PR24

NORTHUMBRIAN WATER living water | ESSEX&SUFFOLK WATER living water

A3-25 WINEP CHEMICALS AND EMERGING CONTAMINANTS

NES39

TABLE OF CONTENTS

1. INTRODUCTION

Our long-term goals include "caring for the long term needs of our environment", and our ambition is to “restore and enhance our local and global environment”[1]. Our plan shows how we meet Water Industry National Environment Programme (WINEP)[2] needs and is endorsed by the Environment Agency (EA).

We are committed to providing for our customers and the environment. To deliver on this commitment we have a statutory obligation through WINEP. We are confident that our current and future plans will enable us to maintain an exceptional level of performance and deliver wider economic and environmental benefits.

In previously funded plans we have invested in chemicals reduction and investigations into emerging contaminants in-line with the WINEP guidance, this has included a collaborative approach to maximise research and learning. This has helped us understand where we need to invest in our future plans, both to remove contaminants and to undergo further investigations.

We aim to meet and go beyond these obligations, putting the environmental outcomes at the heart of our environment programme. Through our approach to WINEP and our Drainage and Wastewater Management Plan (DWMP)[3] we have looked at the environmental and customer needs, focusing on the best long-term options that meet statutory needs and best value outcomes for our customers.

Our plan is prioritised through our robust value framework, this way we have confidence we have chosen the best value options to meet our goals. Our WINEP investment is enabled by our base expenditure and the additional funding we recognise is needed to significantly improve our wastewater assets.

The chemicals we need to treat and remove through this enhancement expenditure have been evidenced through prior investigations. Our AMP8 investigations, research and findings allow us to understand where we need to invest in the future to ensure we are reducing our impact on the environment.

Our approach to our emerging contaminant expenditure is to maximise value through a collaborative approach. This means we’re working together to build the programme and sharing research and trial outputs across the group of other water companies.

[1] Long-term strategy (NES_LTDS)
[2] WINEP, Environment Agency
[3] Our DWMP

This business case describes our proposed approach to meeting the statutory obligations as part of the WINEP. Guidance states[4] that 'under the Water Framework Directive (WFD) chemicals and other substances with Environmental Quality Standards (EQSs) in surface waters may be described as Priority Hazardous Substances (PHS), Priority Substances (PS), Specific Pollutants (SP) or Other Pollutants (OP). PHS, PS, and OP are used to determine chemical status and SP are used in the determination of ecological status. There are also 'emerging chemicals' that do not have EQSs under these categories but may be of sufficient concern to warrant investigations to improve our understanding of the risk they may present, and to inform future interventions to protect the environment.

This business case details four areas of enhancement investment need as shown in Table 1.

TABLE 1: INVESTMENT NEEDS FOR CHEMICALS AND CONTAMINENT INVESTIGATIONS DURING AMP8

Investment need	WINEP drivers	Value (£)
Statutory improvement actions resulting from previous chemical investigation programmes	WFD_NDLS_CHEM1	26.069m
Statutory chemicals investigation programme (CIP4)	WFD_INV_CHEM_CIP4	1.761m
Non-statutory investigations on nitrogen removal technologies and the technical achievable limit	WFD_INV_N-TAL	3.805m
Non-statutory investigations on the impact of microplastics in sludge (industry trials)	WFD_INV_MP	0.520m
Non-statutory bioresources investigations into nutrients & microplastics in sludge and biosolids outlets	WFD_INV	0.875m
TOTAL		**33.030m**

This business case will explain the need for this investment, our approach to developing our solutions and why we believe they demonstrate the best outcomes for our customers, society and the environment.

[4] PR24 WINEP driver guidance – Chemicals version 0.3, Environment Agency, 2022

2. NEED FOR ENHANCEMENT INVESTMENT

2.1. ALIGNMENT WITH STATUTORY PLANNING FRAMEWORKS

Our plan to meet our long-term goals means aligning to all statutory planning frameworks. Our WINEP chemicals and emerging contaminants investment of **£33m** has been developed to meet the WINEP framework guidance on removal of chemicals from wastewater and investigations into emerging contaminants within wastewater.

Our investment is for activities which have not been funded in previous price reviews. We will build on the work funded and delivered in previous plans through the National Chemical Investigation Programmes (Phase 2 and 3).

Our plan for emerging contaminants enhancement investment is made up of five key areas: no deterioration of STW relating to chemical removal (£26.1m), chemicals investigations (£1.8m), nitrogen technically achievable limit (£3.8m), microplastics (£0.5m) and bioresources (£0.9m). The alignment of these needs to our regulatory requirements is detailed in Table 2. WINEP guidance stipulates that, 'investigations should be considered statutory unless they are in relation to emerging substances yet to be required by legislation. However, we strongly support all investigations into emerging substances to go ahead so that evidence is gathered to support the implications.'

TABLE 2: REQUIREMENTS FOR CHEMICALS AND EMERGING CONTAMINANTS DURING AMP8

Requirement	Legislation
The statutory requirement to ensure no deterioration of wastewater treatment and final effluent loads. In line with finding from previous chemical investigations programmes. (WFD_NDLS_CHEM1)	As defined by the Environment Agency (EA) through the WINEP guidance.
The statutory requirement to invest in and undertake trials as part of the water industry Chemicals Investigation Programme (CIP4). (WFD_INV_CHEM CIP4)	As defined by the Environment Agency (EA) through the WINEP guidance.
Non-statutory requirement to investigate: • The industry view of the impact of microplastics on sludge (WFD_INV_MP) • Technology ability to achieve nitrogen technically achievable limit (WFD_INV_N-TAL)	Future legislation is informed by investigations and trials to understand the occurrence of emerging contaminants in wastewater and current technology's ability to remove it. Investigations and trials have EA endorsement.
Non-statutory requirement to investigate: • Bioresources investigations: nutrients in sludge, biosolids outlets, microplastics in sludge (WFD_INV)	Future legislation is likely for nutrients and microplastics. Biosolids outlets are limited due to legislative requirements. Other potential outlets need to be explored to mitigate this.

All these requirements contribute to the EA tier 1 outcome – water company contribution to achieve improvement objectives for water quality or prevent deterioration.

2.2. OUR PROGRESS UP TO 2025

Through previous AMPs and in AMP7 we have been part of the CIP investigations and trials. These investigations and trials have informed the permit development for nutrients and chemicals in wastewater and the need to invest in removal of these as necessary.

During AMP7, our programme for phosphorus removal has been driven by outcome of the CIP2 trials. This programme was a collaborative approach to trialling alternative technologies for phosphorus removal to understand the lowest technical achievable limit (TAL). Understanding the costs required to meet TAL helps to inform permitting decisions to ensure the options are not cost prohibitive.

The CIP2 and CIP3 programme has investigated the presence and removal capability for a broader range of chemicals and metals. These programmes have informed our needs for investment in AMP8 to maintain a 'load standstill' for zinc and cypermethrin.

Our approach to meeting phosphorus reduction requirements in AMP7 has been through our WINEP programme. We have delivered a broad range of solutions including tighter treatment and catchment based solutions. We have an Environmental Performance Assessment (EPA) 3-star rating and are endorsed by the EA to use catchment based permitting approaches. This allows us to look at greener more sustainable options rather than hard engineered solutions.

We have reviewed our sites where it is more cost beneficial to transfer the wastewater rather than treat it to a higher standard. There are five sites where we have taken this approach in AMP7 and more options are covered in our AMP8 plan.

2.3. NEED FOR INVESTMENT IN AMP8

2.3.1 WINEP guidance and AMP8

The scale and timing of the activities in our plan are aligned to the WINEP statutory guidance and supported by the EA.

Our plan for improving our wastewater outputs in line with changes in chemical permit requirements and investigations into emerging contaminants has been developed as part of the WINEP framework. This work will meet the statutory requirements set out in the PR24 WINEP framework driver guidance which are shown in Table 3.

TABLE 3: WINEP FRAMEWORK DRIVER GUIDANCE

Driver	Description	Legal obligation	Required by date
WFD_NDLS_CHEM1	• Measures related to load standstill requirements for chemicals • Water company contribution to achieve improvement objectives for water quality or prevent deterioration	Statutory requirement as defined by the EA through WINEP framework	By 31 March 2030
WFD_INV_CHEM CIP4	• Investigations into future emerging chemicals • Water company contribution to achieve improvement objectives for water quality or prevent deterioration	Requested and endorsed by EA	By 31 March 2030
WFD_INV_MP	• Investigations into micro-plastics • Water company contribution to develop and test ways to remove micro-plastics from the environment	Requested and endorsed by EA	By 31 March 2030
WFD_INV_N-Tal	• Investigations to assess treatment options for nitrogen • Water companies action to develop and test nitrogen treatment options.	Requested and endorsed by EA	By 31 March 2030
WFD_INV	• Bioresources investigations to assess the occurrence and impact of nutrients and microplastics on sludge Plus the availability of alternative biosolids outlets	Agreed with EA	By 31 March 2030

2.3.2 Needs for investigations

The investigation needs within this business case are summarised in Table 4 below.

TABLE 4: LIST OF NEEDS FOR INVESTIGATIONS

Need name	Description	Root cause
CIP4 Chemicals Investigations	Investigations into the fate and transport of persistent chemicals, pharmaceuticals and anti-microbial resistance in the wastewater treatment process and the water environment.	Need to improve understanding of the fate and transport of chemicals in the environment to develop and inform future regulation.
CIP4 Emerging Chemicals Investigations	Investigations into chemicals of emerging concern to analyse and gather evidence to assess the impact on the environment of chemicals that are not yet assessed through statutory requirements.	Need to improve understanding of the fate and transport of emerging chemicals in the environment to develop and inform future regulation.
Nitrogen technically achievable limit investigations.	Investigations and trials to understand to level of nitrogen it is technically possible to reach.	Need to understand how low nitrogen levels can go to inform future regulation
Joint industry trials on Micro-plastics in sludge.	Joint industry trials looking at fate and accumulation of micro-plastics in sludges with alternative treatment technology trials.	Need to understand the input, fate and transport of micro-plastics through wastewater treatment processes so that any potential preventative interventions could be targeted at the most appropriate place.
Bioresources - Investigation of Nutrient Recovery	Reduce the concentration of key nutrients (nitrogen, phosphorus) from the biosolids to ensure continued compliant deployment to the available landbank in future AMPS. Improved management of struvite on Primary Sludge Treatment Centres resulting in increased sludge processing resilience.	Regulation and legislation will potentially drive a reduction in allowed nutrient concentrations spread to land, reducing the available land bank. If both N, P could be managed / removed during / before the advanced anaerobic process this would in theory contribute to future mitigation from new legislation OR could allow greater quantities for biosolids to be spread to the same amount of hectarage - investigation of concept.
Bioresources - Investigation of alternative Biosolids Outlets	Review alternative end products other than biosolids to agriculture which allow its application to an outlet, such as domestic fertilizer, construction materials or biofuels market reducing the reliance of agriculture landbank deployment.	Diminishing landbank requires understanding of alternative treatment outlets.

	Installation of end of process thermal incineration plant to reduce volume biosolids to land.	
Bioresources - Investigation of Microplastics in sludge	Understand in greater detail the impact of microplastics upon soils and crops to mitigate future legislation challenges and remain resilient to landbank deployment.	Review of current knowledge of microplastics throughout the STW process and then through the AAD process.

Chemicals Investigations Programme

Our planned investment of **£1.8m** in the industry collaborative investigation programme is made up of investigations into known chemicals and emerging chemicals. These are contaminants that are new or newly recognisable or measurable. The following CIP4 drivers are identified within the PR24 WINEP and will be addressed through the collaborative industry approach. These investigation needs are shared across the sector and hence the need for a collaborative approach.

- WFD_INV_Chem 4a
    - Proposed permitting approach and investigations PFOS
    - TraC waters
    - Integrated Constructed Wetlands
    - Groundwater and biosolids spreading
- WFD_INV_Chem 4b – Sludge
- WFD_INV_Chem 4c – Groundwater (Chemicals Monitoring)
- WFD_INV_Chem 4d – AMR
- WFD_INV_Chem 4e
    - Emerging Substances
    - Emerging Substances (PFAS)
    - Emerging Substances (CIP3 substances of concern)
    - Emerging Substances (Non-target screening)
    - Emerging Substances (Trend)
    - Emerging Substances (Endocrine Disruptors)
- WFD_INV_Chem 4f – Innovative pathway control
- WFD_INV_Chem 4g – Local investigations

The details of these drivers are within the UK Water Industry Research (UKWIR) CIP4 pre-scoping technical note[5].

[5] UKWIR CIP4 Pre-scoping technical note, SNC Lavalin

Nitrogen Technically Achievable Limit

N-TAL needs, as described in Table 4, are a Department of Environment, Food and Rural Affairs (Defra) approved non-statutory requirement identified under the 1991 Urban Wastewater Treatment Directive (UWWTD) to consider more ambitious levels of nitrogen (N) reduction.

Many UK estuaries are affected by eutrophication, with several designated for their conservation interest. Recently effluent limits have been set mostly for phosphorus under WFD and Habitats Directive/sites of special scientific interest (SSSI) to achieve good ecological status. As the role of nitrogen in freshwater eutrophication, particularly lakes and reservoirs, has also become increasingly recognised, there is now a growing need to consider further nitrogen removal. In addition, Natural England is seeking more stringent levels of sewage treatment works (STW) nitrogen reduction to meet biodiversity targets.

WINEP framework driver guidance[6] sets one non-statutory obligation for nitrogen technically achievable limit (N-TAL). The current N-TAL is 10mg/l, this was set in 1991 as part of the UWWTD. Defra and the EA have identified a need to review the N-TAL with a range of existing and emerging technologies.

Our investment of **£3.8m** is to ensure we can understand the levels of nitrogen we can get to with the available processes and technologies.

Microplastics

Microplastic prevalence within wastewater is an area still being research and investigated. Research[7] shows that current processes at STWs remove a high proportion of microplastics. However, the fate within sludge treatment and subsequent applications of sludges to land is unknown.

As an industry we need to understand the input, fate and transport of micro-plastics through wastewater treatment processes so that any potential preventative interventions could be targeted at the most appropriate place. The need to investigate is shared across all wastewater and sewage companies in the UK. This joint need gives us the opportunity to have a collaborative approach to investing in investigations and trials as described in Table 4.

There is an industry steering group for microplastics, based on the findings of the CIP3. The steering group recorded that there is a need to go further than the initial investigations. All water and sewerage companies (WASCs) are involved in the joint investigations, establishing the need and agreeing the best options for meeting this need. We have agreed to host an investigation at one of our STW, it is yet to be confirmed which one. There will also be four joint field-application trials, hosted across the industry through AMP8.

[6] PR24 WINEP driver guidance – Nitrogen Technically Achievable Limit version 0.3, Environment Agency, 2022
[7] Removal of microplastics from wastewater: available techniques and way forward, Water Science & Technology (IWA Publishing), 2021

Our plan for micro-plastics enhanced investment of **£0.5m** is required to enable a collaborative approach to addressing this industry wide need and has been developed in accordance with the WINEP framework.

Bioresources

Bioresources investigations are non-statutory investigations, the sludge obligation has no investigation drivers hence the EA have agreed that we put forward this need under the WFD_INV driver.

All our liquid sludge is processed through either Bran Sands or Howdon advanced anaerobic digestion (AAD) plants. We are the only WASC that has 100% of their sludge processed through AAD. At present all our biosolids go to landbank. The availability of landbank areas is reducing and we understand the importance of investigating alternative options to ensure we have a continuous outlet for our biosolids to continue our sewage and sludge operations.

Our investigations need to cover three key areas:

- investigation of reducing or removal of biosolids nutrient content specifically nitrogen and phosphorus, to reduce risk of diffuse pollution, which will prevent deterioration of waterbodies and support the status of aquatic ecosystems and wildlife;
- investigation to review and identify alternative end of use pathways for biosolids other than deployment to agriculture land, to reduce risk of diffuse pollution, which will prevent deterioration of waterbodies and support the status of aquatic ecosystems and wildlife;
- investigation into microplastics within sludge to understand:
    - behaviour when processed through AAD;
    - dispersion / transformation upon being deployed onto agriculture land;
    - potential of entering watercourses.

Success of these investigations will contribute to the reduction or removal of non-compliant agriculture practices and a clear direction can be established in terms of mitigation, contributing to potentially improving WFD status of applicable waterbodies.

Our investment of £0.9m covers investigations across the three areas described above.

2.3.3 Needs for chemicals load standstill – no deterioration

We have a statutory requirement to remove chemicals from our wastewater. New chemicals were assessed through previous CIP, this presents the need for us to meet a no deterioration level for these chemicals through our wastewater treatment processes. Our list of 15 sites for chemical investigation has been informed by the EA who provided a list of sites.

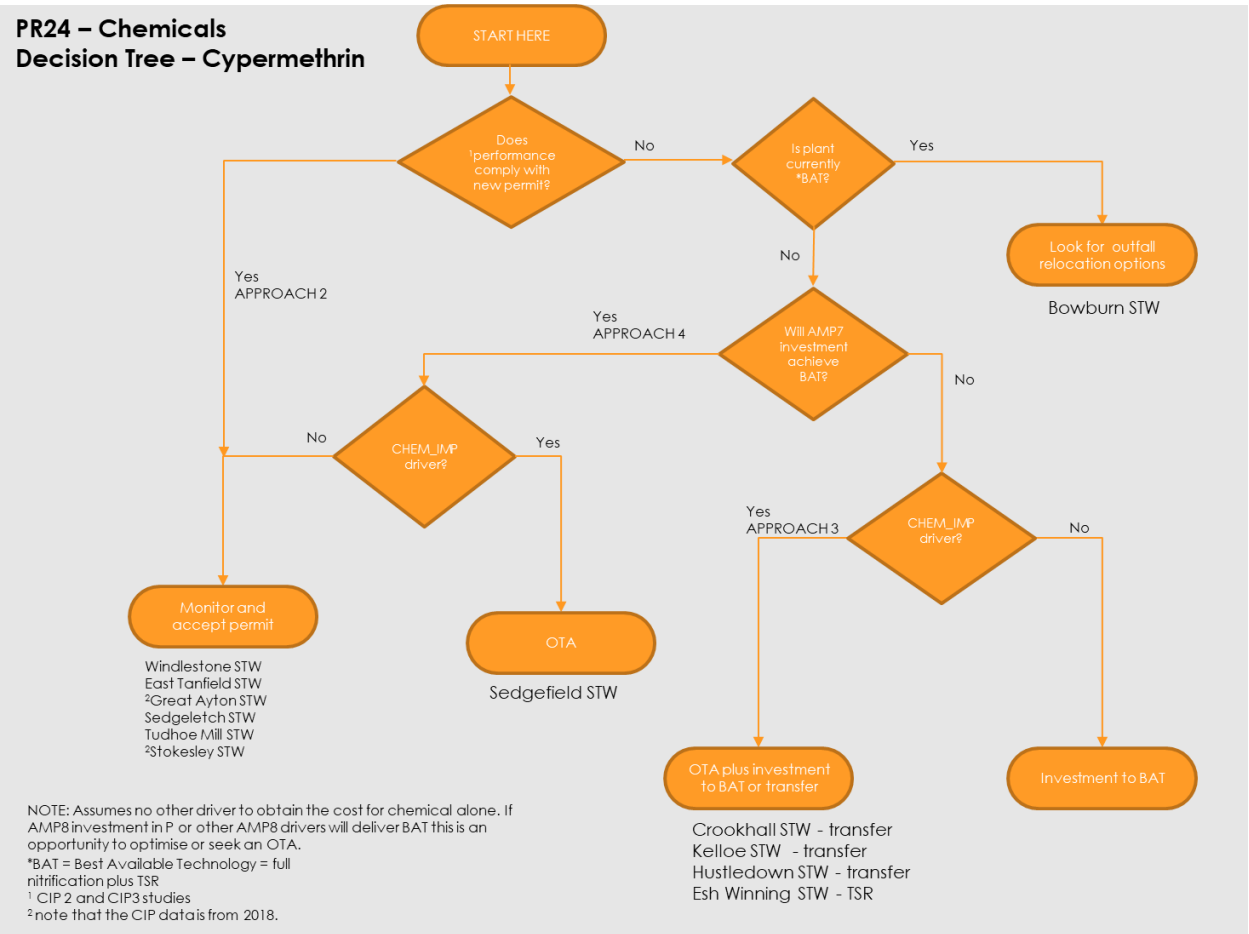
2.3.4 List of Sites WFD chemicals

Our list of sites has been informed by the outputs of the CIP2 and CIP3 programmes. The EA provided a list of sites and required chemical permits at each site. To justify investment there must be sufficient robust evidence that there is:

- a failure of a water quality objective (that is, related to EQS) with at least 75 % confidence.
- a clear link to water industry assets, and an obligation for water industry action.

