innovation in sanitary determinand requirements
Our AMP7 WFD investigations assessed the impacts on rivers of our activities and in two particular locations noted that dissolved oxygen (DO) levels in the river were sometimes low, meaning good ecological status was not reached. However, monitoring and modelling indicated that lowering our effluent BOD and/or ammonia was not likely to resolve the DO sag in the river. Following discussions with the EA we are exploring the application of DO permits and providing solutions to increase the DO in the river or in our treatment works effluent at two sites, Biddenden and Bethersden. This is a novel approach, and we are committed to working with the EA to understand the applicability and effectiveness of DO permits and what are appropriate WINEP actions to improve DO in the rivers.

2.1.1. Phasing investment to maximise benefits in AMP8

Our initial assessment from following the WINEP driver guidance produced a large programme of improvements, beyond what was affordable or deliverable. We have proposed to phase the investment over 8-10 years rather than complete it all within the 5-year AMP8 period. The impact on sanitary determinand investment proposals is relatively small, but there are some sites, required under WFD improvement drivers, where we are proposing to phase investment beyond AMP8.

We discuss our phasing approach in more detail in Section 3.1.1 because the more material impact of phasing WFD improvements is on nutrient removal.

2.2. Best option for customers

Our options assessment considers the existing assets and looks at the technical options available to us to meet the tighter standards set in the AMP8 WINEP. The feasible options can be constrained by the existing treatment facilities on the sites and the permit levels we need to meet in future. Our experience shows us some of our existing treatment processes cannot reliably meet tight permit levels. Where that is the case, seemingly small changes in permit levels can drive significant investment in changing processes, in particular converting a biological filter site to an activated sludge plant (ASP).

We assessed benefits using the tools described in SRN38 Water Industry National Environment Programme (WINEP) Technical Annex and SRN15 Cost and Option Methodology Technical Annex.

Table 2-1 Unconstrained options considered for ammonia reduction

Options	Short description of measures considered
1	Optimising existing assets
2	Addition of NSAF - tertiary nitrifying submerged aerated filter
3	Pumping away Constructed wetland or reed bed
4	Pumping away
5	Converting biological filter site to ASP

For tighter Ammonia permits, the following options have been considered:

1. We first look at the performance of the existing secondary treatment process on the site and assess if this could meet the new permit with the assistance of relatively minor improvements such as provision of flow recirculation or alkalinity dosing at a biological filter works.
2. The other standard solution is provision of tertiary nitrifying stage, typically a submerged aerated filter.
3. On small sites with very tight permit requirements, we consider the use of nature-based solutions such as constructed wetlands or reed-beds,
4. On small sites with tight permit requirements, we may also consider pumping the site away to a larger nearby site. The feasibility of this option will depend on the distance to the nearest site, the availability of spare capacity on the receiving site, and the acceptability of the transfer of flows to the EA and NE.
5. Where we need to achieve very low (1 mg/l) Ammonia permit levels on a biofilter works, we would look at converting the site to an activated sludge process as an option, particularly if we also need to meet tight permit levels for other determinands on the site.

Table 2-2 Unconstrained options considered for BOD reduction

Options	Short description of measures considered
1	Optimise existing processes
2	Convert to activated sludge plant (ASP)
3	Constructed wetland or reed bed
4	Pumping away to nearby site

For tighter BOD permits, the following options were considered:

1. We first look at the performance of the existing secondary treatment process on the site and assess if this could meet the new permit with the assistance of relatively minor improvements such as provision of flow recirculation.
2. One specific problem we have with BOD is when we get a new permit level of 7 mg/l or less on a biofilter site. We have found from operating experience that this is the limit that we can reliably achieve on a biofilter works, so are forced to change the site to an ASP. We have had three such sites in PR24 where we are having to convert biofilter sites to ASP to meet 5 mg/l BOD permits. Depending on the size of the site, alternative options for BOD permits of less than 7 mg/l include submerged aerated fixed film process (SAFF), Tertiary nitrifying trickling filters, or membrane bioreactor (MBR).
3. We consider nature-based solutions, typically installation of constructed wetlands or reedbeds, for smaller sites. The use of these options can be constrained by availability of sufficient land, suitability of soil type to contain the wetland, and the ability of the natural process to achieve the required permit level consistently at all times of the year. There is limited data availability on the ability of

constructed wetlands to meet BOD permits. We have found from experience that land area requirements tend to make wetlands unfeasible for sites of greater than 1,000 population equivalent.

4. On small sites, we also consider closure of the site and pumping of flows to a nearby larger site. The feasibility of this option will depend on the distance to the nearest site, the availability of spare capacity on the receiving site, and the acceptability of the transfer of flows to the EA and NE.

For the two sites with DO permits, we have considered end of pipe solutions only as we developed the WINEP. This is because the permit conditions are novel and there is no industry experience in the success of otherwise of options to meet such requirements. The solution we have used is to incorporate a final effluent aeration chamber between the final treatment process and discharging to the river. However, we intend to explore alternative river restoration or wetland options during detailed feasibility and design, in conjunction with local landowners and stakeholders.

The feasible options we took to full cost and benefits appraisal for sanitary determinand permit tightening and the results of that appraisal are shown in Table 2-3 below. We evaluated benefits, including wider environmental benefits of our options, using the approach described in SRN38 Water Industry National Environment Programme (WINEP) Technical Annex.

Table 2-3 Sanitary determinand schemes: feasible and selected options

Key: The preferred solution is shown with a green coloured cell with other shortlisted options that went through detailed feasibility shown by a cross “x”. We have selected the most cost beneficial scheme which is also in all cases the least cost option. Any non-standard solutions are described in the notes column. All the drivers, apart from WFD_IMP, are “statutory” and therefore cost benefit is not a relevant reason for excluding the scheme from the WINEP. WFD_IMP schemes are “statutory plus” which means there may be a cost benefit assessment before including them.
We show sites with BOD permit levels at TAL (5mg/l) in orange coloured cells.

Site	New BOD Permit level, mg/l	New Amm-N Permit level, mg/l	Additional biological capacity	Optimise existing assets	Addition of NSAF	Pump away	Constructed wetland	Convert to ASP	Tertiary treatment	Primary driver on the WINEP	notes
Appledore		4.7	Y	x						WFD_ND	
Barcombe New	10	2.0	Y	x		x				WFD_ND	
Battle	8			Y		x				WFD_ND	
Bidborough	8		Y	x		x			Y	WFD_ND	
Fairlight		8.0	x			x				WFD_ND	Improved recirculation of flow
Felbridge	10			Y		x				WFD_ND	
Godstone	18			Y		x				WFD_ND	
Hailsham South		1.0		x		x				WFD_ND	Additional PST and control
Hawkhurst South	15			Y		x				WFD_ND	
Headcorn	5			x		x		x	Y	SSSI_IMP	Combined solution for P and BOD, includes chemical dosing
Henfield	18	2.8		x		x			Y	WFD_ND	
Hooe	14			Y		x				WFD_ND	

Site	New BOD Permit level, mg/l	New Amm-N Permit level, mg/l	Additional biological capacity	Optimise existing assets	Addition of NSAF	Pump away	Constructed wetland	Convert to ASP	Tertiary treatment	Primary driver on the WINEP	notes
Horsham New		1.5		x	Y					WFD_ND	Solution includes liquor treatment
Lidsey	14			Y		x				WFD_ND	
Lingfield	10			Y		x				WFD_ND	
May Street Herne Bay	5			x					Y	WFD_ND	
Newbury Lane Cuckfield	15			Y		x				WFD_ND	
Newick	20		x	x		x				WFD_ND	Alkalinity dosing and additional secondary settlement
Oxted	9			Y		x				WFD_ND	
Paddock Wood	10	1.0	Y	x		x				WFD_ND	
Smarden		3.54					x		Y	SSSI_IMP	Combined with P removal solution – chemical dosing
Staplehurst		2.4						x	Y	SSSI_IMP	Combined with P removal solution – chemical dosing
Ticehurst	5			x		x		Y		WFD_ND	
Ulcombe	9	1.5	Y	x		x			Y	WFD_ND	Both solutions needed
Biddenden	River restoration to improve DO						x			WFD_IMP	Final effluent aeration chamber
Bethersden	River restoration to improve DO						x			WFD_IMP	Final effluent aeration chamber

2.2.1. Consideration of delivery through Direct Procurement for Customers (DPC)

Our sanitary determinands WINEP schemes consist of multiple dispersed investments, the vast majority of which are highly integrated with our current operational wastewater treatment sites. None of the individual schemes is above the £200m threshold for consideration as DPC by default. We are therefore not proposing to deliver this programme through DPC.

2.3. Cost efficiency - sanitary determinands

Our standard enhancement solution costing approach, described in Part B of SRN15 Cost and Option Methodology Technical Annex was followed to estimate the costs of the WINEP programme. This approach involves pricing solutions based on the best available information for the expected scope and the cost of that scope, and applying standardised allowances based on analysis of historical data for indirect costs, risks and overheads. The level of design development completed determines the granularity of scope that is available and therefore the specific costing approach to use. Costs are predicted using our libraries of standardised and regularly updated cost models developed from historical cost data augmented with industry information where required. These cost libraries are benchmarked internally and externally by our Cost Intelligence Team to understand relative cost efficiency, and further benchmarking has been performed for the chosen option.

There are many important and designated environmental sites and waterbodies across our region, which means we already have some very tight BOD (less than 10 mg/l) and ammonia (e.g. 1 mg/l) permits. These are increasing our costs relative to our own costs in the past and potentially relative to the costs of other companies for similar population equivalents.

Ofwat’s approach at PR19 was to allow the costs companies requested for improving sanitary determinands prior to a WINEP – level efficiency challenge. A robust benchmark proved elusive because of the variability in cost and scope of the new investment which depending on existing infrastructure and permit levels. We have struggled to find a robust unit cost at the programme level for our PR24 costs for similar reasons. As mentioned above, relatively small reductions in permit levels can lead to considerable investment at some sites due to the new permit levels being beyond the technical capability of the existing processes.

As described in our SRN38 Water Industry National Environment Programme (WINEP) Technical Annex, the source of our costs for PR24 is a set of cost data and cost curves provided by our Cost Intelligence Team, which use benchmarks based on delivery costs of our own recent projects, with normalised data from other sources used to fill any gaps and expand the available benchmarks. We have challenged ourselves on all aspects of costing – direct, indirect, risk and overheads – to ensure our proposed costs are efficient.

On nine of the sites, we are proposing optimisation of existing assets as the preferred solution. On these sites, we have not included costs for any new assets, but have allowed for the cost of additional staff time to optimise the existing site, and addition OPEX for additional power and/or chemicals where they are needed to improve the performance of the existing sites.

At Horsham, the preferred solution to reduce the current Ammonia permit from 2.5 mg/l to 1.5 mg/l is to provide a liquor treatment plant to reduce the ammonia levels returning to the process from the sludge dewatering plant on the site. This solution was identified as part of the design process for the ongoing AMP7 P driver on the site, and the cost was benchmarked against a cost provided by the AMP7 contractor.

On seven of the sites, our proposed solution is the provision of new or additional tertiary treatment processes on the sites instead of additional secondary biological treatment capacity. One of the reasons that we have taken this approach is that we have found in AMP7 that tertiary treatment tends to be more cost effective and offers greater cost certainty than providing additional secondary treatment capacity. As we have had large P removal programmes in both AMP6 and AMP7, we have a good understanding of the costs to install various types of tertiary treatment units. By contrast, we have installed additional secondary biological treatment on relatively few sites. We are only proposing additional secondary biological treatment capacity on five sites, and these are sites where the new permit level is particularly onerous (e.g. Paddock Wood, Ulcombe) or where there is a combination of new permit requirements requiring additional biological treatment capacity (e.g. Barcombe, Bidborough). Even on these sites, we have tried to select innovative types of additional biological treatment capacity such as secondary MBBR, as we know that this is more cost effective than construction of additional biological filter capacity or new ASP capacity, and we also have more certainty of the likely outturn costs.

We have only included the costs of installing the necessary new treatment processes in our WINEP costing. Any capital maintenance expenditure on existing assets is included in our estimate of capital maintenance expenditure elsewhere in our business plan costs.

The detail of our approach to costing and our process for ensuring our costs are efficient are provided in SRN15 Cost and Option Methodology Technical Annex.

