Appendix 4 – Protecting and enhancing the environment: Response to IAP

Wessex Water

March 2019

Wessex Water
YTL GROUP

Summary

This appendix sets out the changes we have made to our investment programme and provides additional evidence in relation to Ofwat's cost assessment for drivers related to protecting and enhancing the environment.

Reductions in forecast expenditure

In our PR19 submission we recognised that we had a very large environment programme, driven by the statutory obligations included in the Water Industry National Environment Programme (WINEP). Prior to submission we worked intensively and collaboratively with the Environment Agency and Natural England to ensure that we had the most cost-effective plan whilst still meeting the extensive list of statutory obligations included in the WINEP and the performance expectations set out in the Water Industry Strategic Environmental Requirements (WISER) issued by the EA. For example, we were successful in changing the phosphorus removal programme so that it is now based on a combination of catchment interventions and cost-effective phosphorus removal at our sewage treatment works, avoiding £50m of investment.

We continued that process after submission of our plan. We have agreed a revised solution for two groundwater nitrogen removal schemes.

For pollution incidents Ofwat's IAP has revised the performance commitment target, allowing us to reduce the forecast expenditure.

Expenditure changes are summarised in the table below, with more detail provided in the main appendix.

Ofwat model / driver	Reduction (totex) £m	Changes
WINEP ~ Groundwater schemes: • Two nitrogen removal schemes removed, and replaced with • Two catchment management schemes together with an investigation.	- 10.9	• Revised business plan enhancement expenditure tables • Minor revision to performance commitment for km of river improved
Pollution reduction: • 2024/25 Target revised from 17 to 19 pollutions per 10,000km	- 12.3	• Revised business plan enhancement expenditure tables • Revised performance commitment target for pollutions
Total	**- 23.2**	

Additional evidence

We have reviewed Ofwat's IAP Technical appendix 2 – Securing cost efficiency, all the enhancement cost models and the deep dive assessments, and provided a response on all the efficiency challenges included in the IAP.

Key issues that we request are addressed in the draft determination are summarised below, with the quantum shown in the subsequent table:

- **Enhancement opex.**
  We do not consider that it is possible to absorb the operating costs of the major environment programme that we are required to deliver in AMP7. The programme includes a significant tranche of schemes that need to be completed and fully operational from 2022. The implications of Ofwat's policy decision is that we will not have the funds to operate the new processes, which will risk permit compliance failures and a detrimental impact on the environment. In the main appendix we discuss the opex position for each driver. In addition, we have commissioned an specialist economics consultancy, jointly with other water companies, to review the implications of Ofwat's decision – their report in included in Appendix 13.

- **Deep dive assessments.**
  In this appendix we provide additional evidence, such as further justification of need, options studies and cost benchmarking in order that partial passes or fails in the deep dive assessments can be turned to passes. We have expanded the options appraisal evidence, such that we would envisage the 20% cost challenge can be removed. We have provided additional evidence, including new external benchmarking by cost consultants, in order to demonstrate that our cost estimates are efficient – thus enabling the company specific efficiency challenge to be reviewed.

- **Output challenge.**
  In the IAP, Ofwat challenged the need for the scheme at West Huntspill Sewage treatment works. We include a detailed justification of the need, options selection, cost estimate, and explanation of how customers are protected. We have commissioned an independent external engineering specialist report confirming the technical solution. In addition, the Environment Agency have written to us and Ofwat confirming the need for a major scheme at the site to improve its performance so that the bathing water quality at Burnham reaches the required standard.

- **IAP enhancement cost models.**
  In some cases the incorrect input variables have been used. For instance, for phosphorus removal Ofwat have not used the correct number of sites requiring improvement. For some of the other cost models we query the robustness of the models and have provided suggestions on how they can be improved.

The quantum of the challenges in each category are summarised in the table below, along with our response and the actions we suggest Ofwat to take in the draft determination. The values stated are the total proposed expenditure that Ofwat has not made adequate allowance for.