The methodology used to identify the needs to comply with WFD improvement and no deterioration actions follows the PR24 WINEP driver guidance is illustrated in Figure 1. This is an example, showing the decision tree for cypermethrin, there is a similar decision tree for zinc.

FIGURE 1: METHODOLGOY FOR WFD_IMP_CHEM, WFD_ND_CHEM AND WFD_NDLS_CHEM



In section 2.3.5, Table 6 shows the list of sites and new permit levels which were provided by the EA on 29 September 2022, these are to be delivered within AMP8 by 2035.

A 95th percentile limit is the concentration of the substance that the discharge must be under at least 95% of the time. If a sample result is higher than its 95th percentile numeric limit, it is an individual look-up table (LUT) exceedance. When a LUT exceedance happens, the number of exceedances for that substance is compared with the number of samples taken in the 12-month period.

The LUT is required to review how many exceedances are allowed for the number of samples taken in the 12-month period. If the number of exceedances is greater than the maximum number allowed, then the site has a LUT failure.
As part of an Operating Techniques Agreement (OTA) a 99th percentile limit can be applied for. Changing the confidence statistic to the 99th percentile will take account of the uncertainty in the effectiveness and reliability of treatment technologies and allow more exceedances of the 95th percentile permit limit before a look up table failure is recorded. This approach will still control the distribution of effluent quality and require the operator to manage the treatment process to treat the

substance. The numbers of allowable exceedances under a 95th and 99th percentile confidence approach are set out in Table below.

TABLE 5: NUMBER OF SAMPLES ALLOWABLE EXCEEDANCES

NUMBER OF SAMPLES	NUMBER OF EXCEEDANCES ALLOWED UNDER A 95%ILE CONFIDENCE	NUMBER OF EXCEEDANCES ALLOWED UNDER A 99%ILE CONFIDENCE
4	1	2
12	2	3
24	3	4

To prevent short-term pollution during the remaining 5% of the time, the Environment Agency normally sets a higher maximum concentration limit for that substance. A maximum limit is a concentration that no sample result must exceed. Maximum limits are often called upper tier or absolute limits and are used in conjunction with 95%ile limits.

The mean compliance limit is used to regulate substances with low acute toxicity (zinc). It aims to limit the overall load of the substance discharged to the environment. This limit is set as an annual (12 months) mean.

TABLE 5: LIST OF SITE AND PERMITS

			STANDSTILL LIMIT (UG/L) NDLS			RIVER NEEDS LIMIT (UG/L) IMP			NO DETERIORATION LIMIT (UG/L) ND		
SITE/WORKS	SUBSTANCE	WINEP DRIVERS	95%ILE	UPPER TIER	BIO METALS (DISS MEAN)	95%ILE	UPPER TIER	BIO METALS (DISS MEAN)	95%ILE	UPPER TIER	BIO METALS (DISS MEAN)
Bowburn STW	Cypermethrin	WFD_ND_CHEM3 WFD_NDLS_CHEM2	0.001202	0.003922	-	-	-	-	0.00024951	0.00081404	-
Crookhall STW	Cypermethrin	WFD_IMP_CHEM WFD_NDLS_CHEM1	0.000574	0.00180128	-	0.000204	0.0006409	-	-	-	-
East Tanfield STW	Cypermethrin	WFD_NDLS_CHEM2	0.000291	0.00077026	-	-	-	-	-	-	-
Esh Winning STW	Cypermethrin	WFD_IMP_CHEM WFD_ND_CHEM3 WFD_NDLS_CHEM1	0.001206	0.0043998	-	0.000857	0.003127	-	0.001098324	0.004005973	
Great Ayton STW	Cypermethrin	WFD_NDLS_CHEM2	0.000995	0.002890	-	-	-	-	-	-	-
Hustledown STW	Cypermethrin	WFD_IMP_CHEM WFD_NDLS_CHEM1	0.001506	0.0051994	-	0.000271	0.00093608	-	-	-	-
Kelloe STW	Cypermethrin	WFD_IMP_CHEM WFD_NDLS_CHEM1	0.000885	0.0023658		0.000364	0.00097272	-	-	-	-
Kelloe STW	Zinc (dissolved)	WFD_NDLS_CHEM2	-	-	21.6	-	-	-	-	-	-
Pittington STW	Cypermethrin	WFD_IMP_CHEM WFD_NDLS_CHEM1	0.005654	0.0249212		0.000858	0.003784	-	-	-	-
Pity Me STW	Cypermethrin	WFD_IMP_CHEM WFD_NDLS_CHEM1	0.001705	0.0055814		0.000158	0.0005175	-	-	-	-
Pity Me STW	Zinc (dissolved)	WFD_IMP_CHEM WFD_NDLS_CHEM1	-	-	124.11	-	-	40.7	-	-	-

			STANDSTILL LIMIT (UG/L) NDLS			RIVER NEEDS LIMIT (UG/L) IMP			NO DETERIORATION LIMIT (UG/L) ND		
SITE/WORKS	SUBSTANCE	WINEP DRIVERS	95%ILE	UPPER TIER	BIO METALS (DISS MEAN)	95%ILE	UPPER TIER	BIO METALS (DISS MEAN)	95%ILE	UPPER TIER	BIO METALS (DISS MEAN)
Sedgefield STW	Zinc (dissolved)	WFD_IMP_CHEM WFD_NDLS_CHEM1	-	-	52.9	-	-	31.4	-	-	-
Sedgefield STW	Cypermethrin	WFD_IMP_CHEM WFD_NDLS_CHEM1 WFD_ND_CHEM3	0.0003	0.0009	-	0.000194	0.00058212	-	0.0001073641	0.0003221433	-
Sedgeletch STW	Cypermethrin	WFD_NDLS_CHEM2	0.000173	0.00065714	-	-	-	-	-	-	-
Sedgeletch STW	Zinc (dissolved)	WFD_NDLS_CHEM2			26.12						
Stokesley STW	Cypermethrin	WFD_NDLS_CHEM2	0.001066	0.0034224	-	-	-	-	-	-	-
Teesside Airport (Goosebeck) STW	Cypermethrin	WFD_NDLS_CHEM2	0.005771	0.0253466	-	-	-	-	-	-	-
Tudhoe Mill STW	Cypermethrin	WFD_NDLS_CHEM2	0.000228	0.00078786	-	-	-	-	-	-	-
Windlestone STW	Cypermethrin	WFD_NDLS_CHEM2	0.002742	0.0083354	n/a	-	-	-	-	-	-
Windlestone STW	Zinc (dissolved)	WFD_IMP_CHEM	-	-	-	-	-	58.3	-	-	-

2.3.5 Detailed list of needs chemicals

Current performance for each site can be seen in the graphs provided in Appendix D.

TABLE 6: LIST OF NEEDS CHEMICALS

NEED NAME	DESCRIPTION	SECONDARY WINEP DRIVER	ROOT CAUSE
Bowburn STW (cypermethrin)	WFD_ND_CHEM3 Bowburn STW has a new cypermethrin non deterioration limit for 95%ile 0.00024951 ug/l and Upper tier of 0.00081404 ug/l.	WFD_NDLS_CHEM2	Bowburn is already at best available technology (BAT) and current performance is not compliant with the new permit.
Crookhall STW (cypermethrin)	WFD_IMP_CHEM Crookhall STW has a new cypermethrin permit of 0.00020424 ug/l 95%ile, and Upper tier of 0.0006409 ug/l.	WFD_NDLS_CHEM1	Crookhall is already at best available technology (BAT) and current performance is not compliant with new permit.
East Tanfield STW (cypermethrin)	WFD_NDLS_CHEM2 East Tanfield STW has a new cypermethrin standstill limit for 95%ile 0.000291 ug/l and Upper tier of 0.00077026 ug/l.	N/A	East Tanfield is currently compliant with the new permit (assessed on 99%ile confidence (look up table -LUT). Need to monitor to ensure it stays within new permit.
Esh Winning STW (cypermethrin)	WFD_IMP_CHEM Esh Winning STW has a new cypermethrin improvement for 95%ile 0.000857 ug/l Upper tier of 0.003127 ug/l.	WFD_ND_CHEM3 and WFD_NDLS_CHEM1	Esh Winning CIP data suggests that further investment in Tertiary Solids Removal is required to meet the new permit.
Great Ayton STW (cypermethrin)	WFD_NDLS_CHEM2 Great Ayton STW has a new cypermethrin standstill limit for 95%ile 0.00099518 ug/l and Upper tier of 0.0028902 ug/l.	N/A	Great Ayton is currently compliant with new permit (assessed on 99%ile confidence look up table -LUT). Need to monitor to ensure it stays within new permit.
Hustledown STW (cypermethrin)	WFD_IMP_CHEM Hustledown STW has a new cypermethrin improvement limit for 95%ile 0.0002712 ug/l and Upper tier of 0.00093608 ug/l. WFD_NDLS_CHEM1 Hustledown STW has a new cypermethrin standstill limit or 95%ile 0.0015064 ug/l and Upper tier of 0.0051994 ug/l.	WFD_NDLS_CHEM1	Hustledown CIP data suggests that investment will not meet the new permit.

NEED NAME	DESCRIPTION	SECONDARY WINEP DRIVER	ROOT CAUSE
Kelloe STW (cypermethrin)	WFD_IMP_CHEM Kelloe STW has a new cypermethrin permit improvement limit for 95%ile 0.00036397 ug/l and Upper tier of 0.00097272 ug/l.	WFD_NDLS_CHEM1	Kelloe CIP data suggests that investment will not meet the new permit.
Kelloe STW (zinc)	WFD_NDLS_CHEM1 Kelloe STW has a new zinc (dissolved) limit of 21.6 ug/l (Bio metals (diss mean)).	N/A	Kelloe CIP data suggests that investment will not meet the new permit.
Sedgefield STW (cypermethrin)	WFD_IMP_CHEM Sedgefield STW has a new cypermethrin IMP limit of 95%ile 0.00019401 ug/l and Upper tier of 0.00058212 ug/l.	WFD_ND_CHEM3 and WFD_NDLS_CHEM1	Sedgefield cypermethrin CIP data suggests that investment will not meet the new permit.
Sedgefield STW (zinc)	WFD_IMP_CHEM Sedgefield STW a new Zinc (dissolved) limit of 31.4 ug/l (Bio metals (diss mean))	WFD_NDLS_CHEM1	Sedgefield zinc CIP data suggests that investment will not meet the new permit.
Sedgeletch STW (cypermethrin)	WFD_NDLS_CHEM2 Sedgeletch STW has a new cypermethrin standstill limit for 95%ile 0.00017346 ug/l and Upper tier of 0.00065714 ug/l.	N/A	Sedgeletch is currently compliant with the new cypermethrin permit (assessed on 99%ile confidence (look up table -LUT). Need to monitor to ensure it stays within new permit.
Sedgeletch STW (zinc)	WFD_NDLS_CHEM2 Sedgeletch STW, Zinc (dissolved), 26.12 ug/l (Bio metals (diss mean))	N/A	Sedgeletch zinc CIP data suggests that investment will not meet the new permit
Stokesley STW	WFD_NDLS_CHEM2 Stokesley STW has a new cypermethrin standstill limit for 95%ile 0.0010659 ug/l and Upper tier of 0.0034224 ug/l	N/A	Stokesley is currently compliant with proposed permit (assessed on 99%ile confidence (look up table -LUT). Need to monitor to ensure it stays within new permit.
Tudhoe Mill STW	WFD_NDLS_CHEM2 Tudhoe Mill STW has a new cypermethrin standstill limit for 95%ile 0.00022828 ug/l and Upper tier of 0.00078786 ug/l	N/A	Tudhoe Mill is currently compliant with proposed permit (assessed on 99%ile confidence (look up table -LUT). Need to monitor to ensure it stays within new permit.
Windlestone STW (cypermethrin)	WFD_NDLS_CHEM2 Windlestone STW has a new cypermethrin standstill limit for 95%ile 0.0027421ug/l and Upper tier of 0.0083354 ug/l	N/A	Windlestone is currently compliant with proposed permit (assessed on 99%ile confidence (look up table -LUT). Need to monitor to ensure it stays within new permit.
Windlestone STW (zinc)	WFD_IMP_CHEM Windlestone STW has a new zinc (dissolved), 58.3 ug/l (Bio metals (diss mean))	N/A	Windlestone zinc – would not meet new permit, EA permit required discussions ongoing.

NEED NAME	DESCRIPTION	SECONDARY WINEP DRIVER	ROOT CAUSE
Pity Me STW (cypermethrin)	WFD_IMP_CHEM Pity Me STW has a new cypermethrin, 95%ile 0.0001584ug/l standstill limit and Upper tier of 0.0005175 ug/l.	WFD_NDLS_CHEM1	Site transferred in AMP7, monitoring is required at new discharge location to ensure EQS at new discharge is not at risk
Pity Me STW (zinc)	WFD_IMP_CHEM Pity Me STW a new zinc (dissolved), 40.7 ug/l (Bio metals (diss mean)) WFD_NDLS_CHEM1 Pity Me STW has a new Zinc 124.11 ug/l (Bio metals (diss mean))	WFD_NDLS_CHEM1	AMP7 – decision better to transfer Site transferred in AMP7, monitoring is required at new discharge location to ensure EQS at new discharge is not at risk
Pittington STW (cypermethrin)	WFD_IMP_CHEM Pittington STW has a new cypermethrin standstill limit or 95%ile 0.00085849 ug/l and Upper tier of 0.003784 ug/l. WFD_NDLS_CHEM1 Pittington STW a new cypermethrin standstill limit for 95%ile 0.005654 ug/l and Upper tier of 0.0249212 ug/l.	WFD_NDLS_CHEM1	Site transferred in AMP7, monitoring is required at new discharge location to ensure EQS at new discharge is not at risk
Teeside Airport (Goosebeck STW) (cypermethrin)	WFD_NDLS_CHEM2 Goosebeck STW has a new cypermethrin standstill limit for 95%ile 0.0057711 ug/l and Upper tier of 0.0253466 ug/l.	N/A	Site transferred in AMP7, monitoring is required at new discharge location to ensure EQS at new discharge is not at risk

2.4. NEED FOR ENHANCEMENT EXPENDITURE IN AMP8

We have not included enhancement investment for activities which were funded at previous price reviews.

PR14 funded phase 2 of the National Chemicals Investigation Programme (CIP2) which occurred in AMP6. The programme sampled 74 substances at over 600 Wastewater Treatment Works aiming to better understand the potential scale of the challenge.

PR19 then funded phase 3 of the National Chemicals Investigation Programme (CIP3) which occurred between 2020 and 2022. This monitored trends in chemicals over time to assess risks to WFD compliance, effectiveness of chemical bans and to fill gaps in knowledge about the fate of chemicals through the treatment process. We also carried out specific technology trials at wastewater treatment works to determine potential solutions to remove trace chemical substances before treated wastewater is released into rivers.

The funding we have included in our plan for AMP8 is to address the needs which have been identified from phase 2 and 3. These are either statutory obligations required prior to April 2030 or investigation to inform actions in AMP9, hence the information is needed within AMP8.

2.4.1 Base vs enhancement expenditure

The proposals to ensure we remain at a load standstill, no deterioration, are new for this AMP. Our investigations and trials are also new needs and there is no overlap with base investment. The following table sets out our assumptions for base and enhancement cases.

TABLE 8: – ASSUMPTIONS FOR BASE AND ENHANCED INVESTMENT

BASE	ENHANCEMENT
Chemicals (no deterioration) • Work to effectively manage our wastewater effluent for existing nutrient and chemical permits	• A new statutory obligation as defined by the WINEP driver guidance • A new Defra approved activity as defined by the WINEP driver guidance.
Investigations • BAU activity following embedding the findings of investigations from previous AMPs	• Water industry collaborative investigations and trials into new areas not previously funded. This includes the next phase of CIP, a statutory obligation.

There is no base expenditure proposed for AMP8 that will contribute to addressing the needs related to these drivers.

2.5. ALIGNMENT TO THE LONG-TERM STRATEGY

Our investment in investigations is in the core pathway. What we find through the investigations will inform future investment and decision points on the core and adaptive pathways.

This investment is needed as part of the 'protecting the local environment' investment area under our **Long-Term Strategy** (LTS) core pathway. We consider this as low/no regret investment because it is needed to meet statutory requirements in 2025-30. We have a legal obligation to deliver £28m of this £32m investment by 2030 as most of this investment is needed to meet statutory requirements for 2025-30 within the WINEP. The remaining £4m on investigations is informing future regulation and we consider to be "no regrets" spend on our core pathway. We therefore consider this investment necessary in 2025-30 to deliver our LTS.

As this enhancement case addresses investigations informing future needs and investments, there are likely to be further requirements in future investment periods. We expect environmental challenges around anti-microbial resistance, persistent organic pollutants and microplastics in the future – which will make some contribution to improving river health, such as removing chemicals. The investment that is needed will depend on the results of current and future investigations, and whether alternative solutions can be implemented such as banning certain chemical products or making behavioural or other product changes to avoid pollutants entering wastewater. We expect that these investments are only needed under some of the scenarios in our long-term delivery strategy – and we have set this trigger point for investment for 2027, with investment beginning from 2032, so that we can understand the impact of technology or social changes.

In addition to this, we will need to review the impacts of climate change, legal changes, and technology on the need for further investment in these areas before the price reviews in 2029 and 2034.

2.6. CUSTOMER SUPPORT FOR THE NEED

Our plan is supported by our customers, both in the near- and long-term aspirations. We see evidence that our customers support environmental protection. They understand the role we play in investigating the best actions for the longer term.