2.4. Customer protection – sanitary determinands

Customers are protected through the common performance commitment of treatment works compliance. Such compliance is monitored against permit conditions which will change as a result of the WINEP. Without carrying out the investment we propose, the sites with tightened permit levels listed above would be highly likely to fail the treatment works compliance performance commitment level.

We describe the forecast of Performance Commitment Level (PCL) and ODI benefits of investment at treatment works to meet new permit conditions in SRN18 Performance Commitment Methodologies Technical Annex.

3. Nutrient Removal

We followed our R&V processes to qualitatively assess a full range of options to meet the new permit conditions at our treatment works, as described in our SRN38 Water Industry National Environment Programme (WINEP) Technical Annex. The types of solution considered for each determinand are listed in sub-sections below and the shortlist of options that were taken forward for quantitative evaluation are shown in Table 3-5 and the following tables below.

Some of the sites where we are proposing improvements in AMP8 are where a comprehensive AMP7 investigation was carried out. In these cases, an alternative options appraisal has informed our option selection. These investigations were performed under the EA guidance at the time and did not incorporate the wider environmental benefits assessment in the same way as we have evaluated through the R&V process. This is because it pre-dated the EA's PR24 wider environmental benefits guidance. However, the investigations included qualitative and quantitative natural and social capital benefits as evaluated at the time of the investigation. This approach was accepted by the EA as a suitable options appraisal for inclusion in our AMP8 WINEP. The EA has received and approved the outcome of the investigation reports which formed part of the AMP7 WINEP. Such investigations are used every AMP to ensure that risks to the environment from our activities are understood and to steer appropriate investment choices that will maximise environmental benefit.

3.1. Needs case for enhancement

Due to the nature of our region and the environmental risks we face, our plan includes a large programme of both phosphorus and nitrogen removal. Nutrient removal is driven by a range of different regulatory needs, all outside management control, including:

- Urban Wastewater Treatment Regulations
- SSSI regulations
- Habitats regulations
- Nutrient Neutrality requirements in the Levelling Up and Regeneration Bill
- Water Framework Directive regulations.

The Urban Wastewater Treatment Regulations (UWWTR) require tighter permit levels when sites cross a population threshold due to growth. Two sites are expected to cross the defined thresholds due to population growth during AMP8. These are Summer Lane Pagham and Wateringbury. Summer Lane Pagham will have a 0.25mg/l phosphorus permit in 2025 but because it will be covered by the UWWTR in AMP8 we are required to note the 2mg/l permit level this requires on the WINEP. Hence investment is not required to meet the Urban Wastewater permit level, but this site is included in our WINEP as investment is needed to meet the new monitoring and reporting requirements. Wateringbury discharges to an area newly designated as sensitive for phosphorus. It will be treating >10,000 population equivalent and so it is required to have a first-time phosphorus permit level of 2mg/l. Although the regulatory date for its completion is 13 May 2030, which is in AMP9, we propose to complete the full scheme in AMP8.

Some of our proposals to reduce phosphorus result from comprehensive AMP7 investigations which studied the state of protected areas, in particular habitats sites and SSSIs. These investigations sampled and monitored the state of the protected area and assessed the impact of our treatment works on their status. We have added to the WINEP actions where the investigations recommend tighter permit levels to enhance the protected area. We provide an example SSSI AMP7 investigation report in Appendix 1.

Water companies have a duty to help protect, conserve and restore European sites. This is reflected in statutory WINEP drivers including HD_IMP_NN, and we are expected to contribute to maintaining or restoring the habitats and species of our European sites at favourable conservation status across their natural range. Many of these sites do not meet favourable conditions for nutrients and therefore, nutrient neutrality will be required until these conditions are met. Nutrient neutrality requires us to make room for development in specified areas. The areas that have been defined by the Secretary of State cover a disproportionately large number of our sites compared to most other companies, as illustrated by Figure 3-1 below many of our wastewater customers live within these designated areas. This is driving an additional and large programme of improvements for both phosphorus and nitrogen across many of our treatment works. However, the legislation that requires these improvements is in draft and has not yet been enacted. The draft legislation is prescriptive in terms of permit levels (to the lowest technically achievable limit) and dates by which site improvements must be made (31 March 2030). Since the legislation is in draft, we are proposing a customer protection mechanism to return funds to customers should the legislation not be passed. We discuss this in section 3.7 below. We are also proposing to phase the investment beyond AMP8 to deprioritise investment where local authority plans indicate low or no housing development growth in the ten years to 2040.

Figure 3-1: Areas in England where >2,000 population equivalent treatment works will be required to meet TAL for phosphorus and/or nitrogen to meet nutrient neutrality guidance

Map courtesy of Natural England, March 2022
[NE785 Revised Edition Natural England Water Quality and Nutrient Neutrality Advice (16 March 2022) (1).pdf (southernwater.co.uk)]

The Water Framework Directive Regulations mean we have been through a comprehensive process of modelling and identifying actions to achieve our contribution to progress towards, or achievement of, ecological status objectives for local surface water bodies for nutrients (and/or sanitary determinands). We are also proposing actions to prevent deterioration of water body status. The WINEP actions result from AMP7 investigations into the impact of our activities on water bodies, and detailed water quality modelling, following the EA's guidance. We reviewed the outcomes of the investigations and modelling with the EA and NE.

The results of our assessment of needs across these different regulatory drivers is a large programme of investment to reduce both nitrogen and phosphorus in our wastewater treatment works effluents.

We are waiting for NE to clarify the boundary of the nutrient neutrality area with respect to one of our sites, Newnham Valley, Preston. It is captured within the current definition of the nutrient neutrality area but we are challenging the need to invest at the site which is downstream of the Stodmarsh protected area, and discharges into a tidal reach of the river. It is included within our WINEP with requirements to meet TAL for both phosphorus and nitrogen but we are awaiting confirmation once discussion on the nutrient neutrality boundary are concluded.

Advancing improvement following an investigation

The EA and NE have requested we include both an investigation and a solution in AMP8, under the SSSI driver, for the impact of the effluent from Coldwaltham WTW. We have included in our AMP8 programme both an investigation, funded through transition funding to start as soon as possible, and also a "holding line" for an improvement to TAL for both phosphorus and nitrogen. Based on other SSSI improvement schemes, this is a likely outcome should the investigation confirm suspicions that our effluent is impacting the SSSI. Responding in a timely fashion if our assets are impacted on the state of the SSSI is imperative, as there is a risk that the whole Arun Valley would be designated for nutrient neutrality, which would lead to considerable additional investment requirements.

We are keen to cut through the usual 5-yearly cycles which typically result in an investigation in one AMP leading to an improvement in the following AMP. This can mean up to ten years between the start of an investigation and resolution of the environmental risks the investigation explores. Our proposed approach will shorten the time taken between the issue being raised as a risk to the environment and its resolution through investment. The proposed regulatory completion date for the Coldwaltham improvement scheme is 2031

Phosphorus removal

We are proposing to invest to meet the tightest technically achievable limit of phosphorus at 45 of our sites in AMP8, some of which serve very small populations. In addition, our WINEP includes one further site, Harestock, against the Nutrient Neutrality driver which is already at this very low permit level, but we were asked to include it on the AMP8 WINEP by the EA. We are being asked to optimise performance to meet stretch targets below TAL at nine of our sites, some of which are large sites such as at Ashford and Canterbury. Harestock is also one of the sites with a stretch permit.

The Environment Act requires an 80% reduction in phosphorus load from a 2020 baseline by 31 December 2038, with an interim target of 50% reduction by 2028. At the start of AMP8 the load we discharge will be reduced by more than 35% of the 2020 baseline.

In total, there are 78 wastewater treatment works impacted by tighter phosphorus permits that we propose to complete in AMP8. Our phased WINEP will means we will reduce the phosphorus load in our wastewater effluent by 58.5% by 2030 compared to the 2020 baseline.[1]

[1] See SRN18 Performance Commitment Methodologies Technical Annex for the approach and calculation of our forecast performance through WINEP investment in the river water quality performance commitment.

Nitrogen removal

Protecting precious water habitats is driving a large increase in total N permits, all but one of which is at the TAL limit of 10mg/l. In total our AMP8 phased WINEP includes new total N permits at 32 sites. 8 of these are at the same level as existing permits, so we plan to invest at 24 sites to reduce total N loads to protect habitats, meet UWWTR and meet nutrient neutrality requirements.

3.1.1. Phasing of nutrient removal to maximise benefits delivered in AMP8

WFD cost benefit

Our most recent customer engagement shows there is strong support to focus investment where environmental benefits are highest. However, customers indicate they prefer to phase to a later date the investments with marginal benefits to smooth the impact on bills.

Our WFD improvement programme in the full WINEP consists of schemes at 52 sites (excluding two that relate to dissolved oxygen). These investment needs are a considerable contribution to the overall WINEP being unaffordable and undeliverable. Since WFD_IMP is a “statutory plus” or “S+” obligation which enables consideration of the balance of costs and benefits, we have prepared our business plan on the basis of a phased WINEP through the use of cost benefit filtering.

We selected 1.5 as the benefit to cost ratio at scheme level below which we would phase investment beyond AMP8. The effect of this phasing on the number of schemes is shown in Table 3-1 below.

Table 3-1 WFD improvements phasing proposal

Benefit to cost ratio scenario	Number of AMP8 schemes	Number of AMP9 schemes
Full WINEP WFD improvement programme	52	0
WFD improvement programme with benefit cost ratio >1.5 (in AMP8)	30	0
WFD improvement programme with benefit cost ratio <1.5 (in AMP9)	0	22

Most of the WFD phased investment is in P removal but there are some sites at which the investment is also to meet new sanitary determinand permit levels.

Phasing of Environment Act P load reduction investment beyond AMP8

Our application of WINEP driver guidance produced a number of schemes with the primary driver relating the Environment Act P load reduction target for delivery in AMP8. Many of the schemes include secondary drivers, but the tightest P permit level is required to meet the Environment Act requirements.

Since the Environment Act target is for 2038, well beyond the AMP8 period, we propose phasing all Environment Act P load reduction investment into later periods. As set out above, even with such phased investment we will be reducing P loads by 58.45% by 2030, and will remain on target to meet the Environment Act target.

Phasing of nutrient neutrality investment beyond AMP8 where negligible growth is forecast

Our initial assessment of the WINEP requirements to meet nutrient neutrality produced a very large programme, and was a significant factor in making our AMP8 enhancement investment unaffordable and undeliverable.

We have applied local authority growth plans to focus our AMP8 investment on nutrient neutrality where the forecast growth to 2040 is great than 2% of the population equivalent served by the site or the forecast growth is more than 200 dwellings. We propose to deliver improvements at sites with a lower forecast growth rate in AMP9.

The phased delivery of these lower growth schemes (less than 200 additional dwellings) will open up the opportunities to explore wider catchment and nature-based opportunities, working with the EA, Rivers Trusts, Catchment Partnerships and developers to find catchment and nature-based solutions. This would mean that we can deliver better solutions in collaboration with Councils and developers.

The implications of our proposals on number of schemes are shown in the table below.