	IAP challenge	Our response	Value £m	Suggested actions for Ofwat
Delivery of the WINEP	Enhancement opex	We do not consider that it is feasible to absorb all the additional opex from the 5 year investment programme. We have provided further information about enhancement opex related to new obligations and service improvements.	19.1	Assess opex in detail, including differentiating between opex driven by growth and opex driven by investment for new statutory obligations and service improvements.
	Deep dive assessments (exc. West Huntspill STW)	We have provided additional evidence to allow the partial passes or fails to be turned to passes.	15.2	Revise deep dive assessments using latest evidence.
	Output challenge – West Huntspill STW	We have provided evidence that the scheme is needed and that the options selection and costing is robust. The EA have confirmed in writing that the scheme is essential to ensure bathing water compliance. The proposed scheme is efficient on whole-life cost basis after consideration of range of options for achieving the intended bathing water outcomes.	12.5	Revise deep dive assessment using latest evidence.
	Cost models	We have clarified the correct input parameters for the models. Where the models do not appear to be robust, we have suggested improvements.	94.8	Revise cost models using latest evidence.
Service Improvement	Pollution reduction	We do not consider that it is feasible to deliver the service improvements within the funding allowed for in base service. Improved service levels require additional funding.	13.3	Re-assess the business cases within our business plan. Allow capex and associated opex as requested.
	Partnership Working	We have provided additional evidence that should allow the partial passes to be turned to passes.	0.6	Revise assessment using latest evidence.
		Total:	**142.5**	

Therefore, in summary:

- We have reduced our investment requirements by £23.2m to allow for changes in the WINEP and a revised PC target for pollutions.
- We have provided additional evidence in relation to £142.5m of the efficiency challenge in Ofwat's IAP related to our environment programme.

Contents

Annexes

These annexes are new or updated versions of those in Supporting document 5.1 – *Protecting and enhancing the natural environment*.

1. Introduction

1.1 Structure of the appendix

This document provides our response to Ofwat's initial assessment of plans (IAP) published on 31st January 2019 with respect to protecting and enhancing the environment. Relevant documents from our September 2018 submission include our main business plan narrative *For You For Life* (section 5.6.1) and *Supporting document 5.1 – Protecting and enhancing the environment.*

The order of this document follows that of Supporting document 5.1. We provide additional evidence and responses in relation to the cost assessments for:

- Improving river water quality – discharges from sewage treatment works
    - Phosphorus and nitrogen removal
    - Ammonia and BOD removal
    - Chemicals removal
    - Improving flow capacity and flow monitoring
- Improving river water quality – intermittent discharges
    - Combined sewer overflows
    - Surface water sewers
    - Pollution reduction
- Improving natural capital in rivers and on land
- Improving bathing and shellfish waters
    - Bathing waters
    - Shellfish waters

We also clarify our partnership working proposals as described in Supporting documents 4.1 and 5.1.

1.2 Summary of expenditure reductions

Since the submission of our plan in September 2018, we have revised the following proposals following a change in the statutory obligations we are required to deliver and revisions to one of the performance commitments. Details are provided in sections 2.3 and 3.4

Table 1-1: Summary of expenditure reductions

Ofwat model / driver	Our response	Amendment £m	Suggested actions for Ofwat
WINEP ~ Groundwater schemes *(WWS2 line 15)*	Revision of our proposals following a change in obligations. (See Section 2.3)	- 11.77	Remove capex allowance
WINEP ~ Groundwater schemes *(WWS2 line 62)*	Revision of our proposals following a change in obligations. (See Section 2.3)	- 0.12	Consider as part of enhancement opex review
WINEP ~ Investigations *(WWS2 line 16)*	Revision of our proposals following a change in obligations. (See Section 2.3)	+ 0.95	Allow revised capex costs due to change in obligations
Pollution reduction *(WWS2 line 34)*	Revision of our proposals following a change in target. (See Section 3.4)	- 10.50	Allow revised capex costs for change in target
Pollution reduction *(WWS2 line 81)*	Revision of our proposals following a change in target. (See Section 3.4)	- 1.80	Allow revised opex costs for change in target
	Total:	**-23.24**	

1.3 Summary of cost challenges

The table below summarises the additional evidence provided, our response to the cost assessment in the initial assessment of plans received in January 2019, and the actions that we suggest that Ofwat could take prior to determinations. The values presented represent the proposed/planned expenditure for which Ofwat has not made an allowance for.