These projects are a consequence of statutory requirements and requirements recommended by the EA. We have not discussed the specific needs with customers. That is because our research shows that customers expect us to meet our statutory obligations, and it is not appropriate to discuss delaying or phasing investment where there are no alternatives to meet the statutory requirement to deliver our part of WINEP.

Our research shows that customers support investment in the environment, including wider environmental and social benefits – though they do not necessarily think they should always pay for this through their water and wastewater bills. In particular, our customers rank dealing with sewage effectively and improving the qualities of rivers as two of their "medium" priorities (**prioritisation of common PCs**, NES44).

In our **qualitative affordability and acceptability testing** (NES49), customers supported our "preferred" plan which included these improvements in treatment of chemicals and investigations into emerging contaminants. Customers found this plan acceptable because it focused on the right things, is good for future generations, and is environmentally friendly. Customers who did not find this plan acceptable said that this was expensive, and water companies should pay out of their own profits. We did not ask specifically about chemicals and emerging contaminants in wastewater (as our individual items were limited only to the largest investments), but customers supported maintaining rivers and reducing pollution (NES49). In our **quantitative research** (NES50), 74% of customers supported our preferred plan, including this investment.

Customers also identified "pollution leading to dead fish in rivers" and "algae choking plants and wildlife" as medium priorities in our **DWMP research in 2020**, similar to storm overflows – but not as high as chemicals and microplastics in wastewater, which one participant described as "the next pandemic".

2.7. FACTORS OUTSIDE MANAGEMENT CONTROL

We understand that there are factors outside of management control that can influence the need for our investigations. The scope and cost are managed through our approach to the options in our plan. We are clear about the current need reflecting both environmental and public desire to better understand the impact of the contaminants in our system.

We understand that the drivers for chemical removal come from the industry studies which we undertake in the previous planning period. This gives us confidence that the requirements are known, despite the occurrence of contaminants being out of our control.

Microplastics is currently a hot topic in the media, this could lead to an increased focus on the topic. We are addressing this through approaching the investigations and trials as an industry to better use our combined resources and knowledge. There is a risk that the abundance of microplastics in sludge will impact our ability to send sludge to land. We are addressing this area through an investigations into microplastics within our biosolids included within this case.

3. BEST OPTION FOR CUSTOMERS

3.1. PROCESS FOR IDENTIFYING THE BEST OPTION FOR CUSTOMERS

We can demonstrate our process and how it gives the best option for our customers. Our value framework means that we are assessing monetised value across the options we have developed. We can show how our selected options will give the best value to our customers.

3.1.1 WINEP options development principles

We have followed the WINEP options development guidance[8], the principles of which are summarised in Table 9.

TABLE 9: WINEP OPTIONS DEVELOPMENT PRINCIPLES

Expectation	How this has been met
Environmental net gain	We have carried out an assessment of environmental net gain options by assessing the potential environmental impacts including the natural environment, net zero, catchment resilience, access, amenity, and engagement of each option and monetised alongside the whole life cost, choosing the one that provides the greatest overall environmental benefit/cost ratio (NPV)
Natural capital	We have assessed each of our options against the full range of natural capital metrics and wider environmental objectives as part of our WINEP assessment to the Environment Agency. The measures that apply to our options are shown in Table 3. These have been quantified through our benefits assessment which is described in section 3.2.4, 3.3.6 and .3.5.4
Catchment and nature-based solutions	We have considered a range of nature-based solutions such as integrated constructed wetlands, reed beds, evaporation, facultative lagoons and infiltration fields as shown in Figure 5.
Proportionality	We have taken a proportional approach to options development based on green book principles. Where there are more than three traditional treatment options, we have screened out those which have obviously less natural capital benefits, higher costs and higher carbon without undertaking a full benefits and cost assessment, which would require a level 2 optioneering scope. In the case of septic tanks, the monetary value of the water quality benefit is far more than the other natural capital benefits as the septic tanks tend to be very small. Further information is contained in the remainder of section 3.
Evidence	The evidence to our options is described within Section 3 and 4 of this document. We clearly record the reasons for discarding options. Further supporting evidence of our solutions development and our data sets is available in our Options Development Report and Options Assessment. Our WINEP submission has been independently audited by a third party (Jacobs) and there are no outstanding actions
Collaboration	We have collaborated with the Environment Agency to define the list of sites. Collaboration with local stakeholders and planning authorities will occur as part of the delivery process.

[8] WINEP options development guidance

3.1.2 Hierarchy for identifying unconstrained options

We have built our plan by considering a broad range of options. All options are real, deliverable and meet the needs defined in the WINEP guidance.

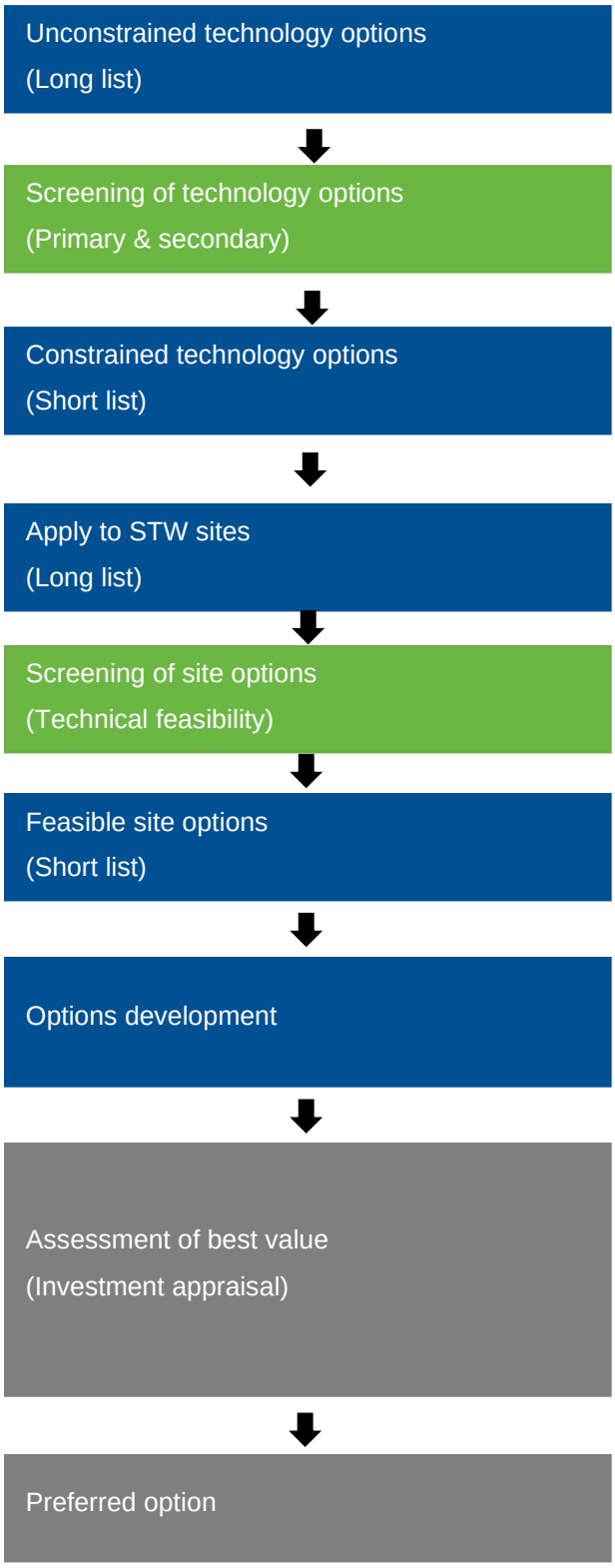
We have a structured approach for categorising and assessing options to meet each need which make sure a consistent approach across all our investment needs regardless of driver.

1. Eliminate – identification of processes and practices that can be stopped possibly by stakeholder management or other, and by challenging the need for existence. Eliminate options are likely to have the lowest costs to deliver the benefit. In this case options include changes to permits.
2. Collaborate – work with stakeholders to re-assign the issue or co-fund. Costs can be shared with third parties either to deliver the same or an extra level of social and environmental benefit.
3. Operate – improved operational management practices to enhance existing capacity.
4. Invigorate – invest in the existing infrastructure to improve performance. These options will provide an increased level of benefit but may be of a lower cost than fabricate options. In this case new infrastructure would be required to meet the standard for secondary treatment, so there are no options for invigorate.
5. Fabricate – new assets to augment or replace existing. These options are likely to have the highest costs. Green options will have lower carbon and potentially higher biodiversity and amenity benefits. Traditional grey options are likely to have highest certainty that service-related benefits will be realised. Innovative options have the potential for greater benefits and lower costs but have the lower certainty that benefits will be realised.

Figure 2 shows our process for identifying the best option for a single site which is based on the principles of the HM Treasury, The Green Book: Central Government Guidance on Appraisal and Evaluation and the WINEP Options Development Guidance[9]. A full description of how this has been applied is contained in the following sections.

[9] WINEP options assessment guidance

FIGURE 1: PROCESS FOR DEVELOPING AND FILTERING OPTIONS



Unconstrained list of technology options

We have developed a broad range of potential technology options in accordance with section 7.2.1 of the WINEP Options development guidance.

Constrained list of technology options (sections 3.2.1)

We have screened the unconstrained list of technology option against:
1) expected to meet statutory obligation, and
2) technically feasible in accordance with section 7.2.2 of the WINEP Options development guidance.

Constrained list of technology options for site options (in section 3.2.3)

We have applied the constrained list of technology options to each of the sites requiring intervention and then screened this to ensure the technology is technically feasible to implement on a specific STW site.

For example, it is not possible to implement a transfer solution where there are no alternative STWs nearby.

Options development (section 3.2.3(2))

We have developed options based on the technology options available and their ability to meet the requirements as described in the need for each site.

Assessment of best value (section 3.2.5

We have undertaken an assessment of benefits and net present value for each of the options from the constrained list at each site using the guidance in section in section 7.3 of WINEP options development guidance.

We have also assessed each option against the Wider Environmental Outcomes Metrics and a deliverability assessment as part of our benefits assessment in accordance with section 7.2 of WINEP Options Development guidance.

Preferred option (section 3.2.6)

The preferred option selected has been described with reasoning where the best value is an alternative to the lowest cost.

3.2. OPTIONS FOR CHEMICALS

3.2.1 Broad range of unconstrained options – load standstill

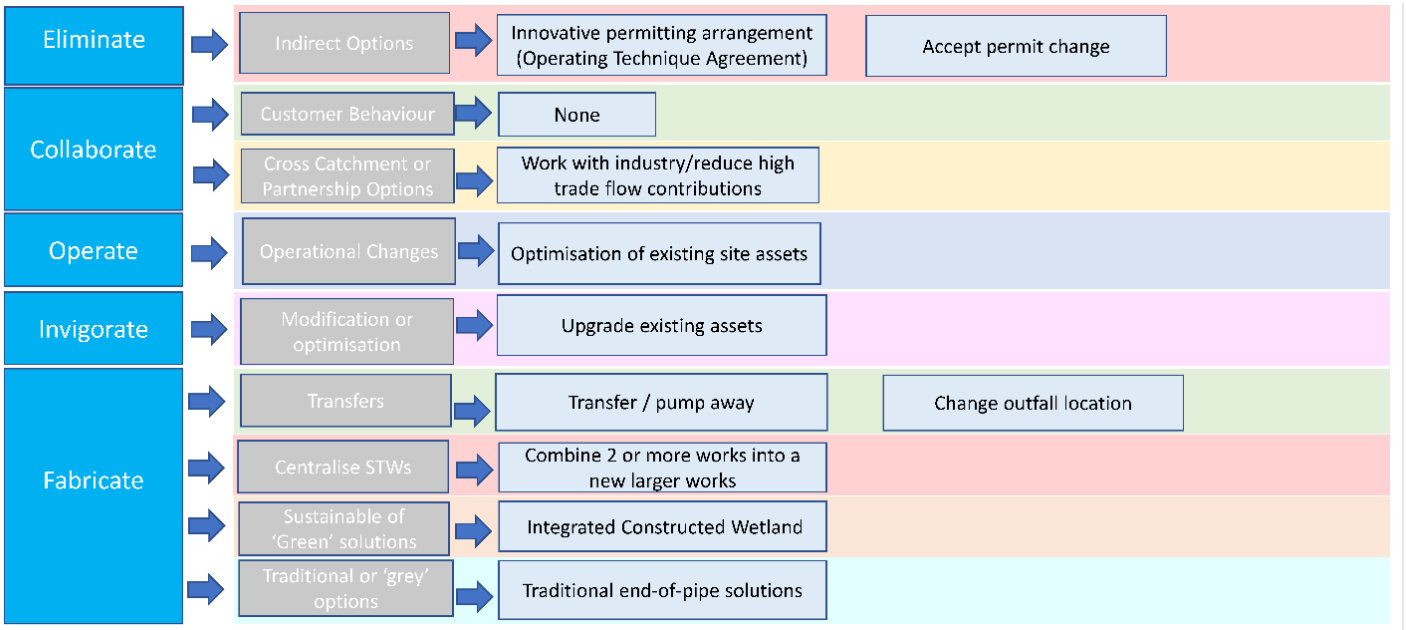
We have built our plan by considering a broad range of options. All options are real, deliverable and meet the needs defined in the WINEP guidance.

To determine the best option for customers to address the need, we have followed an options identification and screening process. Firstly, we identified a broad list of options, as shown in Appendix B, which could be considered to reduce chemicals at wastewater treatment works. Our interventions hierarchy includes operational actions, nature-based solution, influencing customer behaviour. Our hierarchy focuses on minimum and low carbon interventions first.

The long list of unconstrained options has been screened to provide a shorter unconstrained list and then a constrained list of options for the chemicals drivers. Decision trees were developed to use on a site-by-site basis to filter the constrained options list to site specifics and identify feasible options for costing and further assessment.

From the previous Chemicals Investigation Programme (CIP) trials we have determined that conventional treatment methods, which maximise biological treatment and provision of tertiary solids removal, provide Best Available Technology (BAT) for cypermethrin removal. Where this level of treatment is provided by AMP7 investment we propose to monitor performance following that investment to inform AMP8 investment decisions. Where sites fail to meet compliance despite installation of BAT, NW's preferred option is to relocate the outfall to provide increased dilution. No river modelling has been carried out at this stage for these options.

FIGURE 3: INTERVENTIONS FRAMEWORK CONSIDERING RANGE OF APPLICABLE INTERVENTIONS FOR CHEMICALS



3.2.2 Transfers

We have identified a number of sites for cypermetherin and zinc permits that are due to be transferred to larger wastewater treatment works. During AMP7 there are three sites:

- Pittington STW has been transferred to Sherburn WwTW due to deterioration in the site assets and the high cost to refurbish the works. There is also an environmental benefit by transferring Pittington STW to Sherburn STW.
- Pity Me STW is due to be transferred to Brasside STW due to population growth within the catchment.
- Goosebeck (Teeside Airport) STW is due to be transferred to Stressholme STW as it is more cost effective to transfer the crude sewage than treat for a tighter phosphorus permit.

The proposed option for these sites will be to monitor both upstream and downstream of the river at the receiving wastewater treatment works discharge point to confirm chemical concentration will not impact the watercourse.

During AMP8 there are two sites:

- Sedgeletch STW is being transferred to the Wear estuary. This is more cost effective and provides greater environmental benefits to transfer Sedgeletch STW rather than upgrade the works to meet the tightened phosphorus permit.
- Bowburn STW is to be transferred to the Wear. This is more cost effective and provides greater environmental benefits rather than upgrading the works to meet the tightened phosphorus permit and growth requirements.

These are included in the options screening for completeness, the AMP8 transfers are included as the preferred options.

3.2.3 Primary and secondary screening of options

(1) Results of primary screening

For each of the needs we undertook primary screening to determine a shorter list of options based on two criteria:

1) Does the option meet the need?
2) is the option technically feasible to implement?

The results of the primary screening of the need are shown in Table 10. As part of the options development, we have aligned permitting options to guidance that exists for flexible permitting. This guidance asks us to use four approaches, as set out in Table 10.

TABLE 10: FLEXIBLE PERMITTING APPROACHES

Option	Summary	Regulatory approach
Approach 1	Catchment permitting – with individual site limits	Regulated directly in the permit in a conventional manner
Approach 2	99%ile confidence for the 'look up table'	
Approach 3	Best Endeavours	Regulated through operating technique agreements (OTA) linked to the permit via the operating techniques condition
Approach 4	Maximising Benefits of WINEP3	

Approach 1 detail

Under this option water companies are able to 'trade' permitted discharge loads between sites within the catchment to achieve the water quality objectives whilst reducing cost, carbon emissions and regulatory risk.

Approach 2 detail

As described in section 2.3.4, this approach changes the number of allowable exceedances allowed under a 99% confidence.

Approach 3 detail

This option reflects the uncertainty in managing chemicals and could be widely applied to sites where there is a reasonable prospect of achieving a stringent improvement permit limit for chemicals (based on the outputs of the Feasibility and Pilots Technology trials completed as part of the CIP Technology Trials 2015 to 2020). This can also be considered where the technology trials either did not identify a technology that would consistently reduce the levels of a chemical to achieve the proposed river need/improvement permit limits or that there is insufficient evidence that the proposed permit limits can be consistently and reliably achieved.

Approach 4 detail

This option recognises that many sites for which new substance limits are being proposed are already subject to improvement obligations (mainly WFD phosphorus) in WINEP3 and that technologies to be deployed for phosphorus removal in AMP7 have the potential to deliver significant hazardous substance removal.

This terminology is used within the option descriptions where they have been assessed as an available option.