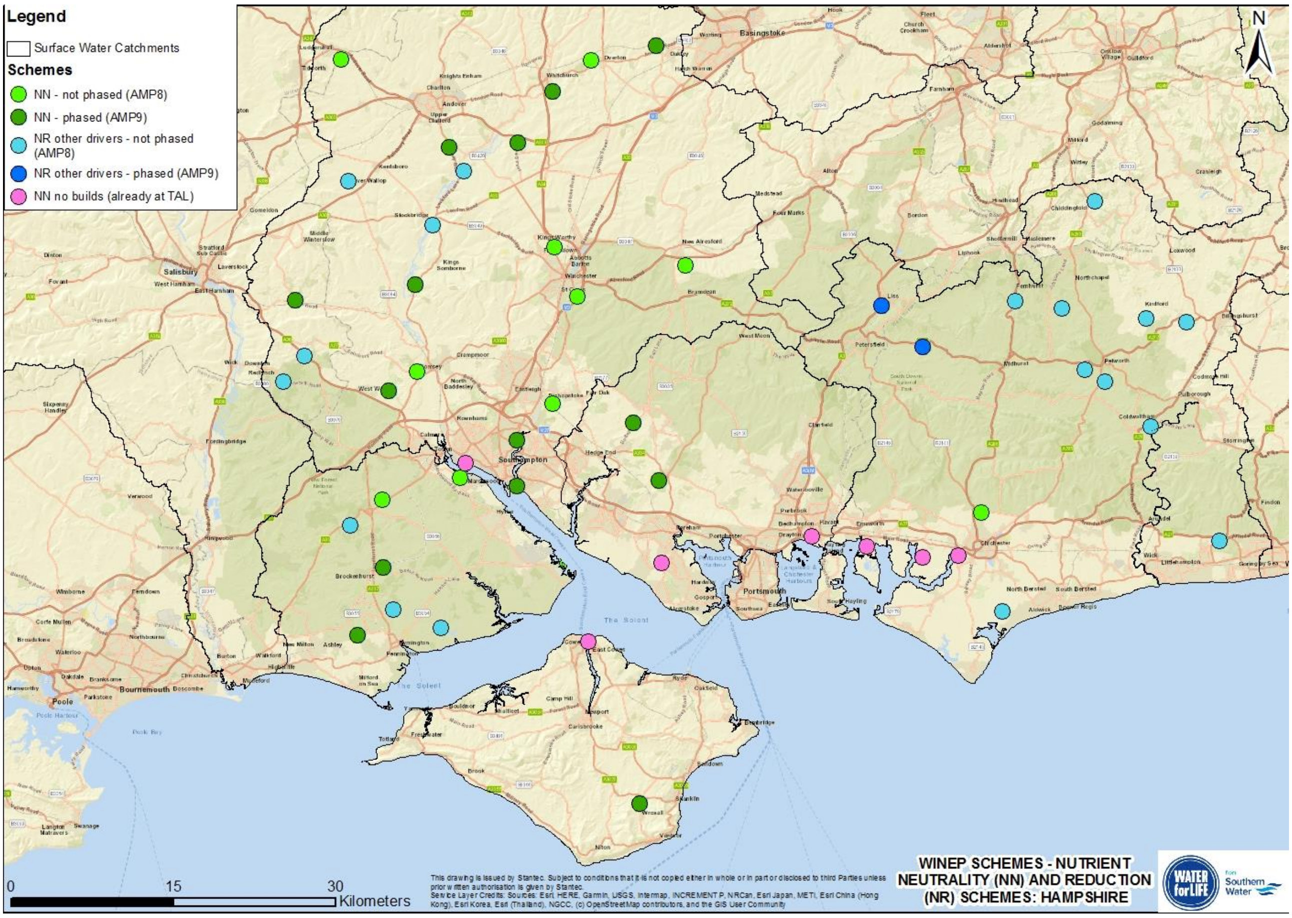
Table 3-2 Nutrient Neutrality phasing proposal

Growth Scenario	Number of AMP8 schemes	Number of AMP9 schemes
Total programme	27	0
AMP8 where LA 2030-40 growth plan >=2% of p.e. served and/or>200 dwellings	14	
AMP9 where LA 2030-40 growth plan <2% of p.e. served and <200 dwellings		13

Most of the nutrient neutrality sites are located in Hampshire, and there is considerable additional nutrient removal being proposed in the same area, as shown in the map below.

The map demonstrates that we are proposing to complete nutrient removal schemes throughout the Hampshire area. It shows that benefits of our AMP8 investment will be seen across the area within our phased approach to delivering our WINEP.

Figure 3-2 Map of locations of AMP8 WINEP nutrient neutrality and nutrient reduction investments in Hampshire



The table below lists the nutrient neutrality sites with a particular focus on nitrogen. It is only those relating to nitrogen that we propose to phase into AMP9 (apart from Newnham Valley Preston, for the reasons described above and West Wellow that has an AMP8 SSSI driver for phosphorus removal). To meet the draft legislation all nutrient neutrality sites will need to meet a 10 mg/l N permit.

Table 3-3 Nutrient neutrality sites and forecast growth

Site	AMP8 WINEP requirement	Totex, £m 2022/23 prices	Proposed to phase into AMP9	2025 permit level for Nitrogen, mg/l (where applicable)	Design population equivalent served by the site.	Number of new homes in local authority plans 2030-2040
BARTON STACEY	N removal	9.920	Y		4,564	0
BISHOPS WALTHAM	N removal	11.241	Y	15	18,202	99
BROCKENHURST	N removal	7.687	Y		3,055	2
EAST GRIMSTEAD	N removal	9.642	Y		3,211	0
FLEXFORD LANE SWAY	N removal	9.203	Y		2,637	20
FULLERTON	N removal	8.101	Y		68,876	161
IVY DOWN LANE OAKLEY	N removal	11.125	Y	35	5,315	14
KINGS SOMBORNE	N removal	9.083	Y		2,373	0
PORTSWOOD	N removal	35.758	Y		83,400	157
WHITCHURCH	N removal	10.758	Y	32	4,762	25
WICKHAM	N removal	9.468	Y		2,909	10
WOOLSTON	N removal	14.506	Y	15	68,342	56
WROXALL	N removal	9.753	Y		2,819	0
ASHLETT CREEK FAWLEY	N removal	24.9	N		13,846	1,330
CHICKENHALL EASTLEIGH	P and N removal	16.5	N		110,950	786
HARESTOCK	N removal and P stretch target	7.043	N		19,640	1,165
LAVANT	N removal	7.943	N		2,750	28
LUDGERSHALL	N removal	9.410	N	27	4,299	495
LYNDHURST	N removal	10.9	N		3,121	48
MAY STREET HERNE BAY	P and N removal	126.2	N		50,546	2,270
MORESTEAD ROAD WINCHESTER	P and N removal	28.6	N		48,250	404
NEW ALRESFORD	P and N removal	14.1	N	25	6,092	210
NEWNHAM VALLEY PRESTON	P and N removal	19.515	N		7,022	25
OVERTON	N removal	9.4	N		4,815	95
ROMSEY	N removal	11.4	N		21,221	1,290

SLOWHILL COPSE MARCHWOOD	N removal	13.6	N	14	74,757	2,524
WEST WELLOW	N removal and P removal	13.295	N		4,537	0
BOSHAM	Already at TAL	0	n/a	10	3,712	155
BUDDS FARM HAVANT	Already below TAL	0	n/a	9.7	401,354	19,208
CHICHESTER	Already below TAL	0	n/a	9.0	44,096	415
PEEL COMMON	Already below TAL	0	n/a	9.0	290,147	9,444
PENNINGTON	Already below TAL	0	n/a	9.5	56,322	1,365
THORNHAM	Already at TAL	0	n/a	10	21,282	2,409

Assuming our sites discharge effluent at the TAL permit level of 10mg/l following the WINEP investment, we have calculated an estimate of the total nitrogen loads that the nutrient neutrality schemes will be removing as follows:

- Our proposed AMP8 nutrient neutrality programme will remove 618 kg/year of total nitrogen from our wastewater effluent, at total cost of £156 million.
- The nutrient neutrality programme we propose to phase into AMP9 will remove a further 485 kg/year of total nitrogen from our wastewater effluent at a cost of £150 million.
- The nutrient neutrality sites where our permits are already slightly below TAL are removing 49.9kg/year of nitrogen more than if they were operating at TAL – the requirements of the nutrient neutrality driver.

3.2. Best option for customers - phosphorus removal

We have successfully delivered many P removal schemes in recent years and have continued to develop our standard P removal solutions through AMP6 and AMP7, working with the supply chain to make the designs leaner, continually challenging our standards, and improving the buildability. We will continue our solution development into AMP8, particularly with solutions to meet TAL across the full size-range of treatment works.

We recognise that chemical dosing options may be difficult for the sector to expand and sustain due to potential restrictions on availability of chemicals and the negative impact on carbon. We are therefore exploring alternatives such as use of algae, absorptive media for and electro-coagulation to generate ferric ions. These tend to be most applicable on smaller sites, with costs of scale-up being prohibitive for larger sites.

We evaluated benefits, including wider environmental benefits of our options, using the approach described in SRN38 Water Industry National Environment Programme (WINEP) Technical Annex.

Table 3-4 Unconstrained options considered for phosphorus removal

Options	Short description of measures considered
1	Chemical dosing, including tertiary solids removal and alkalinity dosing where necessary
2	Biological P removal process, including tertiary solids removal where necessary
3	Conversion to ASP, chemical dosing for P removal, tertiary solids removal and alkalinity dosing where necessary
4	Optimisation of site (where there is existing P removal), addition of tertiary solids removal where necessary
5	Pump away to neighbouring treatment works/ innovation treatment solutions
6	Provide integrated constructed wetland

For Total P permits, the following options were considered:

1. Chemical dosing of usually ferric chloride or ferric sulphate, with additional sodium hydroxide dosing on sites which have low alkalinity levels. In addition, tertiary treatment for solids removal will usually be required on sites where the required Total P permit is 0.7 mg/l or lower. This could be either a sand filter, or a cloth pile filter.
2. On sites where we already have an activated sludge process, modification of the process to facilitate Biological P removal is an option we considered. It is worth noting that we typically have fewer activated sludge sites than most other water companies, relying more on biological filters.
3. Conversion of a filter works to activated sludge can be considered, but it is usually much more expensive than installation of chemical dosing and tertiary solids removal. It is often considered where a tight iron permit may preclude dosing to meet low P permits.
4. On sites where we already have P removal assets such as chemical dosing and tertiary solids removal, we look at the feasibility of meeting the new permit requirements by optimising existing assets before looking at the need for new assets. This tends to be a viable option on sites where there is not much difference between existing and new permit levels.
5. On small sites, we consider closure of the site and pumping flows to a nearby larger site. The feasibility of this option will depend on the distance to the nearest site, the availability of spare capacity on the receiving site, and the acceptability of the transfer of flows to the EA and NE. Innovative solutions such as use of absorptive media for P removal, and the use of electro-coagulation to generate ferric ions instead of chemical dosing are also considered, but again they tend to be most applicable on smaller sites.
6. We consider nature based solutions, typically installation of constructed wetlands or reedbeds, for smaller sites. The use of these options is constrained by availability of sufficient land, suitability of soil type to contain the wetland, and the ability of the natural process to achieve the required permit level. We have found from experience that land area requirements tend to make wetlands unfeasible for sites of greater than 1,000 pe, and they are also unsuitable for achieving permit levels of lower than 0.5 mg/l Total P.

We have explored options involving catchment solutions to reduce P levels in AMP6 and in AMP7, but have found that they have limited application, and they are not something that we have considered for PR24 based on restrictions on our ability to implement such solutions because of our current EPA rating, as explained in SRN38 Water Industry National Environment Programme (WINEP) Technical Annex.

The feasible options we took to full cost and benefits appraisal and the results of that appraisal are shown in Table 3-5 below.

Table 3-5: Phosphorus removal schemes: feasible option benefit to cost ratio values

Key: The preferred solution is shown with a green coloured cell. NPV of whole life benefit to cost ratios are provided for the selected option at each site where benefits could be estimated, otherwise the selected option is shown with a "Y". Other feasible options taken to full cost and benefits appraisal are shown by "x". We have selected the most cost beneficial scheme which is also the least cost option, apart from at any sites indicated in the notes column. We show sites with phosphorus permit levels at TAL in orange coloured cells. More information about these sites can be found in business plan table CWW19.

Note that some of the P removal schemes are listed in section 3.3 below where they are combined with N removal solutions.

Site	P Permit level, mg/l	P stretch target, mg/l	Chemical dosing, and/or secondary or tertiary solids removal	Biological P removal	Convert to ASP plus chemical dosing	Optimise existing site	Pump away	Constructed wetland	Primary driver on the WINEP	notes
Bank	1.0		Y				x	x	SSSI_IMP	
Barns Green	0.25		x			10.58			WFD_IMP	
Barton Stacey	0.25	0.15	Y				x		SSSI_IMP	
Battle	0.3					Y			WFD_ND	
Berwick	1.5		1.57					x	WFD_IMP	
Biddenden	0.25		1.78			x			SSSI_IMP	
Boldre	0.25		x				Y		SSSI_IMP	Pump away WLC = 96% of chemical dosing WLC
Brockenhurst	0.25	0.15	Y						SSSI_IMP	
Burwash Common	0.9		4.46					x	WFD_IMP	
Cherry Gardens Goudhurst	0.4		5.12				x	x	WFD_IMP	
Chiddingfold	0.25					Y			WFD_IMP_MOD	
Chilbolton	0.25		Y					x	SSSI_IMP	Wetland 6 times WLC of dosing.
Clapham	4.0		Y				x	x	WFD_ND	Wetland 6.7 times WLC of dosing.