Table 1-2: Summary of cost challenges

Ofwat model / driver	Our response	Value challenged £m	Suggested actions for Ofwat
WINEP ~ Conservation drivers *(WWS2 line 4)*	We have provided further details of our proposals. (See Sections 2.4, 3.3 & 3.4)	3.20	Review deep dive.
WINEP ~ Event Duration Monitoring at intermittent discharges *(WWS2 line 6)*	We have concerns about the robustness of the model, as there is a wide range of unit costs and uncertainty about the allocation of permit application costs. We have provided further details of our proposals. (See Sections 2.10 & 3.1)	5.69	Clarify the allocation of costs, remove outlier unit costs, and remodel accordingly.
WINEP ~ Flow monitoring at sewage treatment works *(WWS2 line 7)*	We have concerns about the robustness of the model. The stated industry median unit cost is not even sufficient to obtain the MCerts certification let alone the costs of reconstructing inlet flow measurement. Our scope of works have been identified from detailed site investigations. We have provided further details of our proposals. (See Section 2.9)	11.39	Deep dive on outlier schemes (e.g. Poole). Clarify the allocation of costs between improvements (U_MON4) and investigations (U_INV2), and remodel accordingly.
WINEP ~ Schemes to increase flow to full treatment *(WWS2 line 9)*	We have concerns about the robustness of the model. We have one very large (Avonmouth) and one large (Saltford) scheme which have particular engineering challenges, and which, due to their size and particular characteristics, skew the modelling. We have provided further details of our proposals. (See Section 2.7)	31.45	Deep dive on Avonmouth and Saltford STWs as outliers of model. Update model for other schemes accordingly.
WINEP ~ Storage schemes at STWs to increase storm tank capacity *(WWS2 line 10)*	We have concerns about the robustness of the model. We consider that the low correlation of the number of schemes variable does not adequately explain economies of scale.	5.71	Review weighting between models to better reflect their relative strengths.

Ofwat model / driver	Our response	Value challenged £m	Suggested actions for Ofwat
	We have provided further details of our proposals. (See Section 2.8)		
WINEP ~ Storage schemes in the network to reduce spill frequency *(WWS2 line 11)*	We have concerns about the robustness of the model, as it does not take into account economies of scale. Our programme for improving FSOs has the largest number of improvements compared to other companies, and we also include our costs for investigations against this driver. We have provided further details of our proposals. (See Section 3.2)	5.23	Clarify the allocation of costs between improvements (U_IMP4) and investigations (U_INV). Include economies of scale variable within improvement models.
WINEP ~ Chemicals removal schemes *(WWS2 line 12)*	We have concerns about the robustness of the model. It does not take into consideration the specific chemical of interest to be removed (which has a significant impact on the cost), a site's existing performance and removal rate, nor the required new permit level. Nor does the model consider specific site constraints. We have provided further details of our proposals. (See Section 2.6)	8.74	Review deep dives.
WINEP ~ Nutrients (P Removal) *(WWS2 lines 18, 19 & 35)*	The model uses the wrong number of sites requiring improvement, and thus requires correction. We also have concerns that the model does not take into consideration the extent of the change in permit levels or site-specific requirements. We have provided further details of our proposals. (See Section 2.1)	23.00	Correct the number of sites requiring improvement, and remodel accordingly.
WINEP ~ Reduction of sanitary parameters *(WWS2 line 20)*	We have concerns about the robustness of the model, as it does not take into consideration the number of unique sites requiring improvements or the extent of the change in permit levels. Nor does the model consider specific site constraints. We have provided further details of our proposals. (See Section 2.5)	12.29	Carry out deep dive.

Ofwat model / driver	Our response	Value challenged £m	Suggested actions for Ofwat
WINEP ~ UV disinfection (or similar) *(WWS2 line 21)*	We have corrected a mistake in the data tables for our PE, however have concerns about figures provided by some other companies. We have concerns about the robustness of the model, as it does not consider the need to improve/existing other treatment processes to meet the disinfection requirements. We have provided further details of our proposals. (See Sections 5.1 & 5.2)	15.75	Update model for correct PE. Review deep dives.
Partnership working *(WWS2 line 33)*	We have provided further details of our proposals. (See Section 6)	0.62	Review deep dive.
Opex	We do not consider that it is feasible to absorb all the additional opex from the 5 year investment programme. We have provided further information about enhancement opex related to new obligations and service improvements. (See the respective section of each driver for further details.)	19.1	Assess opex in detail, including differentiating between opex driven by growth and opex driven by investment for new statutory obligations and service improvements.
	Total	**142.51**	