TABLE 11: PRIMARY SCREENING WFD CHEMICAL CYPERMETHRIN AND ZINC REDUCTION SCHEMES

OPTIONS TITLE	MEETS STATUTORY OBLIGATION?	TECHNICALLY FEASIBLE?	REASON REJECTED
Flexible permitting: Approach 2 Permit change. Monitoring at all sites will determine whether the permit can be achieved with existing assets at the end of AMP7. The decision to accept permit or deploy an alternative will be taken at this point.	Yes	Yes	**Carried forward** - Windlestone, East Tanfield, Great Ayton, Sedgeletch (cypermethrin and zinc), Tudhoe Mill, Bowburn, Kelloe zinc, Stokesley WwTW, Windlestone
Flexible permitting: Approach 3 Site will be at Best Available Technology with an Improvement driver. Apply for Operation Technique Agreement as mechanism for permitting	Yes	Yes	**Carried forward** - Sedgefield, Esh Winning, Crookhall, Hustledown, Kelloe OTAs will be combined with alternatives to replace/retrofit/expand existing processes, due to the uncertainty associated around the potential benefits of those alternatives.
Trade permit variation Treatment of point sources by imposing trader permits. This will require treatment on the trader site before discharging	No	No	**Discarded** – Cypermethrin is predominately from domestic supplies so will be difficult to completely remove from wastewater. The CIP 2 and 3 trials show no evidence of Cypermethrin coming from industrial sources. Zinc concentration is too varied (industrial and domestic) to effectively reduce
Operational solution Optimisation of existing site assets to achieve new permit to minimise/remove need for new assets	Yes	No	**Discard** – Optimisation of existing site assets will not achieve the required reduction in cypermethrin or zinc to meet the permits.
Replace/retrofit/expand existing primary/secondary treatment processes Introduce a new treatment stage on site, or increase the capacity of existing treatment processes. Available options are additional ASP lanes, NSAF units or tertiary solids removal in parallel with existing or adding a new stage. Or replace secondary biological filters with an activated sludge plant (ASP)	Yes	Possible	**Carried forward** - Esh Winning, Crookhall, Hustledown, Kelloe, Windlestone, Bowburn, Sedgefield, Sedgeletch, East Tanfield, Great Ayton, Stokesley, Tudhoe Mill Most sites will have the maximum biological capacity and tertiary treatment by the end of AMP7, providing limited scope for expansion. Replacing secondary filters with ASP may provide some improvement in

OPTIONS TITLE	MEETS STATUTORY OBLIGATION?	TECHNICALLY FEASIBLE?	REASON REJECTED
			cypermethrin removal and will result in a significant increase in operational carbon.
Transfer/pump away Flow transfer from 1 or more smaller works into an existing larger works	Yes	Yes	**Carried forward** – Pity Me, Pittington & Goosebeck transferred in AMP 7.
Change outfall location Move FE outfall so more relaxed permit is acceptable (discharge into less sensitive or larger water course)	Yes	Yes	**Carried forward** – Bowburn, Crookhall, Kelloe, Sedgefield, Hustledown, Sedgeletch
Centralise STWs Combine two or more STW into a new larger works to achieve efficiencies of scale	No	No	**Discarded** – Sites are large capacity WwTWs which are performing well. Not cost effective to abandon treatment plants and build a very large new WwTW that would not guarantee new cypermethrin permits.
Source control (diffuse source pollution) Control and treat diffuse pollution sources to sewer	No	No	**Discarded** – High Zinc concentrations are a legacy of the mining industry and cannot be removed. Source of Cypermethrin concentration is too varied to effectively reduce.
Integrated constructed wetland (ICW) Create ICW with multiple benefits as treatment solution (only applicable where less stringent permit limits or existing treatment solution that needs to be tighter)	No	No	**Discarded** – technology unproven within the water industry to guarantee permit value can be achieved.
Best Available Technology (BAT): Aerated Reedbed (constructed wetland) A reed bed system wastewater flows continuously through the support medium, made up of a gravel base planted with the common reed. The area around the reeds becomes populated with both aerobic and anaerobic bacteria. It is these bacteria that treats the incoming wastewater.	No	No	**Discarded** - Reedbeds require a large area and are generally not feasible for PE above 2,000. Removal of cypermethrin is 55% with 26% uncertainty.
BAT: Deep Bed Filter	Yes	Yes	**Carried forward** - Esh Winning.

OPTIONS TITLE	MEETS STATUTORY OBLIGATION?	TECHNICALLY FEASIBLE?	REASON REJECTED
Physical separation process, where solids are captured in a bed of granular media such as sand. Solids are removed by backwashing cloth discs			There are a number of deep bed filters which offer around 60% cypermethrin removal. Installing an additional stage of solids removal after an existing process may have limited impact on cypermethrin.
BAT: Ferric dosing Ferric sulphate solution dosed to precipitate phosphorus within the wastewater. Phosphorus removed as a sludge from the process.	Possible	No	**Discarded** – Many sites already have, or will have by the end of AMP8, ferric dosing for P removal. Results for cypermethrin removal are variable and addition of ferric increases soluble zinc, making this option unsuitable for sites with cypermethrin and dissolved zinc permits
BAT: Activated Sludge Plant A wastewater treatment process, well established within the Water Industry which employs bacteria	Possible	Possible	**Carried Forward** – Esh Winning, Crookhall, Replacing filters with activated sludge plant (ASP) will increase cypermethrin and zinc removal, however the exact improvement is not easily quantifiable and the change in process incurs a significant increase in operational carbon. Conversion of ASP to biological phosphorus removal will reduce ferric use on sites where ferric is contributing to elevated dissolved zinc in the final effluent.

*Chem 10 and 11 reports

(2) Investigation and operational interventions

Table 12 shows the constrained options generated through the review process of assessing each carry forward option against the sites needing intervention and understanding the feasibility of each option at each specific site.

TABLE 12: CHEMICAL LOAD STANDSTILL CONSTRAINED ENGINEERING OPTIONS

Wastewater Treatment Works	Accept permit– monitor risk	Innovative permitting Arrangement	Replace/retrofit/expand existing primary/secondary treatment processes	Transfer/pump away	Change outfall location	BAT: Deep Bed Filter	BAT: Activated Sludge
Bowburn STW (cypermethrin)	Yes	No	Yes	No	Yes	No	No
Crookhall STW (cypermethrin)	No	Yes	Yes	No	Yes	No	Yes
East Tanfield STW (cypermethrin)	Yes	No	Yes	No	No	No	No
Esh Winning STW (cypermethrin)	No	Yes	Yes	No	No	Yes	Yes
Great Ayton STW (cypermethrin)	Yes	No	Yes	No	No	No	No
Hustledown STW (cypermethrin)	No	Yes	Yes	No	Yes	No	No
Kelloe STW (cypermethrin)	No	Yes	Yes	No	Yes	No	No
Kelloe STW (zinc)	Yes	No	Yes	No	Yes	No	No
Sedgefield STW cypermethrin)	No	Yes	Yes	No	Yes	No	No
Sedgefield STW (zinc)	No	Yes	Yes	No	Yes	No	No
Sedgeletch STW (cypermethrin)	Yes	No	Yes	No	Yes	No	No
Sedgeletch STW (zinc)	Yes	No	Yes	No	Yes	No	No
Stokesley STW	Yes	No	Yes	No	No	No	No
Tudhoe Mill STW	Yes	No	Yes	No	No	No	No
Windlestone STW (cypermethrin)	Yes	No	Yes	No	No	No	No
Windlestone STW (zinc)	Yes	No	Yes	No	No	No	No

Wastewater Treatment Works	Accept permit– monitor risk	Innovative permitting Arrangement	Replace/retrofit/expand existing primary/secondary treatment processes	Transfer/pump away	Change outfall location	BAT: Deep Bed Filter	BAT: Activated Sludge
Pity Me STW (cypermethrin)	No	No	No	Yes	No	No	No
Pity Me STW (zinc)	No	No	No	Yes	No	No	No
Pittington STW (cypermethrin)	No	No	No	Yes	No	No	No
Teeside Airport (Goosebeck STW) (cypermethrin)	No	No	No	Yes	No	No	No

This shows where there are multiple options and hence the need for a least cost/best value approach. It also shows where there are limited options and hence leaves us with 'do' or 'do nothing' options.

3.2.4 Best value

Our value framework is embedded into our portfolio optimisation tool and contains a mixture of benefits which reflect measures which relate benefits to performance commitments or other social and environmental benefits. First, we score the impact of continuing business as usual and then we score each of the options. Benefits are scored over time for a 30-year horizon. This scoring takes into account the certainty of benefits being realised for different types of options.

3.2.5 Benefit scoring

Our value framework is embedded into our portfolio optimisation tool and contains a mixture of benefits which reflect measures which relate benefits to performance commitments or other social and environmental benefits. First we score the impact of continuing business as usual and then we score each of the options. Benefits are scored over time for both a 30 year and 40-year horizon. This scoring takes into account the certainty of benefits being realised for different types of options.

TABLE 13: RANGE OF BENEFITS IDENTIFIED FOR CHEMICALS REMOVAL DRIVERS

Value measures	Description	Unit	Value	Value source
Improved Treatment Works Performance	Number of non-compliance events	£/Isolated Upper Tier Failure (250-50000 Population)	£40,979.29	NWL Value Framework
Improved Treatment Work Performance	Number of non-compliance events	£/Isolated Upper Tier Failure (50000+ Population)	£52,896.61	NWL Value Framework
Operational Carbon	t/CO2e /year	tCO2e	£256.2*	NWL Value Framework
Embedded Carbon	t/CO2e /year	tCO2e	£256.2*	NWL Value Framework

Notes: *£ value per tonne of CO2e in 2025/26, annual increase (varying rate) reaching £378.6/t CO2e in 2024/55

In Table , we show that first we score the impact of continuing business as usual and then we score each of the relevant options. Benefits are scored over time for a 30-year time horizon. This scoring takes into account the certainty of benefits being realised for different types of options. Each of the technology options for an individual site are designed to deliver the same permit compliance, because the requirement is to deliver a treatment standard to meet the current baseline levels. The differentiators for this business case are carbon and cost.

TABLE 14: BENEFITS FROM WINEP WIDER ENVIRONMENTAL OUTCOMES AND NORTHUMBRIAN WATER'S VALUE FRAMEWORK FOR WFD_NDLS_CHEM1

Options carried	NWG Value framework measures	WINEP Wider Environment Outcomes
Continue business as usual As is position	N/A	N/A
Flexible permitting: Approach 2 Permit change No build solution	Embedded Emissions Improved Treatment Works Performance	Net Zero
Flexible permitting: Approach 3 Individual sites will have a permit issued with the standstill limit required and will also include an Operating Techniques Agreement that will specify target permit limits to be achieved, caveated by a clause stating that the Company will endeavour to remove as much of the substance as is reasonably practicable.	Embedded Emissions Improved Treatment Works Performance	Net Zero

Replace/retrofit/expand existing primary/secondary treatment processes Introduce new treatment stage on site	Embedded Emissions Improved Treatment Works Performance	Net Zero
Transfer flow Flow transfer from 1 or more smaller works into an existing larger works	Embedded Emissions Improved Treatment Works Performance	Net Zero
Change outfall location Individual sites will have pipework to divert current outfall to a location with lighter load restrictions	Embedded Emissions Improved Treatment Works Performance	Net Zero
BAT: Deep bed filter Physical separation process, where solids are captured in a bed of granular media such as sand. Solids are removed by backwashing cloth discs	Embedded Emissions Improved Treatment Works Performance	Net Zero
BAT: Activated sludge plant A wastewater treatment process, well established within the Water Industry which employs bacteria	Embedded Emissions Improved Treatment Works Performance	Net Zero

3.2.6 Investment appraisal

Costs and benefits have been adjusted to 2022-23 prices using the CPIH Index financial year average. The impact of financing is included in NPV calculation. Capital expenditure has been converted to a stream of annual costs, where the annual cost is made up of depreciation/RCV run-off costs and allowed returns over the life of the assets. Depreciation (or run-off) costs are calculated using the straight-line depreciation over the appraisal period. To discount the benefits and costs over time, we have used the social time preference rate as set out in 'The Green Book'.

We have used our Copperleaf asset management system to optimise our plan and select a best value plan. Our best value and least cost selection process has been assured by our third-party assurer, through the price review process.

Our optimisation methodology calculates Net Present Value (NPV) of the investment using the cost and benefits for each option. The present value is calculated by combining the profile of the present value of benefits and the profile of present value of costs over the appraisal period. Across the 15 sites there are 19 needs, for 18 of these, the least cost and best value alternatives were the same. The full results of this assessment are shown in Appendix B, and the preferred options are shown in Table 15. The table shows the NPV for the options to meet the WFD_NDLS_CHEM1 WINEP driver.

TABLE 157: CHEMICAL PREFERRED OPTIONS

Site Name	Chemical	Option	NPV	Least Cost	Chosen Option
Esh Winning STW	Cypermethrin	Flexible permitting (approach 3), Expand Tertiary treatment with new TSR	-2.138	Y	Preferred option
Crookhall STW	Cypermethrin	Flexible permitting (approach 2)	3.402	Y	Preferred option
Hustledown STW	Cypermethrin	Flexible permitting (approach 3)	0.062	N	Preferred option
Kelloe STW	Cypermethrin	Flexible permitting (approach 3)	0.067	Y	Preferred option
Pittington STW	Cypermethrin	River monitoring at Sherburn	0.221	Y	Preferred option
Pity Me STW	Zinc	AMP7 transfer, permit removed	0.000	Y	Preferred option
Sedgefield STW	Zinc	Flexible permitting (approach 3)	0.106	Y	Preferred option
Pity Me STW	Cypermethrin	AMP7 transfer, permit removed	0.000	Y	Preferred option
Bowburn STW	Cypermethrin	Change outfall location to River Wear	-13.085	Y	Preferred option
Sedgefield STW	Cypermethrin	Flexible permitting (approach 3)	0.067	Y	Preferred option
East Tanfield STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Preferred option
Goosebeck STW	Cypermethrin	AMP7 transfer, permit removed	0.000	Y	Preferred option
Great Ayton STW	Cypermethrin	Flexible permitting (approach 2)	4.231	Y	Preferred option
Kelloe STW	Zinc	Flexible permitting (approach 3)	0.106	Y	Preferred option
Sedgeletch STW	Cypermethrin	Flexible permitting (approach 2)	0.418	Y	Preferred option
Sedgeletch STW	Zinc	Change outfall location to River Wear	-12.368	Y	Preferred option
Stokesley STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Preferred option
Tudhow Mill STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Preferred option
Windelstone STW	Cypermethrin	Flexible permitting (approach 2)	1.201	Y	Preferred option

The one option where we are proposing an alternative to the least cost and the best value option is for Hustledown STW. The flexible permit (approach 3) is a higher cost to approach 2, it also presents a lower overall value from a carbon and cost perspective. The rationale for the selection of the preferred option is that is gives greater flexibility to better understand the technologies that have been put in through AMP7 and understand how our permitting can adapt accordingly ensuring that we meet the required levels.

3.2.7 Options for investigations

CIP4 and MICROPLASTICS

In line with the WINEP guidance there is no requirement to develop an unconstrained options list for investigations. CIP is a statutory requirement; the only option is to undertake the investigations.

The following description of the CIP4 investigation approach is taken from the UKWIR CIP4 pre-scoping technical note[10].

CIP4 builds on over two decades of experience from the development of company-specific investigations that contribute to the collaborative national UKWIR programmes of WW17, CIP1, CIP2 and CIP3.

Following on from the programme set out in CIP3, CIP4 again comprises multiple elements. Compared with CIP1 and CIP2, where fewer but more substantial components were included, these elements are more diverse in aim and scope and have been proposed following the success and findings of CIP3.

CIP4 goes beyond previous monitoring programmes as it includes new elements dealing with fish, plant and sediment sampling. Therefore, there is the need to involve research or academic organisations in addition to commercial laboratories. This is akin to the investigation research studies delivered in the CIP3 programme and will require the participation of subject matter experts for, for example, microplastics and AMR.

Microplastics investigations are also an industry collaboration, the scope of which is to look at the prevalence of microplastics in sludge across all processes and process types within the industry. This is different to the investigation described as part of our biosolids investigations below, that looks at how microplastics from our customers are processed through our AAD plant and disposed of on land in our region.

N-TAL

In line with the WINEP guidance there is no requirement to develop an unconstrained options list. For N-TAL the solution types are limited to do nothing, or three trials. To develop our list of technology trials we engaged with the joint National Steering Group – Natural England, EA, and other water companies for N-TAL. We were tasked with using the Environment Agency's collaborative report released in March 2021[11] as our starting point to choose our trial technologies. We are looking to share out trial data with other WASCs also trialling technology and have agreement from Severn Trent already, this will give additional strength to the investigation findings.

Three technology trials are required per WASC. Through an internal workshop we identified algae, Nuvoda and an integrated constructed wetland (ICW):

- **Algae based solution** utilising our current algae trials. We have an algae-based treatment set up at pilot scale on our Bran Sands site. The plant would be extended and duplicated to run 2 streams in parallel, allowing total nitrogen analysis and optimisation on both a side stream sludge liquor and final effluent.

[10] UKWIR CIP4 Pre-scoping technical note, SNC Lavalin
[11] Collaborative Periodic Review (PR) 24 Trials, Environment Agency March 2021

- **Nuvoda** – MOB process (mobile organic biofilm). This process uses an organic cellulose material to ballast small granules providing a surface for simultaneous nutrient removal. The technology has previously been used in the US and has good feedback on improving process stability as well as achieving low Total N and P results. The addition of this natural product also allows an increased capacity without building additional assets. Additional benefits improved solids settlement, improved carbonatious treatment, additional capacity, provides a platform to enhance nitrification and denitrification – leading to less nitrogen, protection of landbank, and resilience in supply chain. The N-Tal trial will also allow confidence in the technology which has potential to benefit other sites in the future.
- Monitoring efficiency of an **Integrated Constructed Wetland** for total N removal. We will monitor our Low Wadsworth site – as far as we know, no-one has monitored an ICW for total nitrogen removal before.

We currently don't have any total nitrogen permits, so it will be beneficial for us to undertake trials to gain insight into our performance for nitrogen through monitoring.

The three trials will allow a thorough investigation into the options for total N removal for our business. The effluent receiving waters will benefit from reduced N and potentially other nutrient reduction such as P. Additional sampling for priority emerging substances is also of importance. Furthermore, following the trial, the equipment can remain in place to extend treatment options at those locations.

Bioresources

Our investigation option descriptions are as follows:

- Investigation of concept of reducing the concentration of key nutrients (N, P) from the biosolids generated / processed at Bran Sands and Howdon Treatment Centres. Include investigations into both prevention, management and removal of sources and nutrients on Primary Sludge Treatment Centres. Target methodologies to remove nutrients at source.
- Investigation to look at alternative disposal. Investigate complete standalone undefined advanced thermal treatment including contribution to research collaboration. Investigation also to include alternative end products other than biosolids which allow its application to an outlet such as domestic fertilizer, construction materials or biofuels market reducing the reliance of agriculture landbank deployment. Investigation to understand the commercial value and opportunity of key elements within the Biosolids composition to other industries. This will need to include the permitting, planning applications, construction cost and OPEX cost. Primary objective of a reduction or cessation of biosolids to agriculture land.
- Investigate current knowledge of microplastics throughout the STW process, through the AAD process and its pathways post deployment to agriculture land. Review and develop future mitigation to their potential impact.

These are our only, and so preferred, options.

3.2.8 Data table alignment

The benefits and investment for our preferred options for chemicals and emerging contaminants are included in Table 16 and Table 17. We will continue to refine the profiling of benefits and expenditure as we continue to work with our strategic delivery partner to carry out further design work and optimisation of the programme for delivery.

TABLE 16: INPUTS FOR TABLE CWW15 – BENEFITS BEST VALUE OPTION

EA/NRW environmental programme	PR24 BP reference	Benefit	Units	2025-26	2026-27	2027-28	2028-29	2029-30	Total AMP8
Treatment for chemical removal	CWW15.177	Discharge permit compliance	%	0	0	0	0	0	0
	CWW15.178	Embedded greenhouse gas emissions	tonnes	514.79	411.83	414.405	422.13	316.60	2,079.75
Treatment for chemical removal	CWW15.177	Discharge permit compliance	£m	0.000	0.000	0.000	0.000	0.091	0.091
	CWW15.178	Embedded greenhouse gas emissions	£m	0.133	0.109	0.111	0.115	0.087	0.556

Source: Northumbrian Water

TABLE 17: INPUTS FOR TABLE CWW15 – BENEFITS ALTERNATIVE OPTION

EA/NRW environmental programme	PR24 BP reference	Benefit	Units	2025-26	2026-27	2027-28	2028-29	2029-30	Total AMP8
Treatment for chemical removal	CWW16.177	Discharge permit compliance	%	0	0	0	0	0	0
	CWW16.178	Embedded greenhouse gas emissions	tonnes	514.79	411.83	411.83	411.83	308.87	2,059.15
Treatment for chemical removal	CWW16.177	Discharge permit compliance	£m	0.000	0.000	0.000	0.000	0.091	0.091
	CWW16.178	Embedded greenhouse gas emissions	£m	0.133	0.109	0.110	0.112	0.085	0.550

Source: Northumbrian Water

The expenditure correlating to these benefits is shown in Table 18.