Site	P Permit level, mg/l	P stretch target, mg/l	Chemical dosing, and/or secondary or tertiary solids removal	Biological P removal	Convert to ASP plus chemical dosing	Optimise existing site	Pump away	Constructed wetland	Primary driver on the WINEP	notes
Coolham	1.0				x	1.38		x	WFD_IMP	
Cowden	0.5		2.10				x	x	WFD_IMP	
Cowfold	0.4					5.76			WFD_IMP	2mg/l Fe permit
Cranbrook	0.4		Y		x				SSSI_IMP	2mg/l Fe permit
Crouch Farm Mayfield	0.3					7.77			WFD_IMP	
Dial Post	1.5		7.03				x	x	WFD_IMP	Electro-coagulation higher cost than dosing
East Hoathly	0.25		3.33				x	x	WFD_IMP	
Evans Close Over Wallop	0.25		Y					x	SSSI_IMP	Wetland WLC 2.21 times dosing WLC
Fernhurst	0.3					15.09			WFD_IMP	
Frant	1.5		10.56				x	x	WFD_IMP	
Frittenden	0.25		Y					x	SSSI_IMP	Wetland WLC 1.6 times dosing WLC
Fullerton	0.25	0.15	x			Y			SSSI_IMP	
Guestling Green	0.25		x			14.21			WFD_IMP	
Harestock	0.25	0.15							HD_IMP_NN	
Headcorn	0.25		0.62		x				SSSI_IMP	
Horsmorden	0.25		0.83		x				SSSI_IMP	
Itchingfield	0.5		x				x	1.39	WFD_IMP	
Kirdford	0.6					1.69		x	WFD_IMP	

Site	P Permit level, mg/l	P stretch target, mg/l	Chemical dosing, and/or secondary or tertiary solids removal	Biological P removal	Convert to ASP plus chemical dosing	Optimise existing site	Pump away	Constructed wetland	Primary driver on the WINEP	notes
Lamberhurst	0.5		6.06	x					SSSI_IMP	
Lenham	0.25								HD_IMP	
Linton	0.25		3.42					x	SSSI_IMP	
Lower Beeding	1.0					6.05	x	x	WFD_IMP	
Lurgashall	2.5		7.14				x	x	WFD_IMP	Electro-coagulation higher WLC than dosing
Nutley	0.5		2.01						WFD_IMP	
Oxted	0.25	0.15				Y			WFD_IMP_MOD	
Penshurst	0.5		x				3.56	x	WFD_IMP	
Petworth	1.0		1.64						WFD_IMP	
Redlynch	0.25		x			Y			SSSI_IMP	
Romsey	0.25	0.15	x			Y			SSSI_IMP	
Shipley	3.5		3.98				x	x	WFD_IMP	
Sissinghurst	0.25			x		Modify existing MBR 3.31			SSSI_IMP	2mg/l Fe permit
Slaugham	0.3		x					1.29	WFD_IMP	
Smarden	0.4		2.81						SSSI_IMP	
Staplecross	0.25				1.46				WFD_IMP	2mg/l Fe permit
Staplehurst	0.25		1.17		x				SSSI_IMP	
Steyning	0.3		1.15						WFD_IMP	

Site	P Permit level, mg/l	P stretch target, mg/l	Chemical dosing, and/or secondary or tertiary solids removal	Biological P removal	Convert to ASP plus chemical dosing	Optimise existing site	Pump away	Constructed wetland	Primary driver on the WINEP	notes
Stockbrodge	0.25		Y					x	SSSI_IMP	Wetland WLC 4.7 times dosing WLC
Stone Hill Road Egerton	0.25		2.61					x	SSSI_IMP	Wetland WLC 3.4 times dosing WLC
Stubbs Lane Brede	0.25				0.21				WFD_ND	2mg/l Fe permit
Sutton Valence	0.25		x	1.69					SSSI_IMP	1mg/l Fe permit
Tillington	1.0		2.88				x	x	WFD_IMP	
Vines Cross	0.25		0.63						WFD_IMP	
Washwell Lane Wadhurst	0.4					6.92			WFD_IMP	
Wateringbury	2.0		Y						U_IMP1	
West Wellow	0.25		Y		x				SSSI_IMP	
Whitegates Lane Wadhurst	0.25		2.06	x					SSSI_IMP	
Whiteparish	0.25		x			Y			SSSI_IMP	
Wilmington	4.0		2.65				x	x	WFD_IMP	
Windmill Hill Herstmonceux	0.3					12.42			WFD_IMP	
Wisborough Green	0.4		2.33						WFD_IMP	

3.2.1. Consideration of delivery through Direct Procurement for Customers (DPC)

Despite being a material programme of work that in itself is greater than £200 million whole life totex, our phosphorus removal programme consists of multiple dispersed investments, the vast majority of which are highly integrated with our current operational wastewater treatment sites. None of the individual schemes is above the £200m threshold for consideration as DPC by default. We are therefore not proposing to deliver our phosphorus removal programme through DPC.

3.3. Best option for customers nitrogen removal

We assessed benefits using the tools described in SRN38 Water Industry National Environment Programme (WINEP) Technical Annex.

Table 3-6 Unconstrained options considered for Nitrogen removal

Options	Short description of measures considered
1	Optimising existing processes and methanol dosing
2	Conversion to Activated sludge plant (ASP)
3	Additional process such as anoxic tank
4	Denitrifying sand filter or moving bed bioreactor (MBBR)
5	Constructed wetland or reedbed
6	Pumping away to nearby site.

On many of the sites identified for Total N permits, we are also getting very tight Total P permits, so the solution will also need to include one of the options for Total P removal listed above. For Total N permits, the following options have been considered:

1. Total N removal to tight permit levels on existing sites which are already capable of removing total N usually requires the provision of additional carbon to encourage the growth of the correct type of bacteria. This is usually achieved by dosing methanol.
2. Achieving a low Total N permit is easier on an activated sludge process than on a filter works. Therefore, if we get a Total N permit close to the 10 mg/l TAL on a filter works, we consider the feasibility of converting the site to an ASP.
3. If there is an existing ASP on the site, we would look at what modifications are needed to encourage Total N removal, e.g. addition of an anoxic tank.
4. Unless we have an activated sludge process design for Total N removal, we would need to provide some form of denitrifying process after the main secondary treatment process, which could be either a denitrifying sand filter or a MBBR (moving-bed biofilm reactor).
5. Nature based solutions, typically installation of constructed wetlands or reedbeds, are considered for smaller sites. The use of these options is constrained by availability of sufficient land, suitability of soil type to contain the wetland, and the ability of the natural process to achieve the required permit level. There is limited data availability on the ability of this type of solution to meet Total N permits. We have found from experience that land area requirements tend to make wetlands unfeasible for sites of greater than 1,000 PE.
6. On small sites, we consider closure of the site and pumping of flows to a nearby larger site. The feasibility of this option will depend on the distance to the nearest site, the availability of spare capacity on the receiving site, and the acceptability of the transfer of flows to the EA and to Natural England.

Table 3-7 Nitrogen removal sites

Key: The preferred solution is shown with a green coloured cell. A cross shows where other constrained options were fully evaluated for costs and benefits. We have selected the most cost beneficial scheme which is also the least cost option. We show sites with nitrogen permit levels at TAL in orange coloured cells.

Site	Permit level, mg/l	Pump away	Provide constructed wetland (natural solutions)	Additional chemical /methanol dosing and tertiary treatment	Methanol dosing and denitrifying sand filters to meet Total N permit Chemical dosing and tertiary solids removal to meet any P permit	Methanol dosing and MBBR to meet Total N requirements. Additional chemical dosing and tertiary solids removal to meet any P permit	Extend existing ASP. Methanol dosing to meet Total N permit Chemical dosing and tertiary solids removal required to meet any P permit	New ASP. Methanol dosing for Total N permit. Chemical dosing and tertiary solids removal required to meet any P permit	Primary driver/ notes
Ashford	0.25 P 10 N				x	Y			HD_IMP
Ashlett Creek Fawley	10 N				Y				HD_IMP_NN
Canterbury	0.25 P 10 N					x	Y		HD_IMP
Charing	0.25 P 10 N				x	Y			HD_IMP
Chartham	0.25 P 10 N				x	Y			HD_IMP
Chickenhall Eastleigh	0.25 P 10 N			Y	x				HD_IMP
Chilham	0.25 P 10 N		x			x		Y	HD_IMP
East End	10 N	Y	x						SSSI_IMP
Harestock	10 N						Y		HD_IMP_NN
Lavant	10 N						Y		HD_IMP_NN

Site	Permit level, mg/l	Pump away	Provide constructed wetland (natural solutions)	Additional chemical /methanol dosing and tertiary treatment	Methanol dosing and denitrifying sand filters to meet Total N permit Chemical dosing and tertiary solids removal to meet any P permit	Methanol dosing and MBBR to meet Total N requirements. Additional chemical dosing and tertiary solids removal to meet any P permit	Extend existing ASP. Methanol dosing to meet Total N permit Chemical dosing and tertiary solids removal required to meet any P permit	New ASP. Methanol dosing for Total N permit. Chemical dosing and tertiary solids removal required to meet any P permit	Primary driver/ notes
Lenham	0.25 P 10 N				x	Y			HD_IMP
Ludgershall	10 N						Y		HD_IMP_NN Current permit 27mg/l N
Lyndhurst	10 N						Y		HD_IMP_NN
May Street Herne Bay	0.25 P 10 N						Y		HD_IMP_NN
Morestead Road Winchester	0.25 P 10 N						Y		HD_IMP_NN
New Alresford	0.25 P 10 N						Y		HD_IMP_NN alkalinity dosing needed Current permit 25mg/l N
Overton	10 N				Y				HD_IMP_NN
Romsey	10 N						Y		HD_IMP_NN
Sellindge	0.25 P 10 N				x	Y			HD_IMP
Slowhill Copse Marchwood	10 N						Y		HD_IMP_NN

Site	Permit level, mg/l	Pump away	Provide constructed wetland (natural solutions)	Additional chemical /methanol dosing and tertiary treatment	Methanol dosing and denitrifying sand filters to meet Total N permit Chemical dosing and tertiary solids removal to meet any P permit	Methanol dosing and MBBR to meet Total N requirements. Additional chemical dosing and tertiary solids removal to meet any P permit	Extend existing ASP. Methanol dosing to meet Total N permit Chemical dosing and tertiary solids removal required to meet any P permit	New ASP. Methanol dosing for Total N permit. Chemical dosing and tertiary solids removal required to meet any P permit	Primary driver/ notes
									Current permit 14mg/l N
Summer Lane Pagham	15 N								U_IMP1 Site already meeting N permit
Westbere	0.25 P 10 N				Y	x			HD_IMP
Westwell	0.25 P 10 N	Y	x			x			HD_IMP
Wye	0.25 P 10 N				x	Y			HD_IMP
Coldwaltham holding line	(0.25 P 10 N)							Y	SSSI_IMP contingent on INV

3.3.1. Consideration of delivery through Direct Procurement for Customers (DPC)

Our nitrogen removal WINEP schemes consist of multiple dispersed investments, the vast majority of which are highly integrated with our current operational wastewater treatment sites. None of the individual schemes is above the £200m threshold for consideration as DPC by default. We are therefore not proposing to deliver our nitrogen removal programme through DPC.

3.4. Cost efficiency - phosphorus removal

Our standard enhancement solution costing approach, described in Part B of the SRN15 Cost and Option Methodology Technical Annex was followed to estimate the costs of the phosphorous removal programme. This approach involves pricing solutions based on the best available information for the expected scope and the cost of that scope, and applying standardised allowances based on analysis of historical data for indirect costs, risks and overheads. The level of design development completed determines the granularity of scope that is available and therefore the specific costing approach to use. Costs are predicted using our libraries of standardised and regularly updated cost models developed from historical cost data augmented with industry information where required. These cost libraries are benchmarked internally and externally by our Cost Intelligence Team to understand relative cost efficiency, and further benchmarking has been performed for the chosen option.

The relative costs of our phosphorus removal programme are higher than at PR19 and we expect them to be higher than those of many other companies due to the nature of our region and our PR24 WINEP. According to the EA almost every river in our area shows quite or very certain evidence of eutrophication, requiring us to reduce nutrients to very low concentrations. We have benchmarked our costs against our own recent outturn scheme costs and Ofwat's PR19 cost model. Our AMP8 proposed costs are higher than the PR19 model suggests are efficient. However, we have a number of mitigating factors that Ofwat should consider as it benchmarks AMP8 P removal costs. We do not consider the Ofwat PR19 model to represent the scope of our PR24 phosphorus removal programme.

The factors that are increasing our P removal costs from those at PR19 include:

- **Lack of targeting through cost benefit assessment**. It is important that Ofwat recognises the impact of new legislation on AMP8 P removal costs. Through the nutrient neutrality requirements and the Environment Act we are required to submit P removal schemes that, under PR19 legislation we would not have submitted. They are not required under other drivers and would have been screened out under PR19 WINEP rules because they fail cost benefit analysis. If our programme was made up of only those with a benefit:cost ratio of >1.0 then our costs are much closer to the PR19 benchmark costs from Ofwat's model.
- **The high number of improvements required at very small treatment works**, treating less than 1,000 population equivalent. We have 32 out of 78 P removal sites with PE of less than 1,000. This compares to an average PE of sites in AMP7 across the industry of 20,000. Our AMP8 programme has a marked diseconomy of scale compared to the industry's AMP7 programme. The total design population of our AMP8 P removal sites divided by the number of AMP8 P removal sites shows an average population served of less than 10,000. Figure 3-3 shows the costs per PE for all WINEP schemes across both AMP8 and phased AMP9 programmes, prior to us applying our AMP8 efficiency challenge. It shows the higher unit costs for our future schemes compared to AMP7.
- **The increasingly tight standards**. We have 45 of the 78 sites with permit levels at TAL (0.25mg/l) and nine of them with stretch targets where we will use best endeavours to go below TAL, typically to 0.15 mg/l. Overall, 61 of the 78 sites (78%) have P permit levels of 0.5 mg/l or less. At PR19 Ofwat considered <0.5 mg/l to be the indicator of a tight permit but this may need to be reconsidered in the light of AMP8 permits. The PR19 model was based on company programmes that ranged from 32% to 65% of sites with permits <0.5mg/l. In addition, on a well-performing site, we would expect to be able to achieve a P permit level of 0.7 mg/l or 0.8 mg/l without the need for tertiary solids removal. Of the 78 sites in PR24, 62 have permit levels of less than 0.7 mg/l, so they will require some form of tertiary solids removal, which considerably increases the costs. Figure 3-4 illustrates the high occurrence of TAL permits in our AMP8 WINEP compared to industry levels at AMP7.

- **Proportion of sites with first time P permits**. 68 of the 78 sites are getting P permit requirements for the first time, so do not have any existing chemical dosing assets on the site. These include the smallest treatment works.
- **Iron permits**. Some of our AMP8 P removal sites have tight iron standards accompanying a tight P permit (1 sites with 1 mg/l Fe permits and 6 sites with 2 mg/l Fe permits), limiting opportunities for use of conventional chemical dosing, and/or requiring enhanced tertiary solids removal to remove residual ferric particles. Unlike some other water companies, we have not previously been successful in obtaining EA permits to use aluminium as an alternative to ferric dosing.
- **Alkalinity constraints**. Because of local water chemistry in the Kent and East Sussex areas, we need to dose sodium hydroxide to protect alkalinity levels on many sites where we dose high levels of ferric. Most of our PR24 P removal sites are in these low alkalinity areas. We will need to install alkalinity dosing on the majority of our P removal sites. In addition to the CAPEX cost of an additional chemical dosing unit, it impacts on OPEX costs due to the high cost of sodium hydroxide.

Figure 3-3: Pre-efficiency WINEP P removal unit costs compared to AMP7

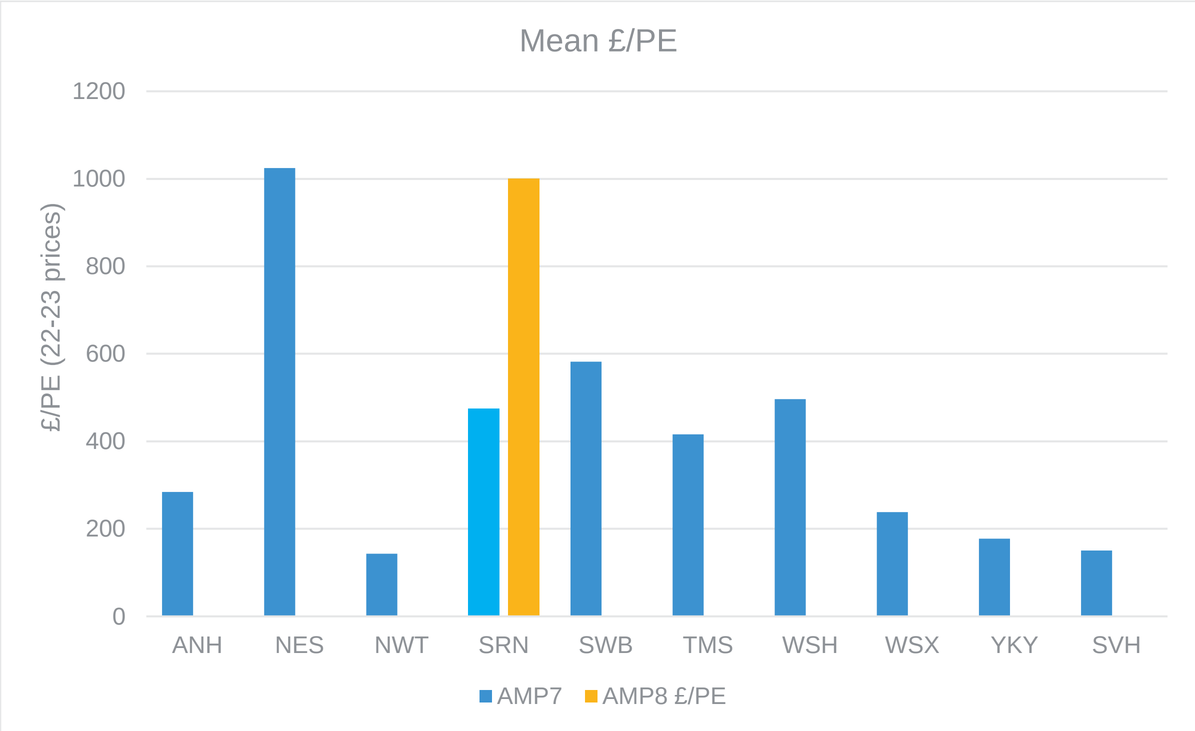
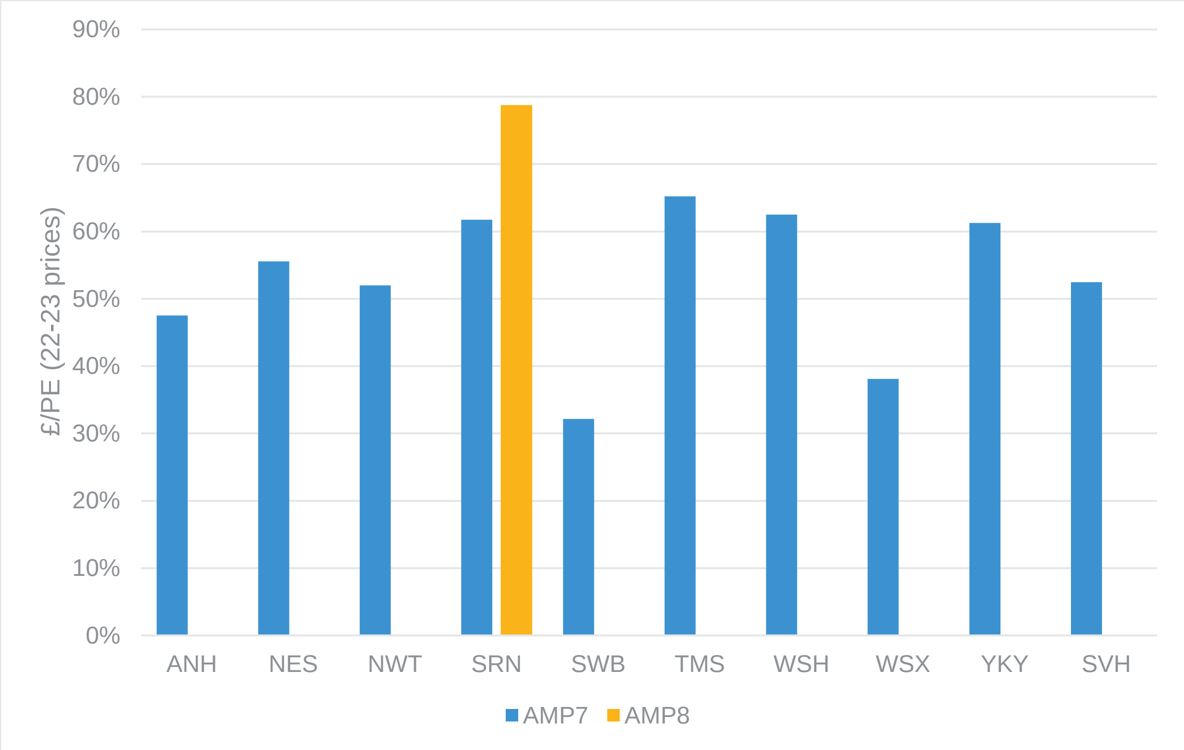


Figure 3-4: Percentage of P removal permits in WINEP that are at TAL of 0.25 mg/l



Unlike at PR19, we are getting Total N permits alongside Total P permits on 15 sites in PR24. All of these Total N permit levels are at the TAL limit of 10 mg/l. The solutions that we have put forward on these sites are to meet both Total N and Total P requirements, with costs allocated according to the process improvements each determinand is requiring to be upgraded.

In addition to Total N, two of the P sites include a solution for a tighter ammonia permit limit, three sites with tighter BOD requirements, and five sites with Chemicals driver requirements. We have allocated costs according to which process improvements each permit change drives.

We have considerable experience in delivering P removal schemes, particularly in AMP6 and AMP7. The source of our costs for PR24 is a set of cost data and cost curves provided by our Cost Intelligence Team, which are based on pre-AMP7 delivery costs on Southern Water projects, with normalised data from other sources used to fill any gaps.

For P permits, we have assessed the performance of all sites which have existing P permits, and determined whether it might be possible to meet the new permit requirements by simply optimising the existing chemical dosing and/or tertiary treatment assets on the site. We have proposed optimisation as the preferred option on 18 sites.

From our experience of delivering large programmes of P schemes in AMP6 and AMP7, we have a good understand on the costs involved in provision of chemical dosing units and of certain types of tertiary solids removal units. We also understand the construction risks and compliance risks associated with these types of units. From our experience of optioneering for the AMP7 programme through our Risk and Value process, we have a good understanding of what chemical dosing and which types of tertiary treatment will be most cost effective on each site, and we have used this experience to propose the most appropriate solutions on a site-by-site basis.

Benchmarking against Ofwat's PR19 P removal model

At an early stage in our WINEP development we updated the four models that Ofwat and the CMA used at PR19 to provide a total cost estimate for our PR24 phosphorus removal plan as specified by the number of enhanced sites, enhanced sites with P permit levels <=0.5mg/l, enhanced sites with P permit levels <=1mg/l, enhanced sites with no prior P permit, and PE of the enhanced sites.

Our benchmarking results indicated that despite using efficient costing approaches based on outturn data and significant internal challenge to those costs, our pre-phased AMP8 WINEP costs appear to be very inefficient in comparison to our own AMP7 proposals and the Ofwat PR19 model. We have concluded this to be because the PR19 model is not accounting for the factors listed above which are increasing our unit cost on both a per site and a per PE basis. This is illustrated in Figure 3-5 and Figure 3-6 below.