TABLE 18: INPUTS FOR TABLE CWW3 - ENHANCEMENT EXPENDITURE £M

EA/NRW environmental programme	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	Total
Treatment for chemical removal (WINEP/NEP) wastewater	0.158	7.104	7.436	7.701	1.159	1.152	1.358	25.911
Chemicals and emerging contaminants monitoring, investigations, options appraisals; (WINEP/NEP) wastewater	0.000	0.000	2.887	2.887	0.104	0.104	0.104	6.086
Investigations, other (WINEP/NEP) - multiple surveys, and/or monitoring locations, and/or complex modelling wastewater	0.000	0.000	0.438	0.438	0.000	0.000	0.000	0.875
Total	0.158	7.104	10.761	11.025	1.263	1.256	1.462	32.872

Source: Northumbrian Water

3.2.9 Uncertainty

Our main areas of uncertainty relating to engineered solutions are shown in Table 19. The highest areas of uncertainty and risk relate to the public perception of change in outfall location and transfer to another treatment plant. This is high due to the disruption that the delivery of these options will cause to the public. This has been taken into consideration in the option selection, only selecting these options where the benefits outweigh this risk.

TABLE 19: ENGINEERED OPTIONS RISK ASSESSMENT

Risk category	Option 1 – Treatment process-based permitting		Option 2 – Change outfall location		Option 4- Transfer to another treatment plant		Option 5- Replace/retrofit/expand existing primary or secondary treatment processes using existing process types or more intensive processes	
	RAG	Comment	RAG	Comment	RAG	Comment	RAG	Comment
Driver compliance		**LOW RISK** – Chosen option is well tested industry standard method of removing phosphorus		**MEDIUM RISK -** Standard method of achieving compliance by transferring to alternative water bodies. Any transfer will be checked to confirm that there is no impact on the receiving water or the baseflow of the river where it is currently discharging..		**MEDIUM RISK -** Transfer influent to other works is a standard approach of treating wastewater. Some consideration needs to be made to the impact of removing the baseflow from rivers.		**LOW RISK** – Chosen option is well tested industry standard method of removing phosphorus. Some risk due to reliance on performance of existing assets
Delivery		**LOW RISK** – frequently used and tested method of removing nutrients from water body		**LOW RISK** – frequently used and tested method of removing nutrients from water body		**LOW RISK –** Delivery and construction of transfer pipelines standard construction project.		**LOW RISK** - The required expansion of assets for tighter nutrient removal is fairly standard with good experience in the industry.

Risk category	Option 1 – Treatment process-based permitting		Option 2 – Change outfall location		Option 4- Transfer to another treatment plant		Option 5- Replace/retrofit/expand existing primary or secondary treatment processes using existing process types or more intensive processes	
	RAG	Comment	RAG	Comment	RAG	Comment	RAG	Comment
Cost		**LOW RISK** –Industry standard method of removing phosphorus good understanding of historical costing information. Some risk to costs due to BREXIT and demand in the industry for P removal assets		**LOW RISK** –Industry standard method of removing phosphorus good understanding of historical costing information. Some risk to costs due to BREXIT and demand in the industry for P removal assets		**MEDIUM RISK** – No detailed evaluation completed to confirm work upgrades required at the receiving works as a result of the transfer		**MEDIUM RISK** – until a detailed site assessment has been complete it is difficult to have cost certainty on any site restrictions.
Resources		**LOW RISK** No specialist resources required		**LOW RISK** No specialist resources required		**LOW RISK** No specialist resources required		**LOW RISK** No specialist resources required
Technology		**LOW RISK** Technology is standard with NWL and wider water industry		**LOW RISK** Technology is standard with NWL and wider water industry		**LOW RISK** Technology is standard with NWL and wider water industry		**LOW RISK** Technology is standard with NWL and wider water industry

Risk category	Option 1 – Treatment process-based permitting		Option 2 – Change outfall location		Option 4- Transfer to another treatment plant		Option 5- Replace/retrofit/expand existing primary or secondary treatment processes using existing process types or more intensive processes	
	RAG	Comment	RAG	Comment	RAG	Comment	RAG	Comment
Supply chain		**MEDIUM RISK** likely to be significant demand in the water industry for this technology, however there are several suppliers for this option		**LOW RISK** Multiple framework suppliers for chosen option		**LOW RISK** Multiple framework suppliers for chosen option		**MEDIUM RISK** likely to be significant demand in the water industry for this technology, however there are several suppliers for this option
Public perception		**MEDIUM RISK –** some disruption will be caused by construction works on site		**HIGH RISK** - pipeline transfer will involve disturbing the landowners along the transfer route which could cause negative publicity		**HIGH RISK** - pipeline transfer will involve disturbing the landowners along the transfer route which could cause negative publicity		**MEDIUM RISK –** some disruption will be caused by construction works on site

3.2.10 Third party funding

No opportunities for third party funding have been identified for the chosen interventions. As described, all chemicals investigations (CIP), microplastics and N-TAL will be collaborative projects benefitting from others investments and resources (time and materials) given in kind.

3.2.11 Direct procurement for customers

We assessed the chemicals programme against the DPC guidance (see our **assessment report**, NES38). This report concludes there are no opportunities for direct procurement for customers relevant to chemicals because the projects are small value and less than <£200m of whole life totex.

3.2.12 Customers views informing option selection

Our research shows that customers support investment in the environment, including wider environmental and social benefits – though they do not necessarily think they should always pay for this through their water and wastewater bills. In particular, our customers rank dealing with sewage effectively and improving the qualities of rivers as two of their "medium" priorities (**prioritisation of common PCs**, NES44).

In our **qualitative affordability and acceptability testing** (NES49), customers supported our "preferred" plan which included these improvements in treatment of chemicals and investigations into emerging contaminants. Customers found this plan acceptable because it focused on the right things, is good for future generations, and is environmentally friendly. Customers who did not find this plan acceptable said that this was expensive, and water companies should pay out of their own profits. We did not ask specifically about chemicals and emerging contaminants in wastewater (as our individual items were limited only to the largest investments), but customers supported maintaining rivers and reducing pollution (NES49). In our **quantitative research** (NES50), 74% of customers supported our preferred plan, including this investment.

Customers also identified "pollution leading to dead fish in rivers" and "algae choking plants and wildlife" as medium priorities in our **DWMP research in 2020**, similar to storm overflows – but not as high as chemicals and microplastics in wastewater, which one participant described as "the next pandemic".

We have not asked customers about specific options for removing cypermethrin or zinc from wastewater. For one of our sites, Hustledown STW, we chose an option which is not least cost – but instead provides improved carbon benefits. We did not ask customers specifically about this, but we compared this to customer views about embedded carbon from storm overflows research (see our line-of-sight report, NES45). Here, customers supported nature-based and hybrid solutions for individual storm overflows where this was not much more expensive and asked us to explore better value green solutions

where we could. Customers supported an increase of £31m in the storm overflows programme to switch to green solutions which were better value because they have lower embedded carbon. We can apply a similar approach here.

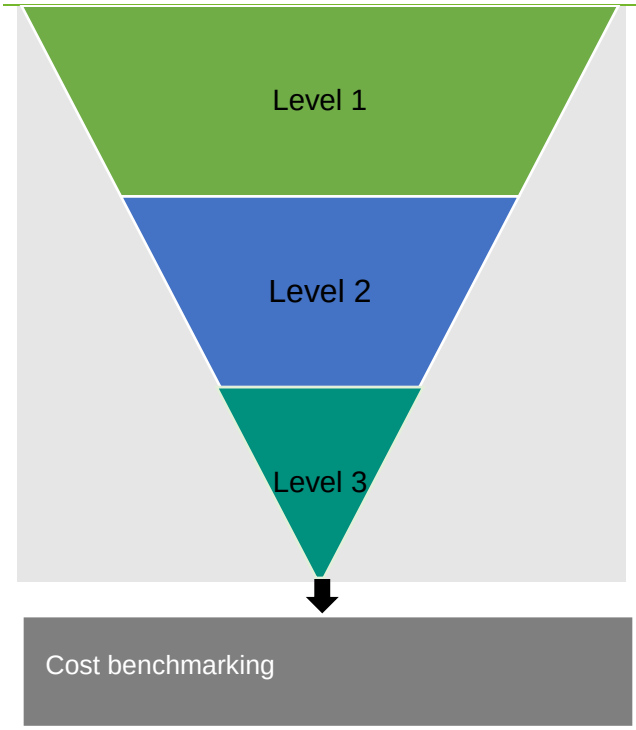
4. COST EFFICIENCY

4.1. APPROACH TO COSTING

4.1.1 Cost methodology

A full description of our costing methodology is contained in appendix A3 – costs (NES04). In Figure 2, all options for chemicals have been costed at Level 2. This level is appropriate for a Price Review submission as it is sufficient to understand that the interventions can be delivered within the cost at a programme level. A level 3 estimate would require a level of detailed design to be undertaken which would incur significantly more cost which is not appropriate until delivery is confirmed.

FIGURE 2: PROCESS COST ESTIMATION



Level – 1 (confidence: – 50% to +100%)

Costing is undertaken using Northumbrian Water's costing curves. Costing occurs at an overall asset level. For example package plant or a pumping for a certain population.

Level – 2 (confidence: - 50% to + 50%) – Chosen approach

Costing is undertaken using Northumbrian Water's costing curves. Costing occurs for each of the main items of scope. For example, the length of rising main and the size of the pumps.

Level – 3 (confidence: - 20% to +30%)

Detailed bottom-up cost of all items taking into consideration factors such as ground conditions.

Cost benchmarking

We have benchmarked 9% of the preferred options against the available cost curves from other companies. Further detail is provided in section 4.1.3.

4.1.2 Options providing cost efficiencies

We have identified three types of delivery efficiencies:

- We are choosing our options where we have more control over the cost certainty.
- We will be packaging work to enable purchasing and delivery efficiencies. For example, bulk buying large cost process units.
- The opportunity to collaborate to deliver CIP4, N-TAL and microplastics investigations, this involves funding from all WASCs maximising the value for investment and data return.

4.1.3 Cost benchmarking

We have benchmarked direct costs for each of the key asset types and indirect costs against the cost curves for other companies in our costing partner's database. As there is no standard asset hierarchy used for costing across all companies, there are differences in what each company includes and excludes.

Therefore, our costing partner has benchmarked where it is possible to carry out an equitable comparison and this ranges between two and five other companies depending on the asset type. Table 20 summarises the benchmarking of direct costs. Direct costs are defined as those incurred on plant, labour, material, and equipment i.e., costs that are directly accountable to the project. This represents costs for site based engineered options, we have not undertaken benchmarking for investigations due to their specificity and small scale. The comparisons shown in the following tables are benchmarks for options for the WINEP Phosphorus and WINEP Chemicals drivers with site treatment based preferred options.

TABLE 20: BENCHMARK OF DIRECT COSTS

Investment Name	Option Type	Northumbrian £k	Benchmark £k	Delta* £k	Delta %**
Bishop Auckland STW (Vinovium NH3)	End-of-pipe	£1,776,715	£1,694,605	£82,109	5%
East Tanfield STW	End-of-pipe	£1,557,535	£1,585,085	-£27,550	-2%
Aycliffe STW	End-of-pipe	£3,607,556	£4,557,297	-£949,741	-21%
Stokesley STW Cyper	End-of-pipe	£920,579	£1,174,379	-£253,799	-22%
Willington STW_Rev1 P02	End-of-pipe	£2,616,237	£2,455,278	£160,959	7%
Stressholme STW WFD UWWTR	End-of-pipe	£10,477,481	£9,370,611	£1,106,870	12%
Total		£20,956,103	£20,837,254	£118,848	1%

Note: * Delta = Northumbrian – Benchmark

** Delta % = Delta ÷ Benchmark

Source: Northumbrian Water

In addition to benchmarking the direct asset costs, we conducted an analysis of client and contractor indirect costs, comparing our own project and contract overheads to data provided by six comparator water companies. A larger number of comparator companies is available for indirect costs than for direct costs. Table 21 shows that our indirect costs are calculated as 63.40% of direct costs which is 10.46% below the industry benchmark.

TABLE 21: BENCHMARK OF INDIRECT COSTS

Indirect cost type	Northumbrian cost	Benchmark cost	Delta
Total Contractor Indirect	36.88%	48.01%	-11.14%
Total Client Indirect	26.52%	25.84%	0.68%
Total Project Indirect	63.40%	73.86%	-10.46%

Source: Northumbrian Water

The WFD programme is currently 5% below the industry benchmark when including indirect costs to the original direct costs as showed in Table 22 (below). With many items benchmarked, most of them across three other companies, there is confidence that the items identified have been analysed robustly.

TABLE 22: SUMMARY FOR WFD INCLUDING INDIRECT COSTS

Investment Name	Option	Northumbrian	Benchmark	Delta*	Delta %**
Bishop Auckland STW (Vinovium NH3)	End-of-pipe	£2,903,152	£2,946,241	-£43,089	-1%
East Tanfield STW	End-of-pipe	£2,545,012	£2,755,829	-£210,816	-8%
Aycliffe STW	End-of-pipe	£5,894,746	£7,923,316	-£2,028,570	-26%
Stokesley STW Cyper	End-of-pipe	£1,504,227	£2,041,774	-£537,548	-26%
Willington STW_Rev1 P02	End-of-pipe	£4,274,931	£4,268,746	£6,185	0%
Stressholme STW WFD UWWTR	End-of-pipe	£17,120,204	£16,291,744	£828,460	5%
Total		£34,242,272	£36,227,650	-£1,985,379	-5%

Note: * Delta = Northumbrian – Benchmark

** Delta % = Delta ÷ Benchmark

Source: Northumbrian Water

4.1.4 Factors affecting cost allowances

We are not currently submitting any evidence to support that our costs for areas covered in this enhancement case would be different than other companies.

5. CUSTOMER PROTECTION

5.1. PERFORMANCE COMMITMENT

The ability of the wastewater treatment works to treat an increased load will be covered under the discharge permit compliance (numeric) metric which is a common performance commitment. This measure is based on a calendar year and has an underperformance payment should the commitment not be achieved.

Compliance against dry weather flow permit measures are not currently covered by a performance commitment but these will likely become a statutory requirement which will form part of the Environment Agency's Environmental performance assessment during AMP8 leaving company's open to prosecution should they fail to meet statutory requirements.

5.2. PRICE CONTROL DELIVERABLES

Our approach to determining Price Control Deliverables (PCD) is outlined in Section 12.3 of **A3 – costs** (NES04). In **Error! Reference source not found.** below, we assess our protected areas and bathing water related enhancements to test if the benefits are linked to PCs, against Ofwat's materiality of 1%, and to understand if there are outcome measures that can be used. Our assessment has highlighted that the benefits we expect to deliver through our AMP8 WINEP programme will not be measured through PCs. Therefore, we propose a PCD to ensure protection for customers through delivery of our WINEP programme.

TABLE 23: ASSESSMENT OF BENEFITS AGAINST THE PCD CRITERIA

Enhancement scheme	Benefits linked to PC?	Materiality	Possible outcomes?
Wastewater WINEP – Chemicals and emerging contaminants (NES39)	Pass – benefits are environmental or investigations	Pass – 2%	Outcome difficult to measure effectively and vary between schemes (particularly investigations). Customers could be protected through an output measure based on delivery of schemes.

Our WINEP programme is set by the Environment Agency, which determines the statutory and non-statutory investments we should make. The EA assures that WINEP actions are delivered to the agreed timeframe, and environmental obligations are met. We therefore propose a PCD that makes sure that costs are returned to customers either where the EA has decided that a project is no longer required, or where we have not delivered to the agreed timeframe and/or environmental obligations have not been met (according to the EA). A summary of our PCD for WINEP programme delivery is outlined in Table 24.

TABLE 24: SUMMARY OF THE PRICE CONTROL DELIVERABLE FOR OUR WINEP PROGRAMME DELIVERY TO PROTECT CUSTOMERS

Description of price control deliverable	Delivery of WINEP projects as specified in our WINEP enhancement cases (NES17, NES18, NES19, NES28, NES29, NES30, NES31, NES34, NES39).
Measurement and reporting	We will report on the delivery of WINEP projects at the next price review (PR29), including specifying the individual projects that have been delivered, not delivered, or that the EA has decided are no longer required (under the EA's WINEP alterations process). This is in addition to the WINEP guidance which specifies how we will need to report progress against delivery of the WINEP actions and tracking and reporting WINEP delivery in a transparent and auditable manner.
Conditions on allowance	Projects must be delivered to the specification agreed with the Environment Agency under WINEP.
Assurances	The Environment Agency will confirm that WINEP actions have been delivered to the agreed timeframe, and that environmental obligations have been met. As set out in the WINEP guidance, there will be regular liaison between water companies and the EA to discuss progress, risks and issues associated with delivery of the WINEP programme and to identify any alterations. The EA uses the WINEP measures sign-off, technical review and audit guidance for assurance that the environmental obligations as set out in the WINEP are completed as planned.
Price control deliverable payment rate	We will return funds back to customers for individual projects, as specified in Tables 27 to 30 above (for NES39)
Impact on performance in relation to performance commitments	There are some benefits to greenhouse gas emissions in NES39.

We propose a single PCD for most of our WINEP programme delivery (with the exception of storm overflows). This should:

- Be set according to individual project costs, rather than a "per project" unit cost. This is because these costs vary considerably, and a single rate would create an incentive to deliver more of the cheapest projects (at the expense of more expensive projects). Ofwat's guidance in IN23/05 identifies this incentive and expects us to set out scheme level deliverables where costs vary significantly across schemes (so our approach here is consistent with the guidance).
- Not include an automatic penalty for non-delivery (beyond returning the costs to customers). This is because this PCD includes projects where the EA has decided these are no longer required, which should not lead to a penalty. If we did not deliver a project that is required (and where we had not agreed a change with the EA), we would not meet our statutory obligations and so this does not require an additional incentive to deliver.
- Change according to the EA's WINEP alterations process. In 2020-25, our ODI for WINEP delivery does not automatically take into account projects that are removed from WINEP by the EA – but this should be for the EA to determine. Costs should be returned to customers for projects that are not required, without further interventions needed from Ofwat.

This is an aggregated PCD across all our WINEP schemes except for storm overflows. We chose to aggregate these PCDs because most of our WINEP enhancement cases or projects would not be individually material, and these share the same reporting, assurance, and conditions.

6. APPENDIX A: WFD CHEMCIALS CURRENT PERFORMANCE

The data presented in the following graphs was collected through the national CIP trials. The period required for sampling and data collection was not continuous, therefore the data shown has periods with no data.