Figure 3-5: P removal costs - PR19 and our PR24 totex vs population equivalent (PE) (pre-phasing)

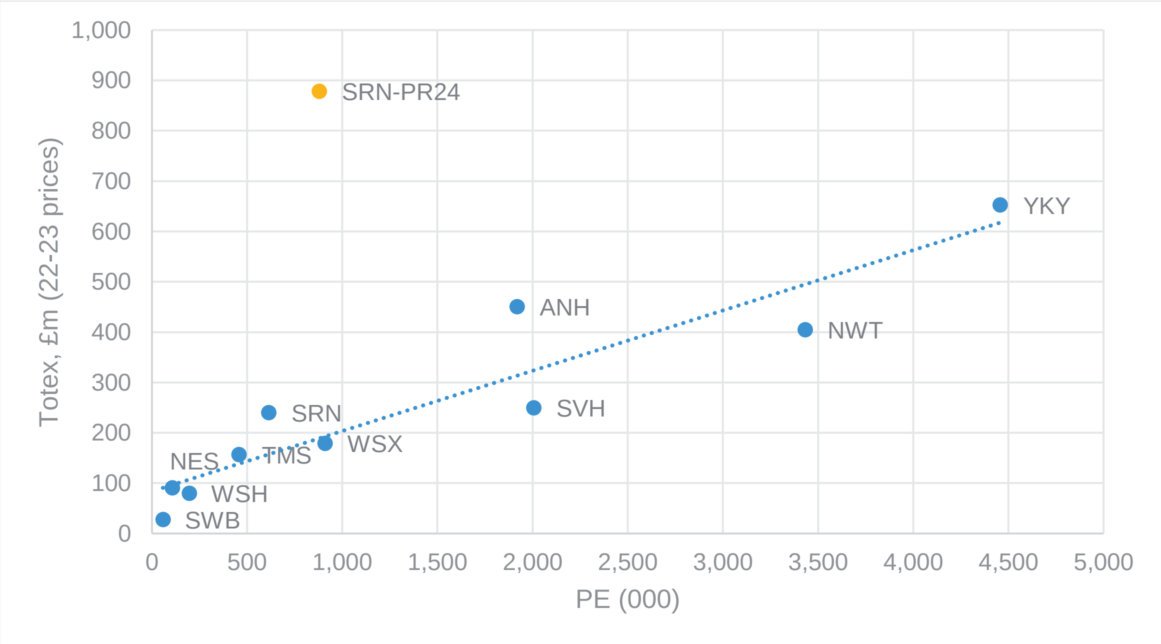
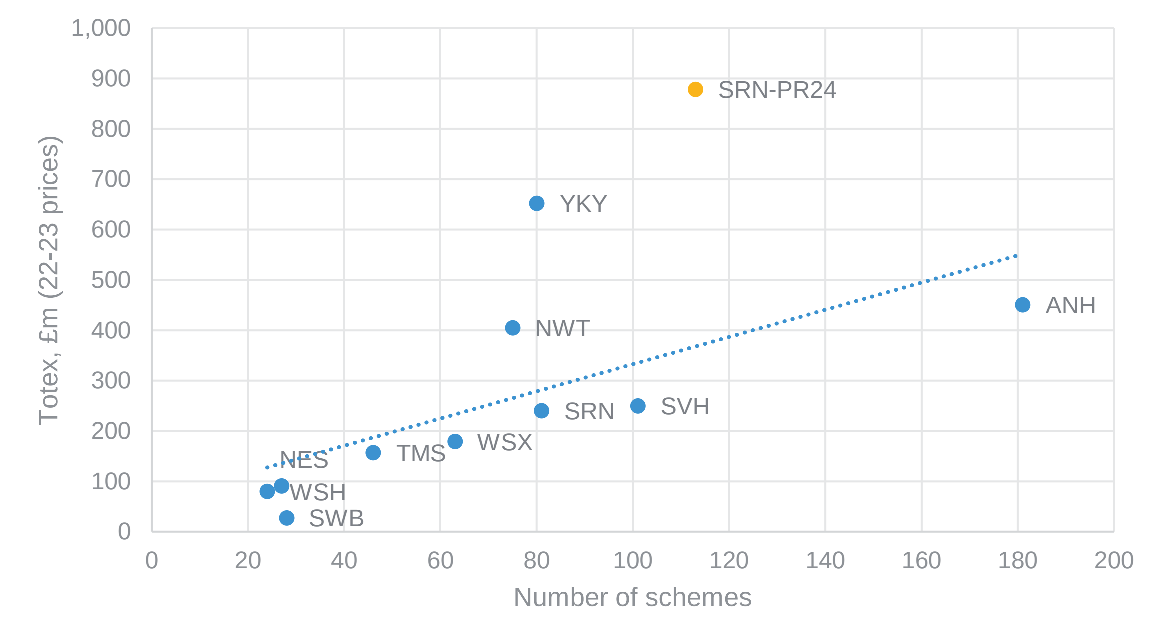


Figure 3-6: P removal costs – PR19 and our PR24 totex vs number of sites (pre-phasing)



We have only included the costs of installing the necessary new treatment processes in our WINEP costing. Any capital maintenance expenditure on existing assets is included in our estimate of capital maintenance expenditure elsewhere in our business plan costs.

3.5. Cost efficiency – nitrogen removal

Our standard enhancement solution costing approach, described in Part B of SRN15 Cost and Option Methodology Technical Annex was followed to estimate the costs of the nitrogen removal programme. This approach involves pricing solutions based on the best available information for the expected scope and the cost of that scope, and applying standardised allowances based on analysis of historical data for indirect costs, risks and overheads. The level of design development completed determines the granularity of scope that is available and therefore the specific costing approach to use. Costs are predicted using our libraries of standardised and regularly updated cost models developed from historical cost data augmented with industry information where required. These cost libraries are benchmarked internally and externally by our Cost Intelligence Team to understand relative cost efficiency, and further benchmarking has been performed for the chosen option.

At PR19 Ofwat allowed nitrogen removal costs in full for the two companies that proposed them which was SW and Wessex, prior to applying a WINEP-specific efficiency challenge. However, at PR24 we anticipate a larger N removal programme across the industry due to nutrient neutrality driver.

As a result of concerns about nutrient neutrality in sensitive areas, PR24 has seen a major step change in the number of Total N permits being proposed. We are proposing 24 schemes, all but one of which is to meet TAL limit of 10 mg/l. This compares to one Total N scheme that we are delivering in AMP7, and one in AMP6. Having said that, we do have more past experience of delivering Total N projects than the rest of the industry, having 16 sites which already have Total N permits, mostly sites in the south Hampshire area discharging to the Solent. Our experience on these sites has given us a good understanding of what are the efficient options to deliver a Total N permit of 10 mg/l.

The standard solution that we use for a Total N permit of 10 mg/l is to provide methanol dosing to enhance biological denitrification and tertiary solids removal. If the main treatment process on the site is activated sludge, then an anoxic tank is also needed. Upgrade of site ICA is also usually required to enable Real-

Time-Control of the process. On small biofilter works, conversion of the site to an extended aeration process can also be a feasible option, especially if the site also has drivers for tighter permits on other sanitary determinands. For clarity, we have allocated costs for these schemes to “treatment for nitrogen removal (chemical)” as they are all chemically assisted biological processes, but we could equally have allocated the costs to “treatment for nitrogen removal (biological)”. We are not using any purely chemical nitrogen removal processes.

The source of our cost estimates for PR24 is a set of cost data and cost curves provided by our Cost Intelligence Team, which are based on pre-AMP7 delivery costs on Southern Water projects, with normalised data from other sources used to fill any gaps.

We have comparatively little recent experience in the delivery of nitrogen removal compared to P removal, so we have less cost data on which to base cost curves. However, most of the building blocks of a nitrogen removal process (methanol dosing, a denitrifying tertiary treatment stage such as a nitrifying SAF or a MBBR, and a Real-Time-Control system) are items for which we do have experience and cost data from AMP6 and AMP7 projects.

We only have one nitrogen removal project in AMP7 against which we can benchmark our proposed costs, and that is Summer Lane, Pagham. Pagham is a 13,000 pe treatment works which is getting a 0.25 mg/l P permit, a 15 mg/l N permit, and a 2.5 mg/l Ammonia permit. The solution that is currently under construction is to convert the existing biological filter site to an ASP, and the current estimated cost is £[redacted] In AMP6, the only new Total N permit that we had was at Shipton Bellinger, where the constructed solution was also to convert the existing biofilter works to an ASP. By comparison, for PR24 we are only proposing to convert two small sites (Chilham and Coldwaltham) from biological filters to ASP, and are instead proposing lower cost options to utilise existing biological treatment processes on all other sites with new Total N permits.

We have only included the costs of installing the necessary new treatment processes in our WINEP costing. Where this is replacing a biological filter works with an ASP we have assumed all costs are enhancement because our approach to capital maintenance would not be to replace a filter works with an ASP which is a high capex solution. For example, we undertook considerable growth and capital maintenance investment at Chilham in AMP6 which is now in good working order. If the permit were not being changed we would not be carrying out any significant capital maintenance investment at the site. Our AMP6 scheme included:

- New inlet screen, screw compactor and maintenance bypass arrangements
- Partition weir in existing balance tank to form new balance tank sump, with associated new pipework, valving and covers.
- Control valve and flow meter located on the inlet main to PST
- Replacement of filter distributor arms
- New desludging pumps
- Modifications to existing control and electrical switch gear

Any capital maintenance expenditure on existing assets at the same location is included in our estimate of capital maintenance expenditure elsewhere in our business plan costs.

3.6. Customer protection P removal - Impact on river water quality performance commitment levels and resulting benefits of WINEP

Our WINEP phosphorus removal programme will impact directly on our performance as measured by the common performance commitment for river water quality. The definition of the performance commitment is "% reduction in kg/year of P discharged in treatment works effluent relative to the discharge in 2020 (base year)"

We describe the forecast of the river water quality PCL and ODI benefits of our WINEP P removal of investment in SRN18 Performance Commitment Methodologies Technical Annex.

So as to avoid double counting the benefit of this investment we have excluded the sites with new P permit levels from the calculation of benefits from WINEP from the treatment works compliance performance commitment.

3.7. Customer protection for nitrogen removal

Customers are protected through the common performance commitment of treatment works compliance. Such compliance is monitored against permit conditions which will change as a result of the WINEP. Without carrying out the investment we propose, the sites with tightened permit levels listed above would be highly likely to fail the treatment works compliance performance commitment level.

We describe the forecast of PCL and ODI benefits of investment at treatment works to meet new permit conditions in SRN18 Performance Commitment Methodologies Technical Annex.

3.8. Customer protection – mechanisms in addition to ODIs

Coldwaltham SSSI improvement scheme

There is one potential SSSI improvement where the current evidence is insufficient to robustly demonstrate the level of improvement required for water quality nutrient issues in the Waltham Brooks SSSI. However, as a direct discharge (no dilution) into a waterbody with discharge water quality not at the receiving water quality likely standards, it is likely to be required. In conversation with NE and the EA we have agreed to undertake further monitoring and studies early in AMP8 to investigate the link between the SSSI nutrient condition and our Coldwaltham treatment works effluent quality. We are keen to expedite improvement in this SSSI, should the investigation confirm a tightening of permit conditions is required. In conversations with Natural England we were informed this catchment was at risk of Nutrient Neutrality and early delivery would help this situation. The 2025 permit at Coldwaltham includes a 1 mg/l phosphorus permit. Any tightening would require tertiary sand filtration which is a major element of the scheme we have costed and included in this enhancement claim.

We expect the investigation to conclude in 2027 and should a scheme be required, we propose to complete it and meet a tighter permit by 2031. This presents two potential problems that we propose to address through a PCD, firstly whether we need to invest at all, and secondly the timing of that investment that would straddle the AMP8/AMP9 boundary.

We have included in our WINEP a proposed improvement scheme at Coldwaltham to meet TAL in both nitrogen and phosphorus, at a cost of £7.886m capex in 2022/23 prices. It has a regulatory completion date of 31/03/2031, 67% of the costs of which we have included in our PR24 business plan to account for an as yet unconfirmed but most likely expenditure scope and profile. We anticipate including the remaining 33% in our PR29 business plan to complete the scheme by the regulatory completion date. We will include in our

PR29 business plan the additional operating costs associated with the new permit levels, for 2031/32 onwards.

We are not proposing any specific customer protection over the uncertainty of the need for this scheme, since the scheme itself is not sufficiently material to justify an individual PCD.

Nutrient Neutrality proposals

In line with EA and NE guidance, we have included schemes in our WINEP to meet the requirements of the Habitats - Nutrient Neutrality driver, to install N and/or P removal to TAL at a number of our treatment works for which there is no other nutrient removal driver. However, as noted above, we are proposing to phase beyond AMP8 investment at sites where there is little or no growth forecast before 2040.

The nutrient neutrality requirements are defined within the Levelling Up and Regeneration Bill which has not been enacted into law, and as drafted require us to improve specific treatment works to meet TAL for phosphorus and/or nitrogen by 2030. We consider it appropriate to protect customers from paying for improvements that are not confirmed as required by the legislation, and also to protect the company should there be other changes to the bill prior to it being enacted.

We would provide such customer protection through an uncertainty mechanism, described in SRN58 Uncertainty Mechanisms Technical Annex.