FIGURE 3: CIP2 AND CIP3 CYPERMETHRIN DATA FOR BOWBURN STW

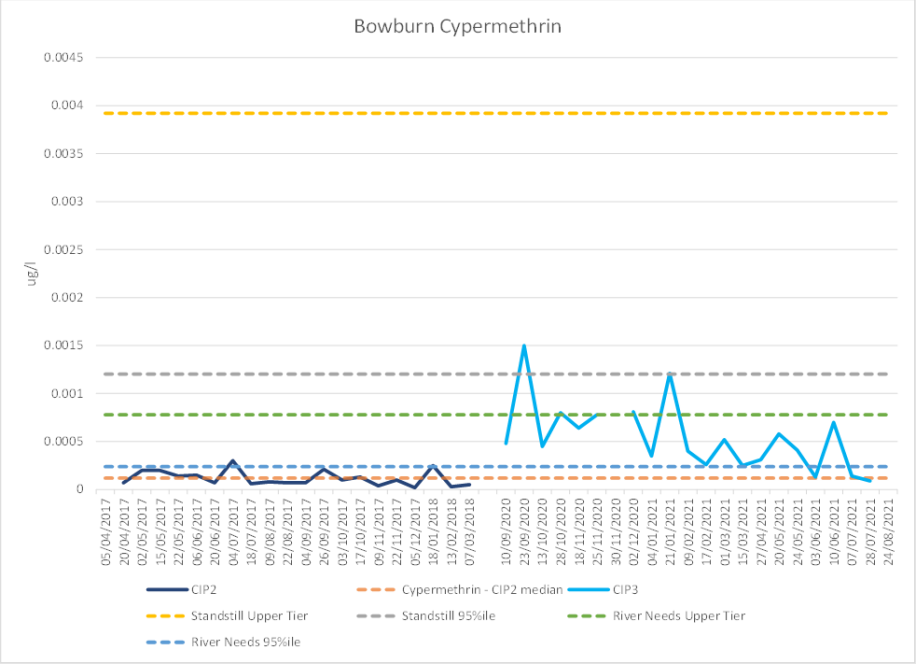


FIGURE 4: CIP2 AND CIP3 CYPERMETHRIN DATA FOR CROOKHALL STW

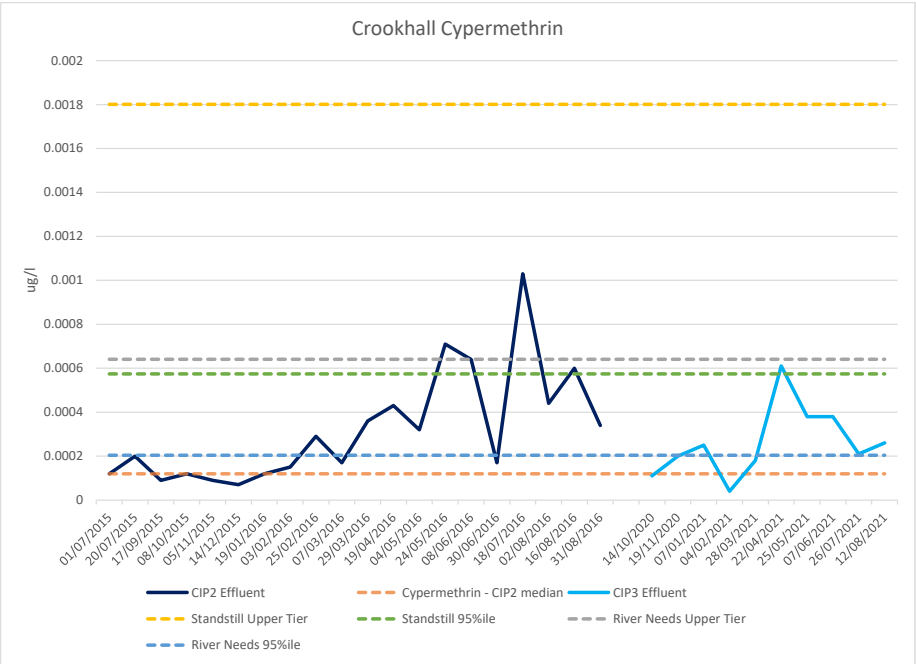


FIGURE 5: CIP2 AND CIP3 CYPERMETHRIN DATA FOR EAST TANFIELD STW

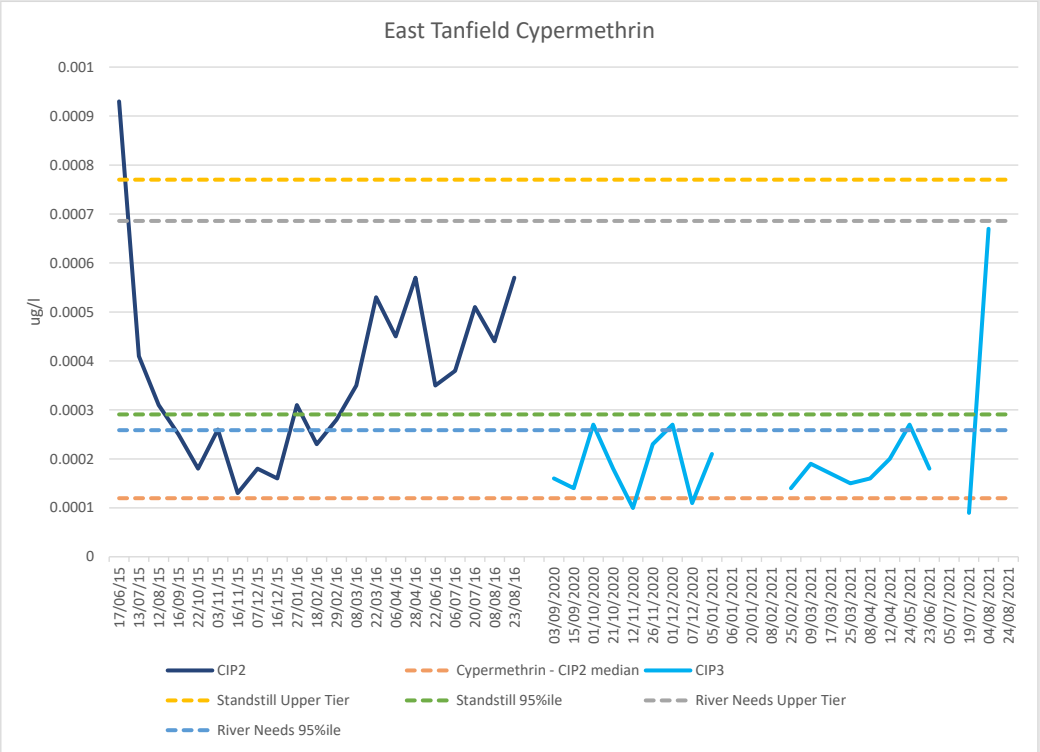


FIGURE 6: CIP2 AND CIP3 CYPERMETHRIN DATA FOR ESH WINNING STW

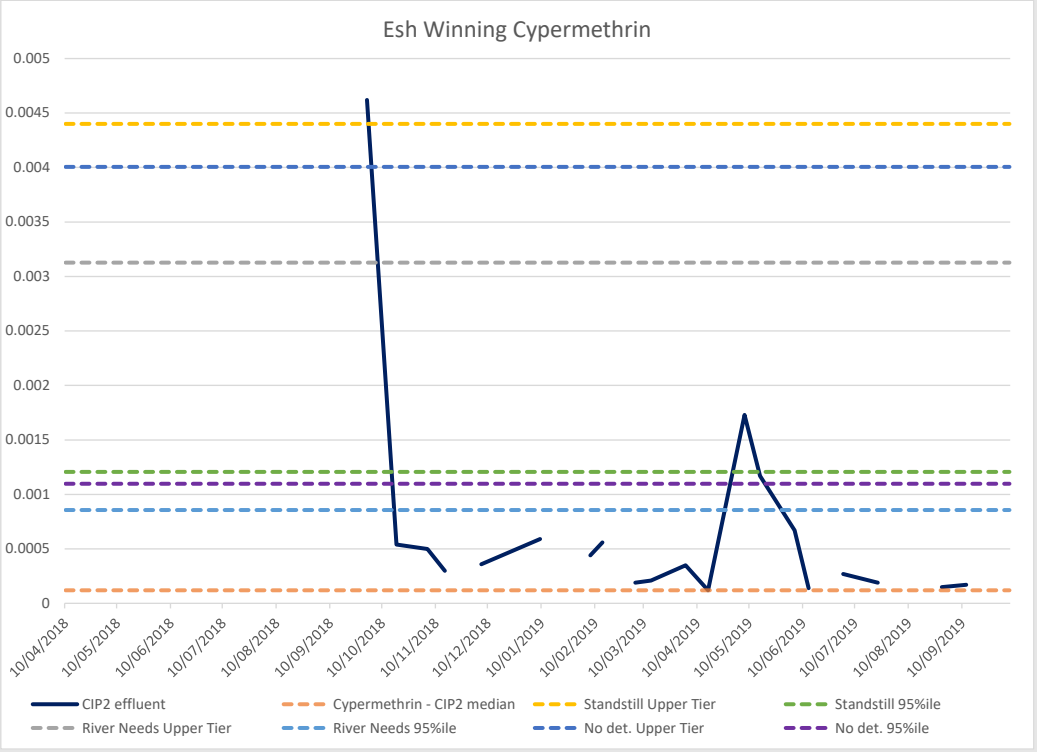


FIGURE 7: CIP2 AND CIP3 CYPERMETHRIN DATA FOR GOOSEBECK STW (TEESIDE AIRPORT)

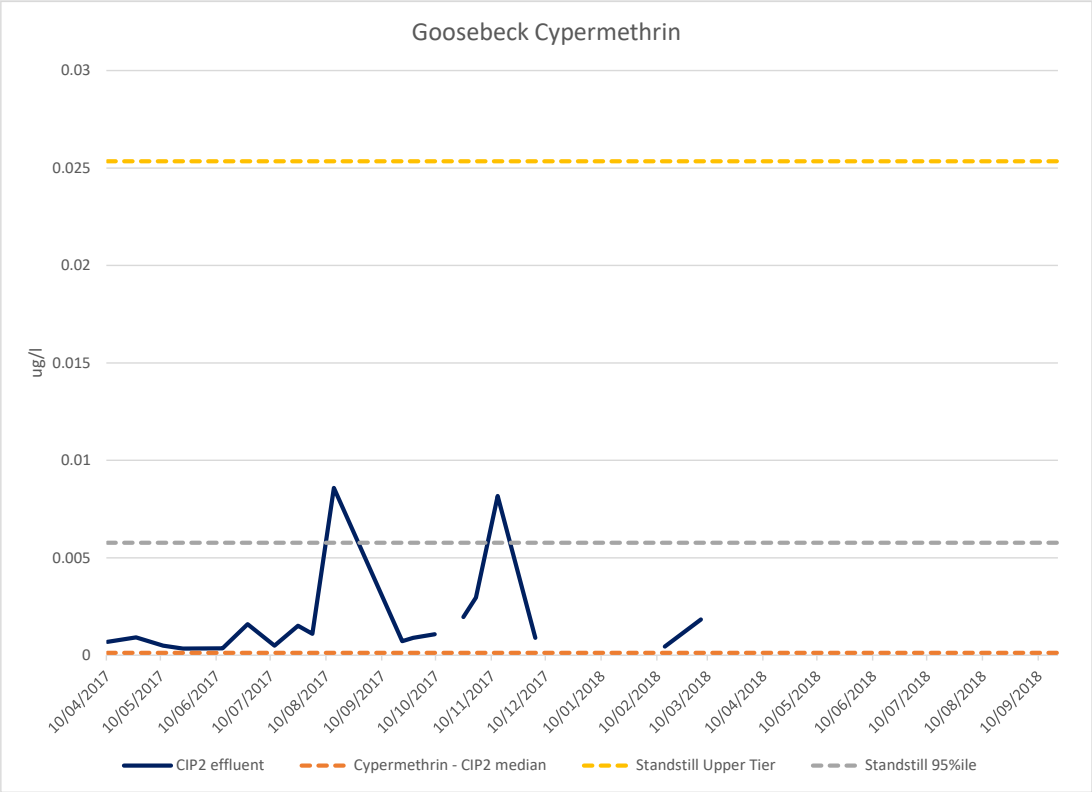


FIGURE 8: CIP2 AND CIP3 CYPERMETHRIN DATA FOR GREAT AYTON STW

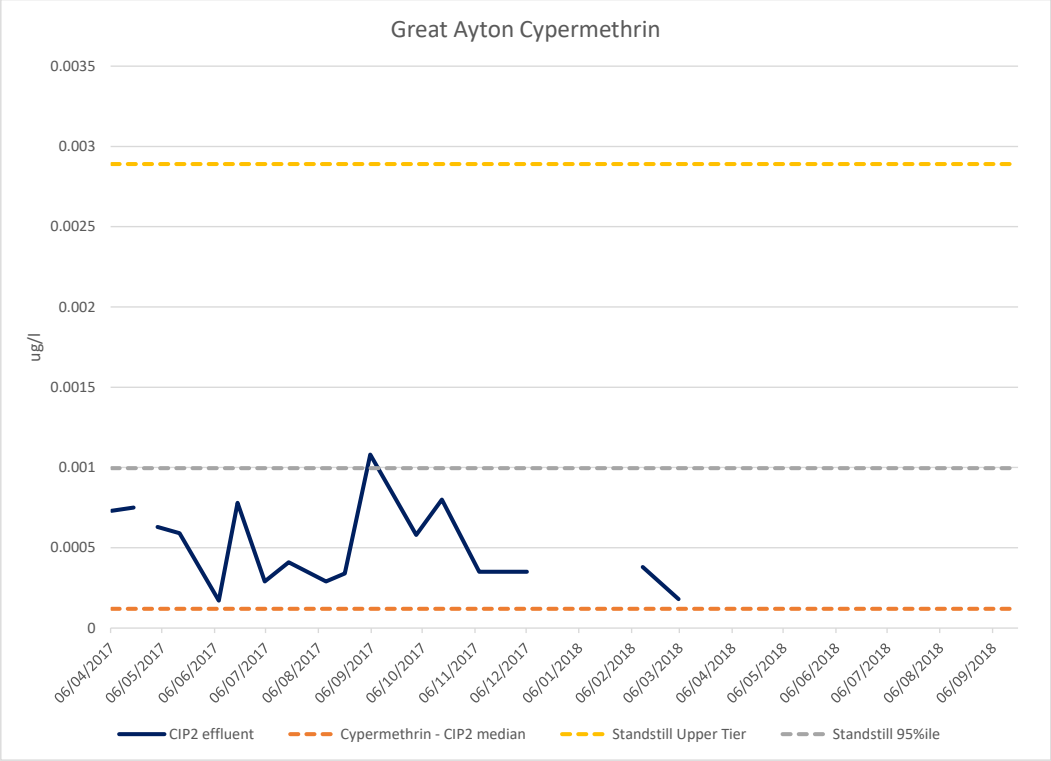


FIGURE 9: CIP2 AND CIP3 CYPERMETHRIN DATA FOR HUSTLEDOWN STW

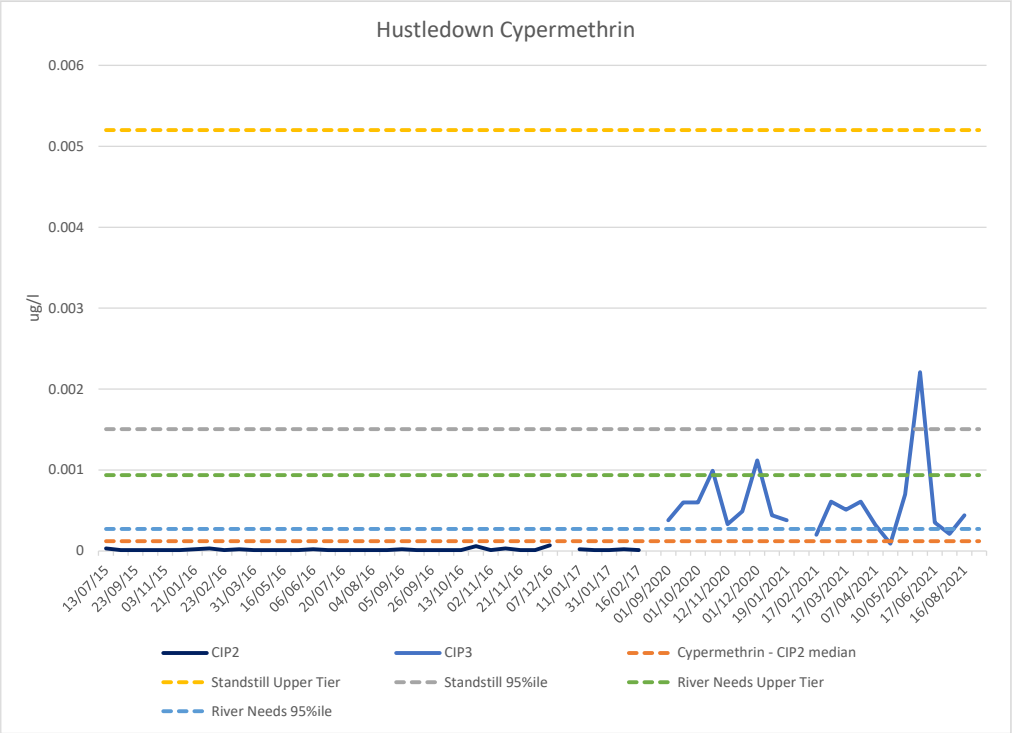


FIGURE 10: CIP2 AND CIP3 IRON DATA FOR HUSTLEDOWN STW

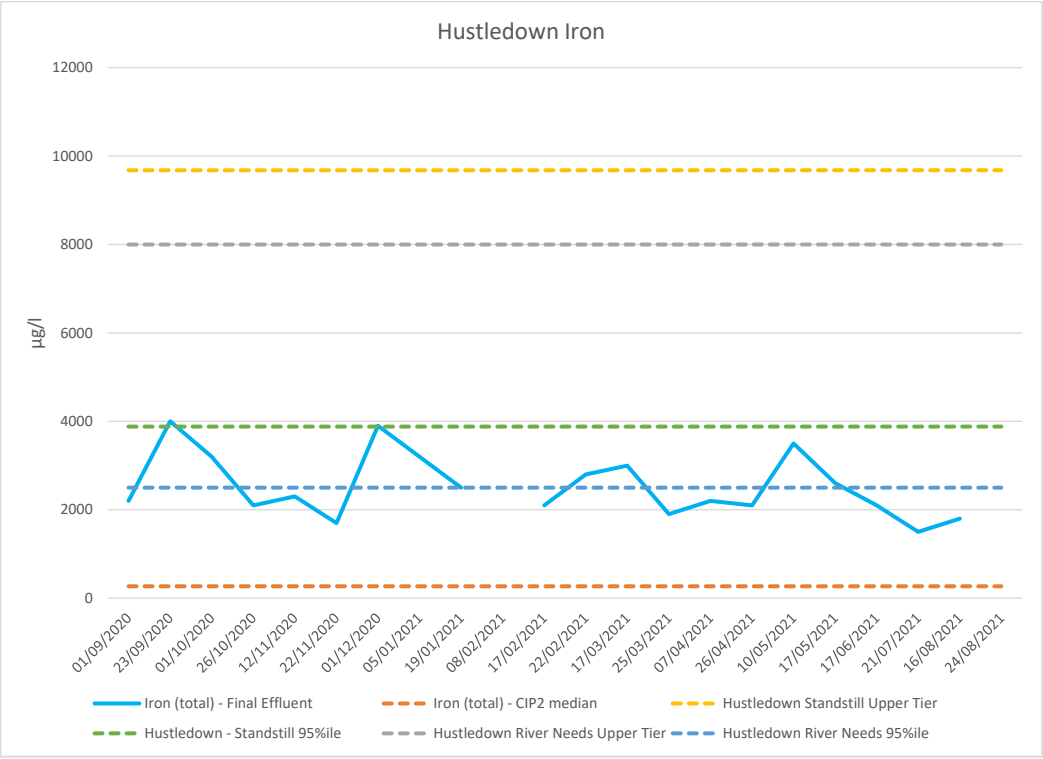


FIGURE 11: CIP2 AND CIP3 CYPERMETHRIN DATA FOR KELLOE STW

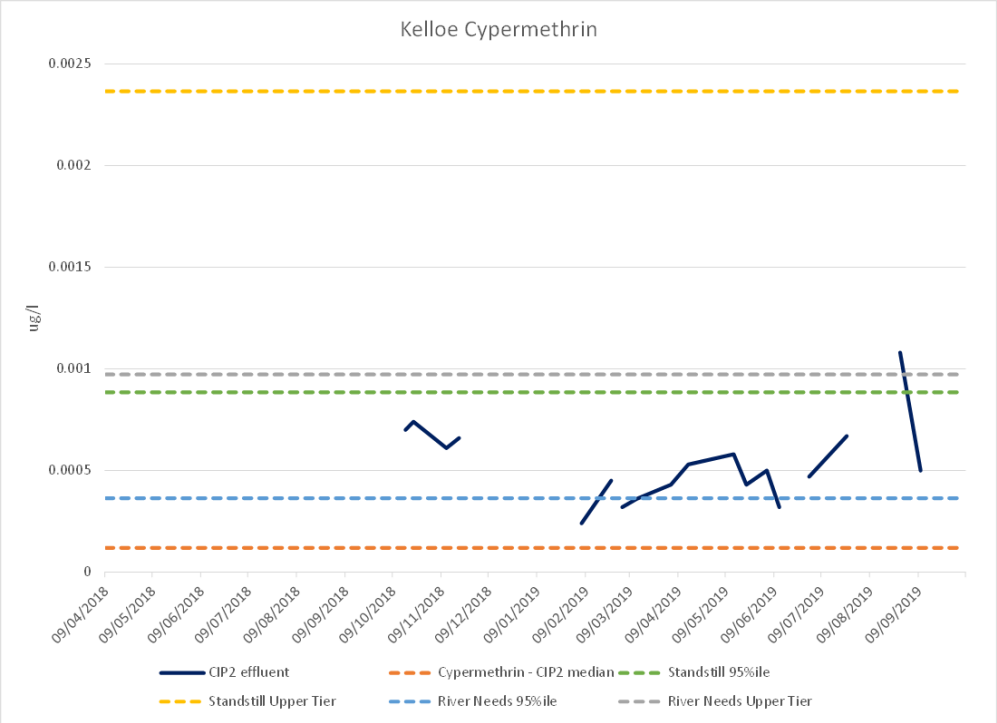


FIGURE 12: CIP2 AND CIP3 ZINC DATA FOR KELLOESTW

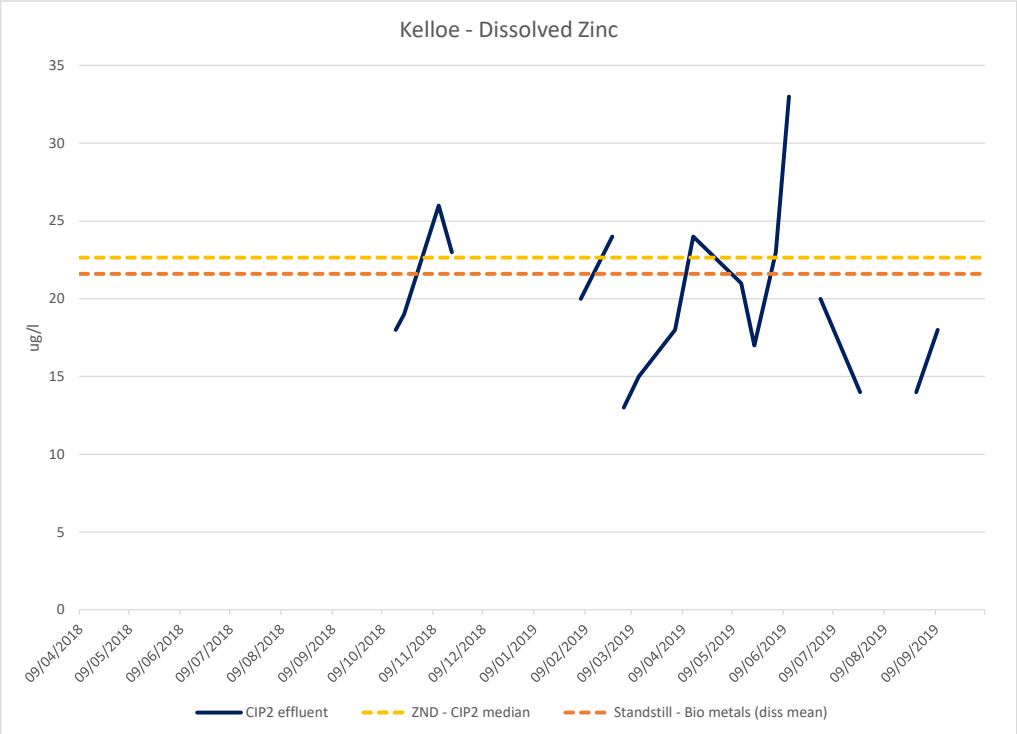


FIGURE 13: CIP2 AND CIP3 CYPERMETHRIN DATA FOR PITTINGTON STW

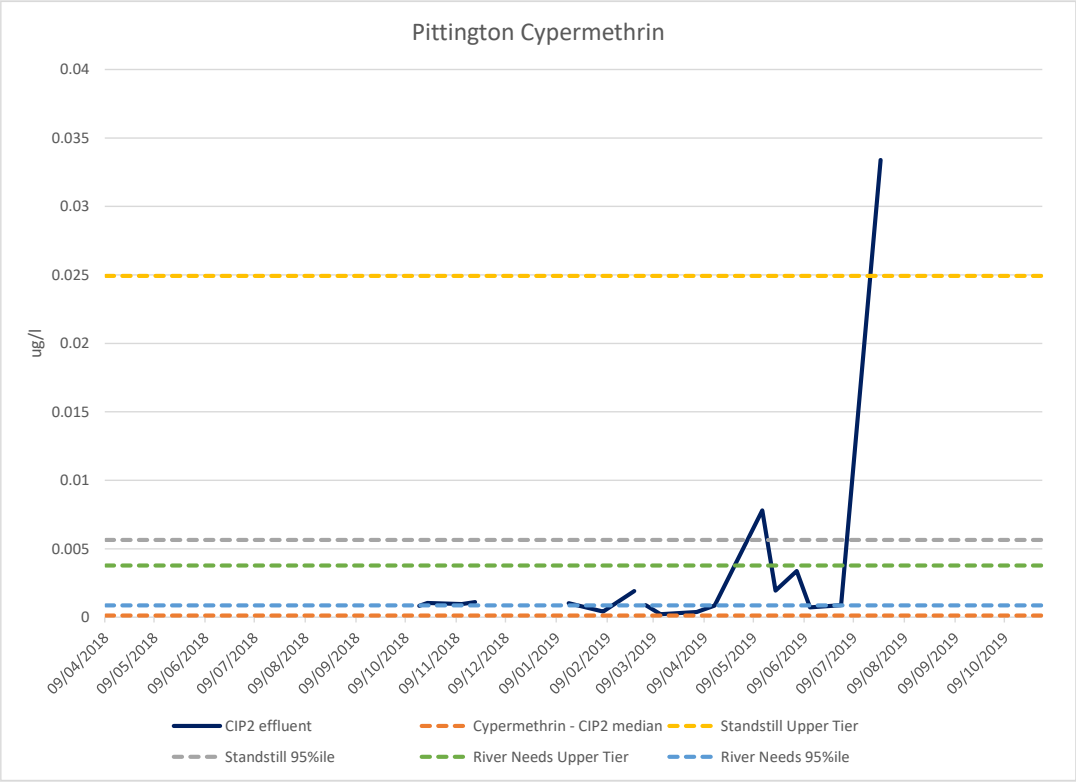


FIGURE 14: CIP2 AND CIP3 CYPERMETHRIN DATA FOR PITY ME STW

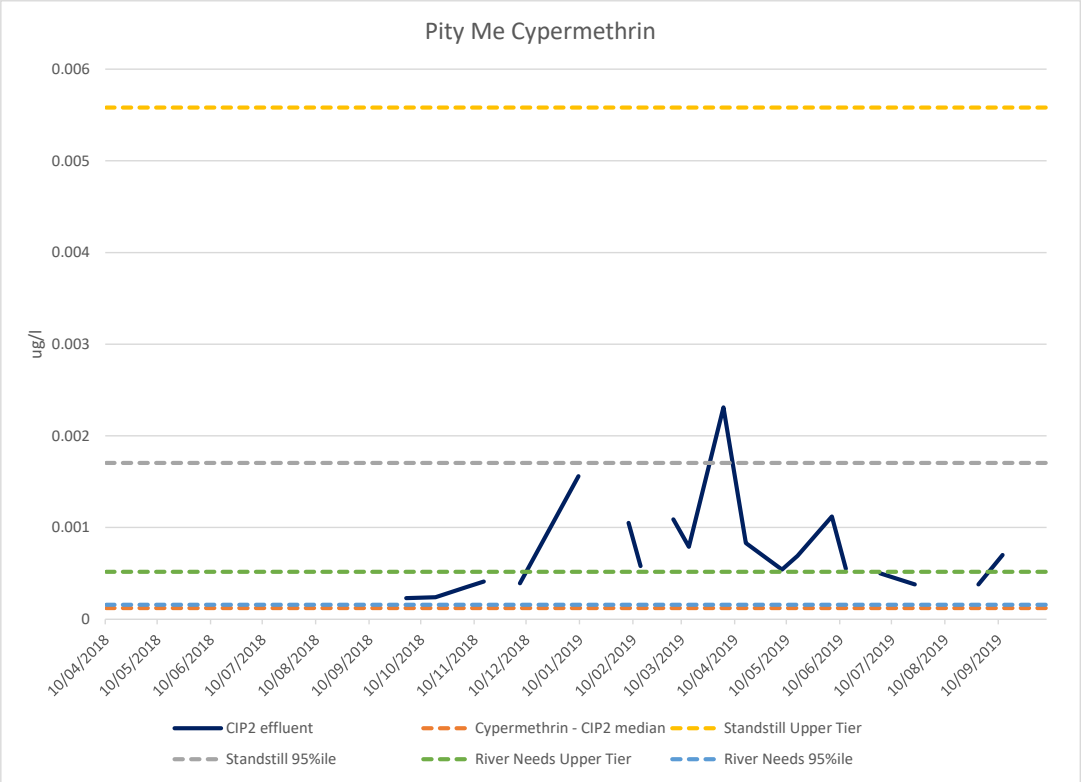


FIGURE 15: CIP2 AND CIP3 ZINC DATA FOR PITY ME STW

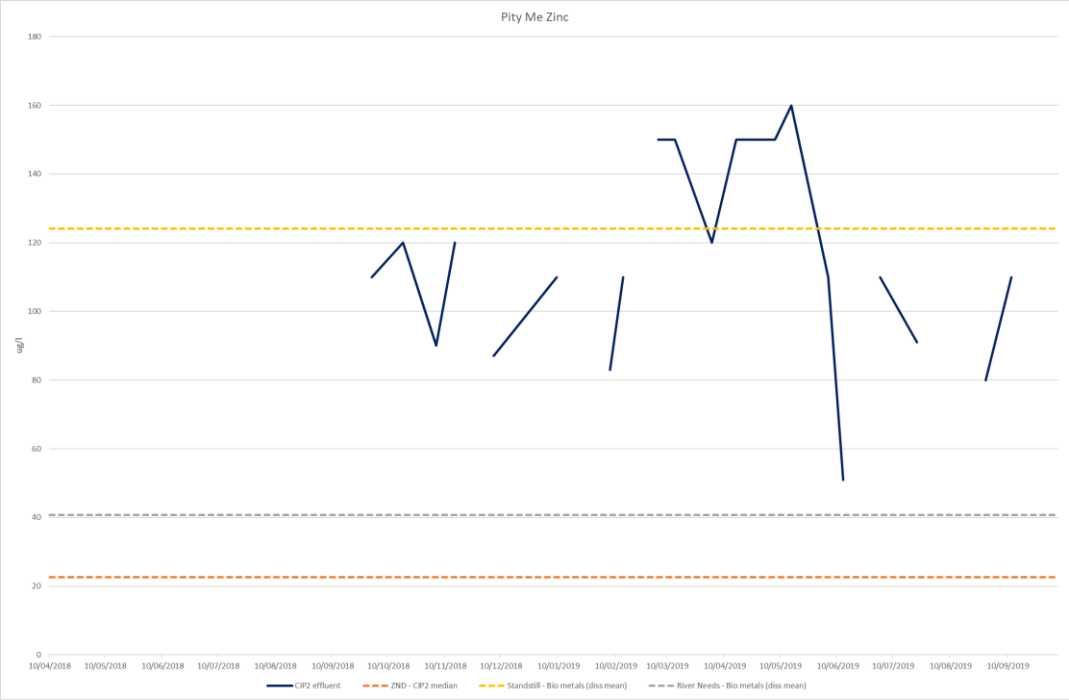


FIGURE 16: CIP2 AND CIP3 CYPERMETHRIN DATA FOR SEDGEFIELD STW

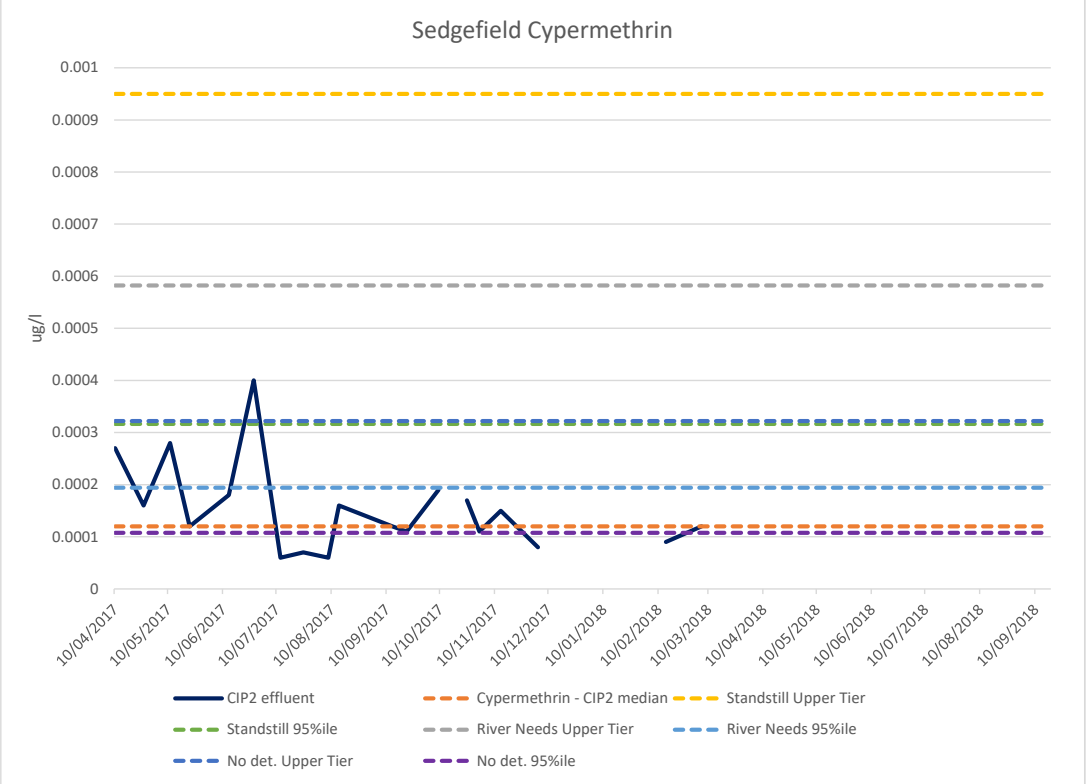


FIGURE 17: CIP2 AND CIP3 ZINC DATA FOR SEDGEFIELD STW

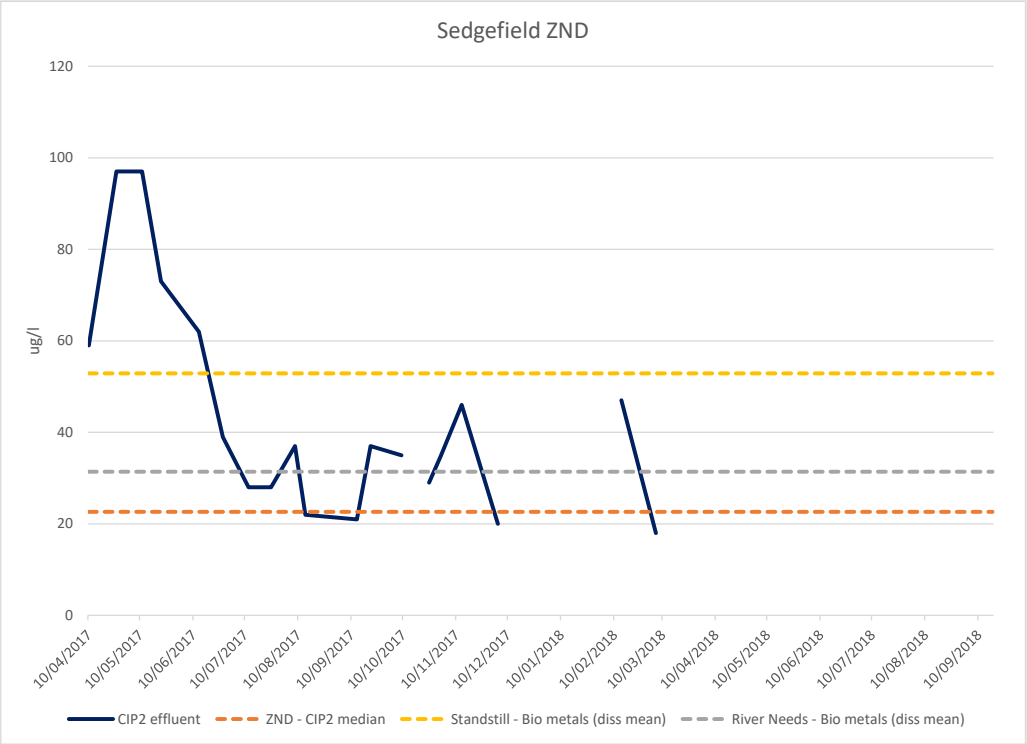


FIGURE 18: CIP2 AND CIP3 ZINC DATA FOR SEDGELETCH STW

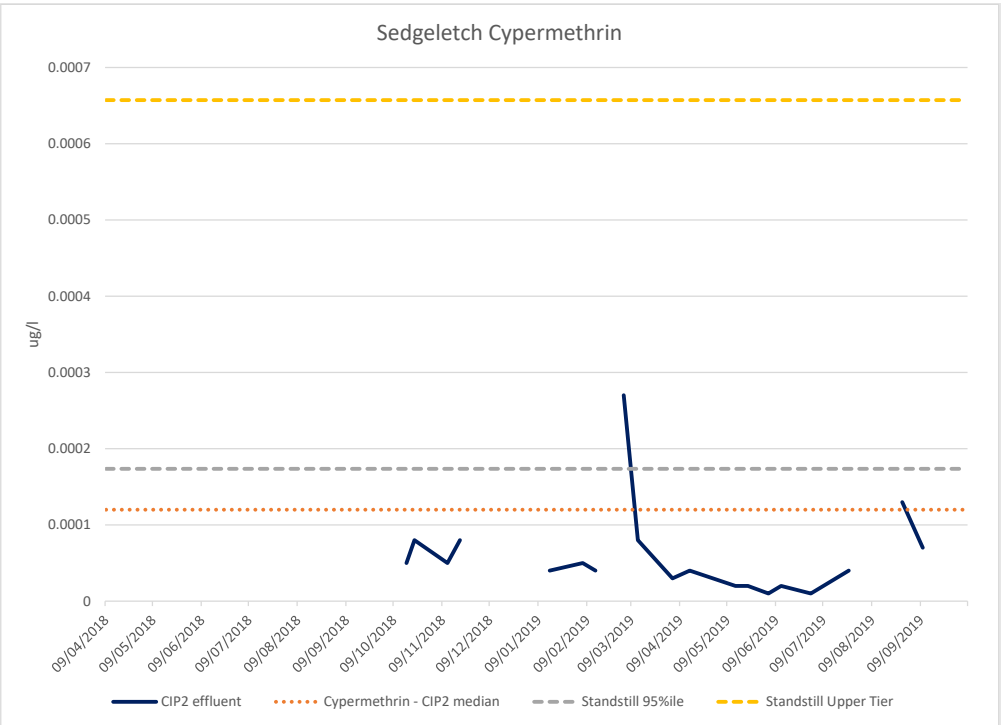


FIGURE 19:CIP2 AND CIP3 ZINC DATA FOR SEDGELETCH STW

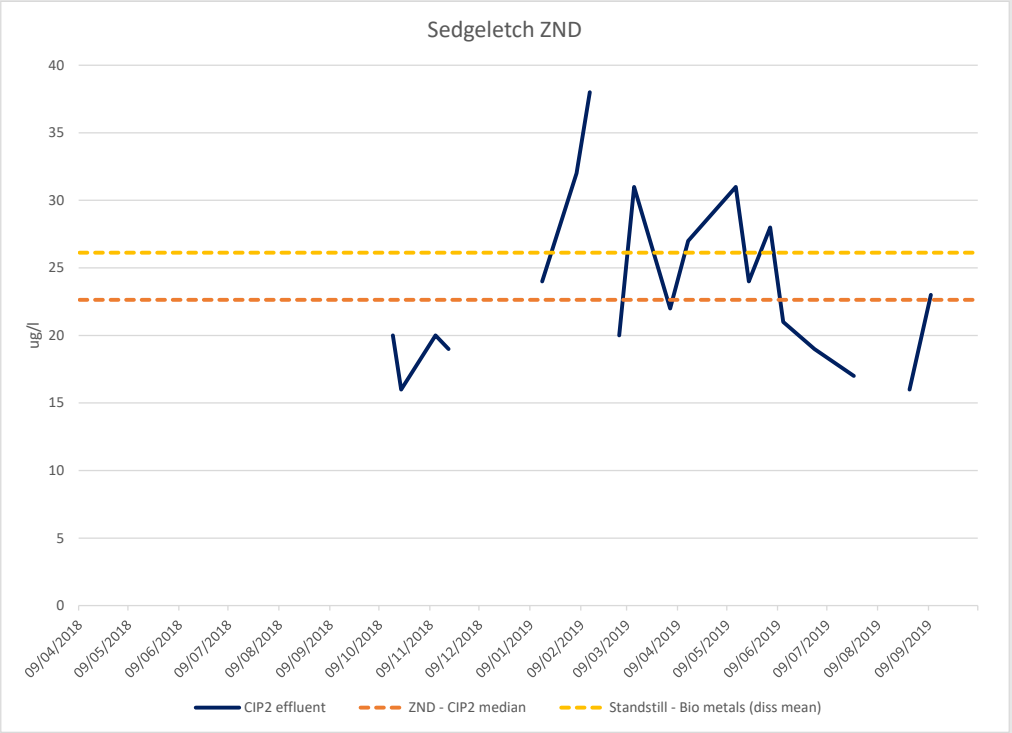


FIGURE 20: CIP2 AND CIP3 CYPERMETHRIN DATA FOR STOKESLEY STW

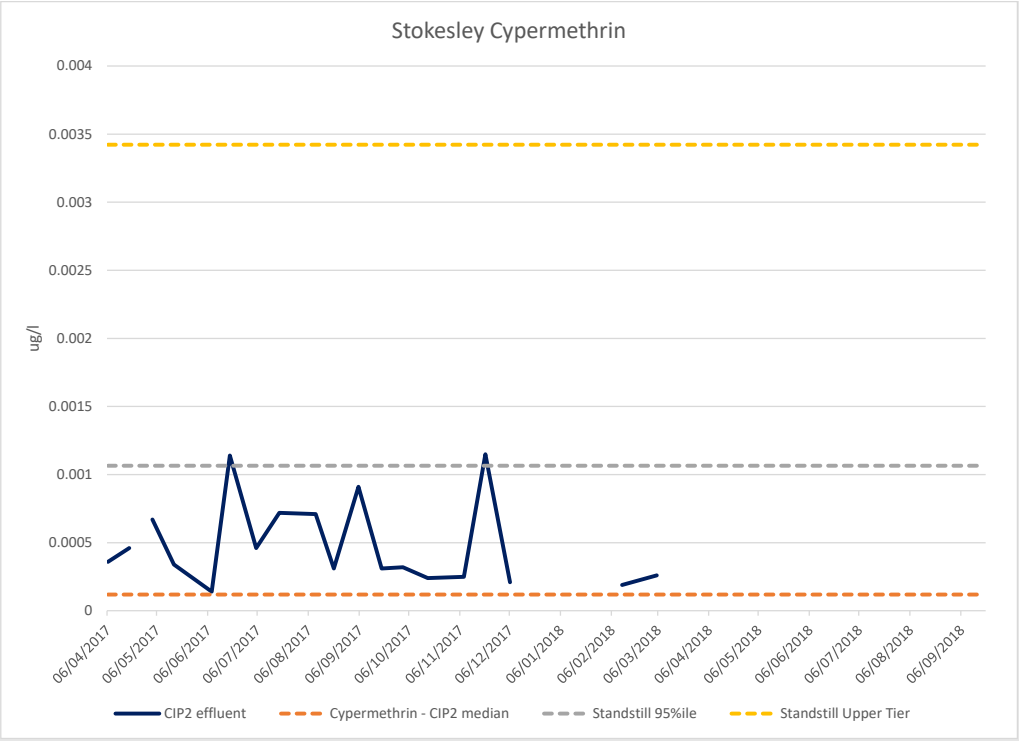


FIGURE 21: CIP2 AND CIP3 CYPERMETHRIN DATA FOR TUDHOE MILL STW

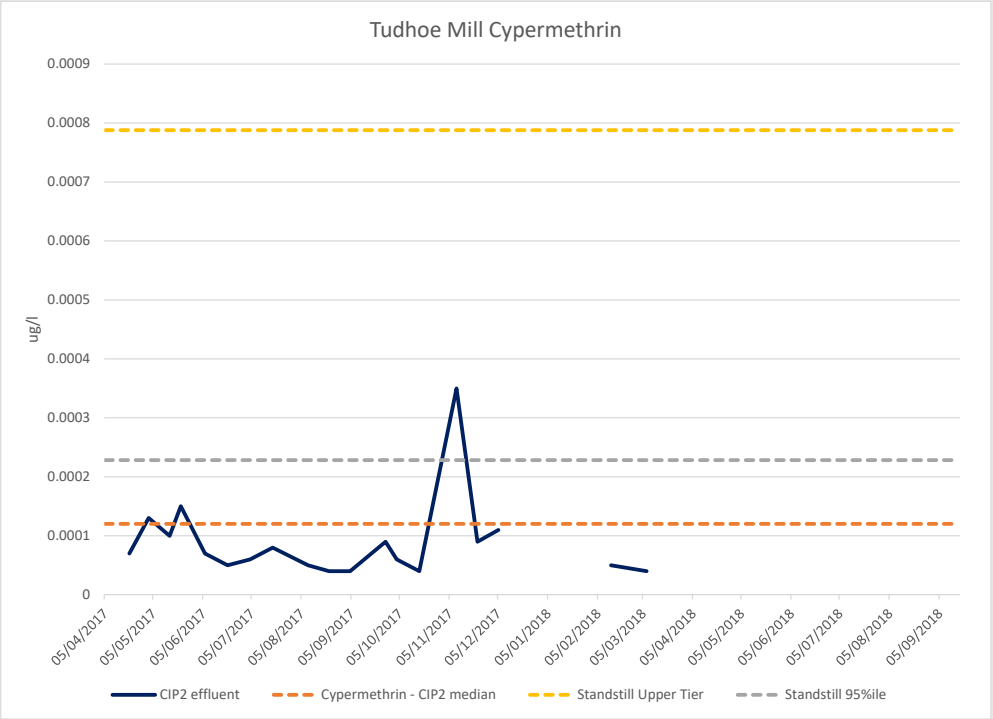


FIGURE 22: CIP2 AND CIP3 CYPERMETHRIN DATA FOR WINDLESTONE STW

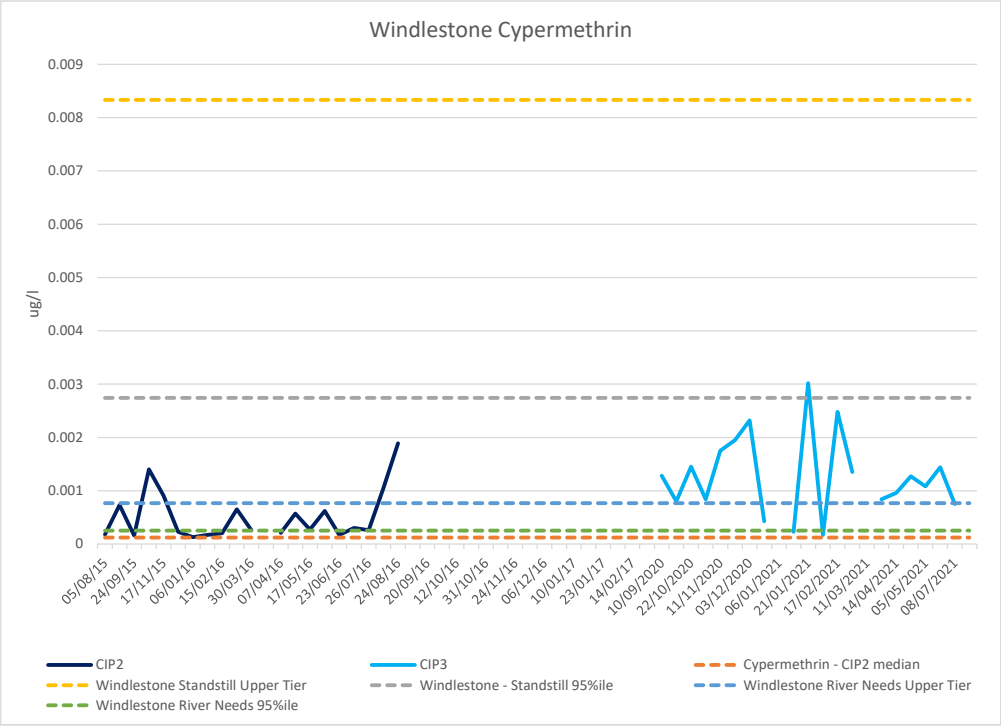
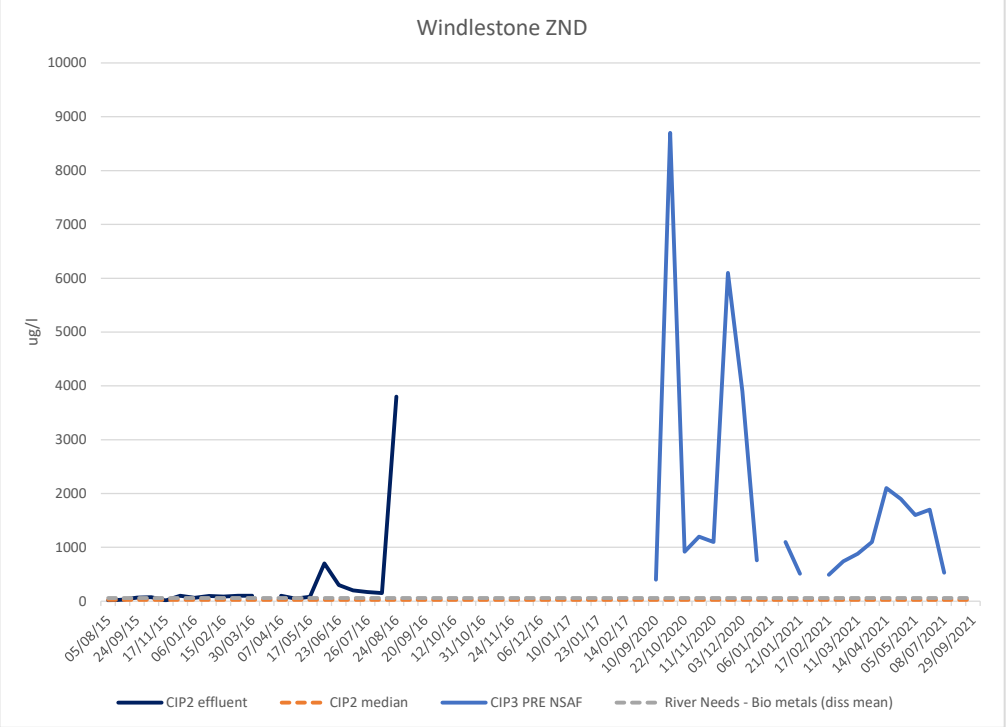


FIGURE 23:CIP2 AND CIP3 ZINC DATA FOR WINDLESTONE STW



7. APPENDIX B: NPV AND PREFERRED OPTIONS

TABLE X NPV AND PREFERRED OPTIONS FOR CHEMICAL REMOVAL

Site Name	Chemical	Option	Value NPV £m	Least Cost	Chosen Option
Esh Winning STW	Cypermethrin	Change outfall location to River Wear	-3.062	N	Alternative option
Esh Winning STW	Cypermethrin	Flexible permitting (approach 3)	-0.017	N	Alternative option
Esh Winning STW	Cypermethrin	Flexible permitting (approach 3), Expand Tertiary treatment with new TSR	-2.138	Y	Preferred option
Esh Winning STW	Cypermethrin	Flexible permitting (approach 3), Replace existing secondary treatment with ASP	-4.141	N	Alternative option
Crookhall STW	Cypermethrin	Change outfall location to River Wear	-14.936	N	Alternative option
Crookhall STW	Cypermethrin	Flexible permitting (approach 2)	3.402	Y	Preferred option
Crookhall STW	Cypermethrin	Replace existing secondary treatment with ASP	-5.109	N	Alternative option
Hustledown STW	Cypermethrin	Change outfall location to River Wear	-22.558	N	Alternative option
Hustledown STW	Cypermethrin	Flexible permitting (approach 3)	0.062	N	Preferred option
Hustledown STW	Cypermethrin	Flexible permitting (approach 3), expand existing tertiary treatment - NSAF	-1.601	N	Alternative option