4. Chemicals Removal

4.1. Needs case for chemicals removal

The chemical drivers aim to gather intelligence and reduce or restrict the presence of chemicals and other substances within the environment in order to deliver the aims of the Government's 25 Year Environment Plan. We are proposing a number of improvements to ensure our treatment works better remove chemicals, or ensure there is no increase in chemical loads they discharge due to growth.

We carried out our own cost benefit assessment using central estimates of both costs and the benefits provided to us by the EA. We were later asked by the EA to include on the WINEP schemes that had a lower benefit to cost ratio than 0.8. This was because the EA's upper estimate of benefits was much higher than the central estimate and some of the schemes became cost beneficial when comparing a central estimate of costs with an upper estimate of benefits. However, we propose to rephase these three build schemes beyond AMP8 so we have not included them in our business plan submission

National trials and sampling programmes over successive periods have informed our chemicals removal programme for AMP8, as have site-specific investigations which resulted in options appraisal reports. Cypermethrin is the chemical driving much of the investment, with very low levels set in new AMP8 permits at 20 sites. We also have new permit levels for zinc, copper, cadmium, PFOS and nonylphenol at some sites. These requirements are driven by the low WFD chemical status of the receiving waters.

4.1.1. Phasing investment beyond AMP8 based on cost benefit

In our pre-phased WINEP there were six build schemes required for Cypermethrin removal. We propose to phase three of them to AMP9 on cost-benefit grounds. They were considered to pass the cost benefit test by the EA based on revised assessment of the benefits values.

We applied a cost benefit screening for actions under the WINEP Chemical driver guidance to meet the proposed cypermethrin permit levels. We originally discounted schemes where our central estimate of benefits was <0.8 of the central estimate of costs from our WINEP. This included a scheme at Wingham (Dambridge) which has been removed from the WINEP by the EA on the grounds of failing the cost benefit test

We were asked by the EA to include on the WINEP 3 schemes that according to our assessment of costs and benefits have a similar benefit to cost ratio to that at Wingham (Dambridge). However, using the EA's upper estimate of benefits and the central estimate of costs, some of the schemes became cost beneficial, as shown in Table 4-1. We show the central benefit to cost ratios with green coloured cells for the sites the EA consider pass cost benefit and in orange for the site the EA assessed as failing the cost benefit test and which has been removed from the WINEP.

For two of the three sites the EA has included on the WINEP, the upper estimated NPV of benefit is >0.8 NPV of costs, and for Tunbridge Wells North even the upper estimate of benefits is <0.8 of our central cost estimate. The central values of benefit and cost give benefit to cost ratios significantly below 1, hence the costs outweigh the benefits by some margin. We would expect commercial organisations not to invest at these levels of costs and benefits.

Our proposal is to rephase the three schemes the EA asked to be included in the WINEP (Bidborough, Cranbrook and Tunbridge Wells North) to AMP9. We have not included the costs of these schemes in our AMP8 business plan proposals.

It is notable that the EA has removed from the WINEP in provided to us on 3 July for cypermethrin at Wingham (Dambridge) on the basis of failed cost benefit test. However, a no deterioration driver for cypermethrin applies at the same site, which requires us to invest in the same solution as we would install to meet the improvement driver requirements.

Table 4-1 Chemicals improvement schemes considered failing cost benefit - NPV of benefits and costs

EA Benefit Assessment NPV (£k)				NPV of Cost (£k)	Benefit to cost ratio *
Site	Lower Estimate	Central Estimate	Upper Estimate	(2020/21 prices)	
Bidborough	3,736	3,823	17,313	14,322	0.27
Cranbrook	2,148	2,199	9,955	10,126	0.22
Tunbridge Wells North	4,871	4,986	22,575	29,218	0.17
Wingham (Dambridge)	2,443	2,500	11,321	12,225	0.20

*Based on central estimate of benefit

4.2. Best option for customers - chemicals removal

Our range of solutions includes source control measures in the catchment, nature-based solutions and additional or upgraded treatment processes. The nature-based and treatment solutions typically aim to provide greater control of dissolved and particulate materials in the effluent through dosing and/or improved solids capture.

Table 4-2 Unconstrained options considered for chemicals removal

	Short description of measure to remove zinc
1	Convert to activated sludge plant
2	Convert to membrane bioreactor
3	Provide NSAF and/or deep bed sand filter
4	Provide alkalinity dosing
5	Provide metal scavenger dosing (Na_2S or TMT-15)
6	Switch to aluminium dosing from iron dosing
7	Provide granular activated carbon filtration
8	Provide reed bed
9	Do nothing
10	Pump away
11	Trade effluent control
12	Public awareness
13	Catchment mitigation
14	Provide constructed wetlands

Some of our WINEP proposals result from AMP6 and AMP7 investigations which concluded with site-specific options appraisal (SSOA) reports to a defined standard agreed with the EA. An example SSOA is provided in Appendix 2 to illustrate the extent of options appraisal processes that were undertaken in line with guidance at the time. We did not routinely revisit our options appraisals carried out following best practice at the time, nor the resulting recommended options. However, in some cases where we have additional treatment improvements required at the same site, we have reviewed the recommended option from the investigation to ensure we promote a holistic solution that meets all relevant regulatory drivers at the site.

At some sites, sampling has shown that the site meets the new permit level without any additional treatment capacity. At these sites we propose regular monitoring within the catchment and targeted visits to trade effluent producers to ensure appropriate control in the catchment.

Table 4-3 Constrained and preferred options evaluated for each WINEP chemicals action

Key: Promoted options are shown with green highlighted cell marked "Y", and others that were costed and assessed through full benefits evaluation with a cross. The schemes promoted under a WFD_IMP_CHEM driver have the cost benefit ratios provided. For those which are promoted as preventing deterioration, cost benefit is not appropriate since there is no benefit for maintaining current water quality standards.

Site	Chemical to be controlled	No build – monit or levels	Change to alum dosing	Alkal-inity dosing	N-SAF and /or DBSF	ASP	GAC filtrati on	Reed bed or wetland	Catch-ment mitigation/ control	**Notes**
Ashford	Cadmium	Y	x	x						
Ashford	Cypermethrin	Y			x				x	
Ashford	Nonylphenol	Y			x				x	
Battle	Cypermethrin				Y	x				
Bidborough	Zinc	Y	x	x						
Bidborough	Cypermethrin	Y							x	Phasing build solution to AMP9
Billingshurst	Cypermethrin	Y				x				(NSAF DBF installed)
Burgess Hill (Goddards Green)	Cypermethrin	Y							x	
Cranbrook	Zinc	Y	x	x						
Cranbrook	Cypermethrin	Y								Phasing build solution to AMP9
Felbridge	Zinc	Y	x	x						
Horsham	PFOS	Y					x		x	
Luxfords Lane (East Grinstead)	Cypermethrin	Y			x					
Luxfords Lane (East Grinstead)	Zinc	Y	x	x						
Oxsted	Cypermethrin	Y			x					
Paddock Wood	Cypermethrin	Y			x					
Paddock Wood	Zinc	Y	x	x						
Pembury	Copper	Y		x						
Pembury	Zinc	Y	x							
Pembury	Cypermethrin	Y			x					

Site	Chemical to be controlled	No build – monit or levels	Change to alum dosing	Alkal-inity dosing	N-SAF and /or DBSF	ASP	GAC filtrati on	Reed bed or wetland	Catch-ment mitigation/ control	**Notes**
Quickbourne Lane Northiam	Zinc	Y	x	x						
Quickbourne Lane Northiam	Cypermethrin				x			Y		
Redgate Mill Crowborough	Cypermethrin	Y			x			x		
Stubbs Lane Brede	Iron		0.36		0.07					Failed cost benefit. No solution proposed in WINEP
Sutton Valence Zinc	Zinc	Y	x	x				x		
Tangmere	Cypermethrin	Y							x	(NSAF DBF installed)
Tonbridge Low Flows	Cypermethrin	Y			x				x	(trader control underway)
Tonbridge High Flows	Cypermethrin	Y							x	NSAF DBF installed
Tunbridge Wells North	Cypermethrin	Y								Phasing build solution to AMP9
Tunbridge Wells South	Zinc	Y	x	x						
Tunbridge Wells South	Cypermethrin	Y							x	
Uckfield	Cypermethrin	Y			x					(NSAF DBF installed)
Uckfield	Zinc	Y	x	x						
Windmill Hill	Cypermethrin	Y			x					
Wingham (Dambridge)	Cypermethrin				Y	x				

The one site that failed the cost benefit test as assessed by the EA was Stubbs Lane Brede which was investigated for elevated iron levels in the effluent and solutions developed to meet a tighter iron permit. This has not been promoted as part of our WINEP.

4.2.1. Consideration of delivery through Direct Procurement for Customers (DPC)

Our chemicals improvements WINEP schemes are not sufficiently material to be considered for DPC. They consist of dispersed investments which are highly integrated with our operational wastewater treatment sites. None of the individual schemes is above the £200m threshold for consideration as DPC by default. We are therefore not proposing to deliver this programme through DPC.

4.3. Cost efficiency - chemicals removal

Our standard enhancement solution costing approach, described in Part B of SRN15 Cost and Option Methodology Technical Annex was followed to estimate the costs of the chemicals removal programme. This approach involves pricing solutions based on the best available information for the expected scope and the cost of that scope, and applying standardised allowances based on analysis of historical data for indirect costs, risks and overheads. The level of design development completed determines the granularity of scope that is available and therefore the specific costing approach to use. Costs are predicted using our libraries of standardised and regularly updated cost models developed from historical cost data augmented with industry information where required. These cost libraries are benchmarked internally and externally by our Cost Intelligence Team to understand relative cost efficiency, and further benchmarking has been performed for the chosen option.

Comparison with PR19 benchmark costs is not possible since the chemical Ofwat assumed to be driving costs at PR19 was zinc. Zinc permits are proposed at 10 sites in AMP8 whereas Cypermethrin permits are required at 22 sites, as well as PFOS, nonylphenol and other metals such as cadmium and copper.

The scale and nature of our programme is different to the industry's at PR19. Our AMP8 programme is £19.1 m. The following table lists the number of new permits by determinands, and shows how many require construction of new assets.

Table 4-4 Chemical determinand and the number of sites included in our AMP8 WINEP

Chemical Determinand	Number of Sites	Build solutions	Monitor solutions
Cadmium	1	0	1
Copper	1	0	1
Cypermethrin	20	3	17
Iron	0 (1 site failed CBA)	0	0
Nonylphenol	1	0	1
PFOS	1	0	1
Zinc	10	0	10

On the sites where we have identified the need for additional assets, we are proposing a tertiary biological treatment stage (NSAF) on two of the three sites to assist with cypermethrin removal (Battle and Dambridge). These are all biofilter works, where the existing secondary treatment is not sufficient to achieve the level of cypermethrin removal that is required. As an alternative to an NSAF, we are proposing a nature-based solution on one small site (Quickbourne Lane) where there is space available to construct a reed-bed to provide the additional treatment required.

On the remaining sites where we have assessed that we can meet the new permit requirements using existing assets, we forecast a small increase in annual OPEX costs to cover the cost of the additional analytical tests to monitor the new determinands.

To ensure cost efficiency, our main emphasis has been on identifying as many no-build sites as possible. We have set up a monthly sampling regime on all sites covered by the Chemical drivers to monitor the new determinand levels, and it is the information from this sampling that has given us the confidence to propose no-build solutions on such a high proportion of the sites. We have also proposed to defer the three sites with the poorest cost-benefit ratio to AMP9 so that more data can be gathered to verify the need for capital investment on these sites.

We do not have any existing Cypermethrin permits, so have limited information on the most suitable treatment processes to remove it. To mitigate this we have drawn on our Engineering and Technical Solutions (ETS) supply chain to bring expertise from across the industry to bolster our experience and expertise. Using these expertise we have also sought to identify options where we do have delivery experience and where we can have greater confidence in the costs. We have proposed use of NSAF tertiary treatment at Battle and Dambridge as we have recent experience of building NSAF units in AMP6 and AMP7 and are confident that they are a cost-effective solution to provide additional biological treatment capacity needed compared to alternatives. We are proposing a reed-bed solution at Quickbourne Lane in line with our aim to put forward nature-based solutions where we assess them to be viable and cost effective.

We have only included the costs of installing the necessary new treatment processes in our WINEP costing. Any capital maintenance expenditure on existing assets is included in our estimate of capital maintenance expenditure elsewhere in our business plan costs.

4.4. Customer protection – chemicals removal

Customers are protected through the common performance commitment of treatment works compliance. Such compliance is monitored against permit conditions which will change as a result of the WINEP. Without carrying out the investment we propose, the sites with tightened permit levels listed above are highly likely to fail the treatment works compliance performance commitment level which is set at 100% compliance.

We describe the forecast of PCL and ODI benefits of investment at treatment works to meet new permit conditions in SRN18 Performance Commitment Methodologies Technical Annex.

5. Improving Bathing and Shellfish Water Quality

5.1. Needs case for improving shellfish and bathing waters

By assessing the risk and issues list of priority shellfish waters provided by the EA for PR24 and a combination of local knowledge, DWMP risk assessment results and AMP7 investigations we have identified priority shellfish waters requiring asset improvements.

As well as reducing the frequency of storm overflows to shellfish water which we describe in SRN40 WINEP storm overflows enhancement business case, we propose installing final effluent disinfection at 5 treatment works to help meet microbiological standards required for shellfish quality standards. Due to the large scale of AMP8 investments driven by statutory drivers, we are phasing all other treatment works improvements which would contribute to improving bathing waters beyond “sufficient” quality standard into AMP9. Contributing to moving bathing waters to “good” or “excellent” are Statutory + WINEP actions which give us discretion over the timing of investment, and for which we need support from our customers. Although we know customers want to see bathing waters at high standards, they are concerned about overall affordability of the AMP8 investment plan. We expect minor bathing waters improvements will be made through the AMP8 storm overflow investment proposals, although intermittent discharges are not often a reason for bathing water quality failures since sampling is suspended during heavy rainfall events.

5.2. Best option for customers - improving shellfish and bathing waters

We completed investigations in AMP7 that cover the actions relating to shellfish and bathing waters and these ensure that we have a good understanding of the requirements for improvements across all assets to reduce the microbial load. The investigations included shellfish flesh sampling and water quality modelling, with source apportionment and sensitivity testing to ensure robust proposals have been made.

The optioneering process carried out as part of the investigations considered the shellfish waters and a comprehensive suite of 38 options to reduce microbial load from both continuous and intermittent discharges, as listed in Table 5-1 below.

We assessed the costs and benefits, including wider environmental benefits, of interventions throughout the catchment using best practice at the time of the investigation which was prior to the AMP8 guidance from the EA. An example bathing/shellfish waters investigation is provided in Appendix 3.

Table 5-1 Long list of solutions for reducing microbial load to shellfish waters

Ref	Solution	Description/ notes
Operational enhancements in addition to base activities		
1	Increase maintenance	
2	Active management controls	
3	Site-specific operational intervention	
Green solutions		
4	Sacrificial green space / raised guttering channelling	Swales within urban and semi rural areas
5	Water gardens/permeable paving	Rain scaping – SUDS, Green Roofs etc to retain water
6	Adapt local planning policy and influence strategic developments	More relevant for other risk management authorities but water companies are statutory consultees

Ref	Solution	Description/ notes
7	Natural flow management	Are there green spaces uphill that can be better managed? Rewilding, improved farming practices etc. Can usually demonstrate good secondary benefits (Refer to [redacted] tool). Cattle troughs, Caravan Park run off, Marinas, dog walking areas/bins.
8	SuDS systems in green spaces	SuDS are most effective in areas downhill/downstream of hardstanding and/or directly uphill/upstream of flood risk receptors. It is difficult to find green spaces that fit this bill in cites but edges of towns/villages can be suitable. Can usually demonstrate good secondary benefits ([redacted] tool).
9	SuDS systems in urban areas (including below ground storage)	Often better located than SuDS in green spaces (see above) but usually too expensive (or just unviable) as a flood alleviation scheme. Can work well if tying into other works (e.g. car park resurfacing, traffic calming, SW disconnection from foul sewers) or if dealing with combined flows. Can sometimes demonstrate good secondary benefits ([redacted] tool).
10	Fluvial attenuation	Can be effective where you have wide, flat fields to push out into. Not very effective in steep catchments or around watercourses with constrained banks. May be able to demonstrate secondary benefits (e.g. wetlands creation). Refer to [redacted] tool.
11	Reduce impermeable surfaces	Very easy to model, but difficult/expensive to actually achieve. Needs public buy in if you are going to rely on home owners to do their part (driveways/patios)
12	Daylighting of culverts	Increases in-channel storage but typically also increase capacity which can shift problems from upstream to downstream. The area around the culvert can suddenly become flood prone. Most effective in green open spaces. Can usually demonstrate good secondary benefits ([redacted] tool).
13	Riparian vegetation management	Liaison with NFU / landowners etc regarding leaving protective strips along base of fields to reduce fertiliser run off
14	Reed bed establishment	Filtering option to reduce pollutants from attenuated water prior to release. Also serves to slow run off thus assisting with flooding and excessive run off.
15	Fencing	This should be first port of call to keep livestock away from the water edge
16	Reduce cattle numbers	In general in the catchment, fairly obvious less cattle less load
17	Retention/stabilisation ponds	Provide a holding area where bacteria die out before entering the watercourse
18	Installation of reed beds	Creates a high population of microorganisms to breakdown bacteria, also removes nutrients from enriched waters
19	Provision of buffer strips	Mixture of vegetation and ponds
20	Provision of drinking troughs	Positioned to divert livestock away from watercourse
21	Planting of trees away from watercourse	Provides shade for cattle to encourage them to seek shelter away from watercourse
22	Levees construction	Although this has flooding implications

Ref	Solution	Description/ notes
23	Rewilding	For example, the introduction of beavers into a system to manage flows and retain load so that it can die off and enter the system, also lagging the impact of the loads from assets
24	Sensitive farming practices	For example, managing muck spreading, and advising how farmers plough fields to retain more water (horizontal to slope not perpendicular) etc
Traditional grey solutions		
25	Online storage and associated throttles.	Increased pipe diameter/length. Concrete/digging necessary.
26	Offline storage (pumped return)	Installation of tank and associated pipes and pumps. Concrete/digging necessary
27	Offline storage (gravity return)	Installation of pit/tank and associated piping. Concrete/digging necessary.
28	Upsizing	Increased pipe diameter/length. Concrete/digging necessary.
29	Increase conveyance capacity of drainage systems	Usually quite expensive (especially in urban areas) and can just pass the problem downstream. Can be effective in tidal areas or areas where a small catchment with highly variable flows discharges into a large water body (main river/reservoir/sea) or if dealing with combined flows.
30	Storm water separation	New/retrofit, Eastbourne pilot study?
31	Telemetry upgrades/consent linkage	Understand spills to date in regulatory year and focus on known imminent breaches
32	WPS upgrades	Understand spills to date in regulatory year and focus on known imminent breaches
33	CSO upgrades	Understand spills to date in regulatory year and focus on known imminent breaches
34	WWTW upgrades	Understand spills and continuous discharges
35	Online storage and associated throttles	Increase pipe diameter/length. Concrete/digging necessary
36	Network diversions	

As well as spill reduction proposals, the optioneering process carried out through the AMP7 investigations recommended adding disinfection at five treatment works, as shown in

Table 5-2 below. We are proposing UV disinfection on these five sites where the need had been identified through AMP7 studies and investigations. As the proposed permits from the EA specifically require the use of UV disinfection, consideration of alternatives is not appropriate.

Table 5-2: Sites with AMP8 WINEP proposals for treatment works continuous discharge UV disinfection to improve shellfish waters

Site	Secondary driver	Shellfish waters to be improved
Thornham	EnvAct_IMP2 EnvAct_IMP4	Chichester Harbour (Chichester Channel, Emsworth Channel, Thornham Channel)
Sittingbourne	EnvAct_IMP4	Swale East, Swale Central
Faversham		Swale East, Swale Central
Queensborough	EnvAct_IMP4	Swale East, Swale Central
Eastchurch		Swale East, Swale Central

5.2.1. Consideration of delivery through Direct Procurement for Customers (DPC)

Our shellfish disinfection WINEP schemes are not sufficiently material to be considered for DPC. They consist of dispersed investments which are highly integrated with our operational wastewater treatment sites. None of the individual schemes is above the £200m threshold for consideration as DPC by default. We are therefore not proposing to deliver this programme through DPC.

5.3. Cost efficiency - disinfection for shellfish and bathing waters

Our standard enhancement solution costing approach, described in Part B of SRN15 Cost and Option Methodology Technical Annex was followed to estimate the costs of the shellfish and bathing waters programme. This approach involves pricing solutions based on the best available information for the expected scope and the cost of that scope, and applying standardised allowances based on analysis of historical data for indirect costs, risks and overheads. The level of design development completed determines the granularity of scope that is available and therefore the specific costing approach to use. Costs are predicted using our libraries of standardised and regularly updated cost models developed from historical cost data augmented with industry information where required. These cost libraries are benchmarked internally and externally by our Cost Intelligence Team to understand relative cost efficiency, and further benchmarking has been performed for the chosen option.

At PR19 Ofwat applied a deep dive approach to assessing UV disinfection costs and ultimately allowed them in full prior to applying a WINEP-specific efficiency challenge.

We are proposing UV disinfection on five sites where the need had been identified through AMP7 WINEP studies and investigations. As the proposed permits from the EA specifically require the use of UV disinfection, consideration of alternatives is not appropriate for this driver.

On each site, in addition to the cost of the UV treatment channel, we have allowed for the cost of a low lift pumping station to feed the UV channels and overcome hydraulic restrictions on the site. We have also allowed for the cost of upgrading the size of the incoming power supply to each site to provide the additional capacity needed for the UV treatment which consumes relatively high levels of electricity.

We have only included the costs of installing the necessary new treatment processes in our WINEP costing. Any capital maintenance expenditure on existing assets is included in our estimate of capital maintenance expenditure elsewhere in our business plan costs.

Our costs for these schemes are robust and efficient because they have been built up using our experience of delivery from AMP7 where we invested £13.5m across 2 projects at Millbrook and Slowhill Copse. We recognise that these types of solutions are not particularly common across the industry, so our recent experience leaves us well placed to learn lessons and forecast efficient delivery costs for PR24.

5.4. Customer protection – improving shellfish and bathing water quality

Customers are protected through the common performance commitment of treatment works compliance. Such compliance is monitored against permit conditions which will change as a result of the WINEP. Without carrying out the investment we propose, the sites with tightened permit levels listed above are highly likely to fail the treatment works compliance performance commitment level which is set at 100% compliance.

We describe the forecast of PCL and ODI benefits of investment at treatment works to meet new permit conditions in SRN18 Performance Commitment Methodologies Technical Annex.

6. Conclusion

Section	Key Commentary	Section
Introduction & Background	Our AMP8 WINEP provides an opportunity to make step change improvements that will help to improve and enhance the local environment. It is an unprecedented scale of investment, particularly to reduce nutrient loads and improve the quality of effluent from our treatment works.	1
Need for Enhancement Investment	The WINEP is a statutory programme, developed to meet legislative requirements as translated by our environmental regulators into guidance that we have followed. The WINEP details improvements we need to make to our wastewater treatment works effluent to meet new permit conditions. It is therefore an enhancement programme, delivering a step change in service. We are phasing targeted improvements that resulted from following the WINEP guidance over an extended period to make our plan more deliverable and affordable	2.1; 3.1; 4.1; 5.1
Best Option for Customers	We have carried out extensive options appraisal processes, ranging from detailed AMP7 investigations carried out by third parties, through to our internal process engineering experts assessing a long list of options to meet the new requirements.	2.2; 3.2; 3.3; 4.2; 5.2
Cost Efficiency	We have challenged our costs using benchmarks from: • Internal outturn data • Third party water industry-wide data • Applying top down efficiencies to our costs; • APR outturn data and • Ofwat's PR19 benchmark models where appropriate. In addition we have applied efficiency assumptions to future costs compared to historical costs.	2.3; 3.4; 3.5; 4.3; 5.3
Customer Protection	We have calculated the PC benefits associated with our WINEP proposals at treatment works which we set out in SRN18 Performance Commitment Methodologies Technical Annex.	2.4; 3.6; 3.7; 3.8; 4.4; 5.4

Appendix 1: Example SSSI AMP7 Investigation Report

Available on request

Appendix 2: Example Chemicals Site Specific Options Appraisal (SSOA)

Available on request

Appendix 3: Example AMP7 Shellfish Waters Investigation

Available on request