Hustledown STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Alternative option
Kelloe STW	Cypermethrin	Change outfall location to River Wear	-9.898	N	Alternative option
Kelloe STW	Cypermethrin	Flexible permitting (approach 3)	0.067	Y	Preferred option
Kelloe STW	Cypermethrin	Flexible permitting (approach 3), expand existing tertiary treatment processes with NSAF	-0.549	N	Alternative option
Pittington STW	Cypermethrin	River monitoring at Sherburn	0.221	Y	Preferred option
Pity Me STW	Zinc	AMP7 transfer, permit removed	0.000	Y	Preferred option
Sedgefield STW	Zinc	Change outfall location to Seaton Carew	-29.820	N	Alternative option
Sedgefield STW	Zinc	Flexible permitting (approach 3)	0.106	Y	Preferred option
Pity Me STW	Cypermethrin	AMP7 transfer, permit removed	0.000	Y	Preferred option
Bowburn STW	Cypermethrin	Change outfall location to River Wear	-13.085	Y	Preferred option
Bowburn STW	Cypermethrin	Expand existing tertiary treatment processes with NSAF	-1.657	N	Alternative option
Bowburn STW	Cypermethrin	Flexible permitting (approach 2)	2.530	N	Alternative option
Sedgefield STW	Cypermethrin	Flexible permitting (approach 3)	0.067	Y	Preferred option
Sedgefield STW	Cypermethrin	Flexible permitting (approach 3) combined with expand existing tertiary treatment with NSAF	-0.827	N	Alternative option
East Tanfield STW	Cypermethrin	Expand existing tertiary treatment with NSAF	-1.803	N	Alternative option
East Tanfield STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Preferred option
Goosebeck STW	Cypermethrin	AMP7 transfer, permit removed	0.000	Y	Preferred option
Great Ayton STW	Cypermethrin	Expand existing treatment processes with NSAF	-1.693	N	Alternative option
Great Ayton STW	Cypermethrin	Flexible permitting (approach 2)	4.231	Y	Preferred option

Kelloe STW	Zinc	Change outfall location to River Wear	-9.898	N	Alternative option
Kelloe STW	Zinc	Flexible permitting (approach 3)	0.106	Y	Preferred option
Kelloe STW	Zinc	Flexible permitting (approach 2)	0.208	N	Alternative option
Sedgeletch STW	Cypermethrin	Expand existing tertiary treatment with TSR	-7.660	N	Alternative option
Sedgeletch STW	Cypermethrin	Flexible permitting (approach 2)	0.418	Y	Preferred option
Sedgeletch STW	Zinc	Change outfall location to River Wear	-12.368	Y	Preferred option
Sedgeletch STW	Zinc	Flexible permitting (approach 2)	0.218	N	Alternative option
Stokesley STW	Cypermethrin	Expand existing tertiary treatment with NSAF	-9.386	N	Alternative option
Stokesley STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Preferred option
Tudhow Mill STW	Cypermethrin	Expand existing treatment processes with TSR	-2.426	N	Alternative option
Tudhow Mill STW	Cypermethrin	Flexible permitting (approach 2)	0.187	Y	Preferred option
Windelstone STW	Cypermethrin	Expand existing tertiary treatment NSAF	-1.197	N	Alternative option
Windelstone STW	Cypermethrin	Flexible permitting (approach 2)	1.201	Y	Preferred option