2. Improving river water quality – discharges from sewage treatment works

2.1 Phosphorus removal

This chapter should be read in conjunction with Chapter 3.2 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-1: Business plan table details for phosphorus removal

Table	Lines	Line Description
WWS2	18 / 65	WINEP ~ Nutrients (P Removal at activated sludge STWs)
WWS2	19 / 66	WINEP ~ Nutrients (P Removal at filter bed STWs)
WWS2	35 / 82	WINEP ~ Catchment Nutrient Balancing

In this chapter we expand on our proposals for phosphorus removal in PR19. In the first section we comment on the feeder model used by Ofwat in assessing our PR19 phosphorus removal proposals. In summary, the enhancement feeder model does not take into consideration the number of unique sites requiring improvements, the extent of the change in permit levels or site-specific requirements. In the subsequent sections we provide evidence to further justify our costs for the sites requiring improvements. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our phosphorus removal programme.

2.1.1 Ofwat's cost assessment

<u>Capex</u>

Ofwat's capex cost assessment is based on the results from their phosphorus removal enhancement feeder model. Costs for enhancement at all STWs (both activated sludge and filter bed style) have been merged for this model. Our freeform line of 'Catchment Nutrient Balancing', which covers our industry-leading approach to phosphorus removal through catchment offsetting, has been reallocated. This provided a capex allowance of £151.5m for the combined lines compared to our business plan estimated capex cost of £174.5m to meet our new obligations.

Ofwat presents results of four econometric models (linear capex, log capex, linear totex and log totex), with allowance derived from the average of the modelled costs obtained from the linear models alone. We see no justification as to why the linear models are chosen over the log models. The linear models result in a much wider range of relative efficiency – with ranges 32% - 137% predicted vs actual – than the log models, which raises concerns about their applicability. Furthermore, using the linear totex and capex models to calculate an 'implicit' opex for each company, and then applying the sum of this implicit opex across the companies to pro rata with each company's share of modelled totex, and then calculating the average score between these two models (linear capex and linear totex – implied capex) does not seem appropriate to create a robust forecast. Potentially, the calculations are guided by the assumption that the capex/opex mix across companies is, or should be, the same. However, this does not correspond to reality. Indeed, at the extremes, TMS' share of opex out of totex on this enhancement category is 0.02%, whilst SRN's is 9%. This assumption does not support Ofwat's stance of not prescribing what type of solutions companies should adopt.

Further to our above comments on how Ofwat draws on the models it presents, we also have concerns of the models themselves, which we address further below. These concerns are:

i) The models do not take into consideration the number of unique sites requiring improvements.
ii) The models do not take into consideration the extent of the change in permit levels or site-specific requirements.

Ofwat's feeder model uses "Number of Schemes" or "Number of Sites" interchangeably and "Population Equivalent" as the two parameters driving the model. This is despite the number of schemes and number of sites not necessarily being the same number. As described in Supporting document 5.1, some sites have two separate phosphorus removal lines in the WINEP, such as Urban Waste Water Treatment Directive (UWWTD) and Water Framework Directive (WFD) drivers. Notwithstanding the need for clarification, the model used an incorrect number of 42 for Wessex Water, whether in relation to schemes or sites. We believe Ofwat have erroneously taken this number from Table 2-5 in Supporting document 5.1, however this is only for the amber (medium certainty) schemes in WINEP3. The table below clarifies the number of our STWs identified for phosphorus removal and with permit changes as per WINEP3 and as covered by the business plan table lines.

Table 2-2: Sites requiring phosphorus removal improvements in PR19

Phosphorus Removal	Schemes/Lines in WINEP3	STWs with P removal schemes
New Permit	57	51
Tightened Permit	15	12
Total:	72	63

For completeness, the number of STWs with phosphorus removal schemes excludes Gillingham STW, which has a "green" certainty UWWTD driver, however the site is already operating to a tighter WFD permit standard and the additional reporting costs for UWWTD compliance will be adsorbed in our AMP7 programme. There are also four "red" certainty schemes in WINEP3 for which no investment is proposed in AMP7 – these are not included in the above table.

We consider that there are limitations in having an econometric model controlling for three or more factors when there are only ten observations (WaSCs). In such circumstances it may be appropriate to rely more on company's proposed costs and Ofwat's assessment of the quality of companies' evidence on those costs.

<u>Opex</u>

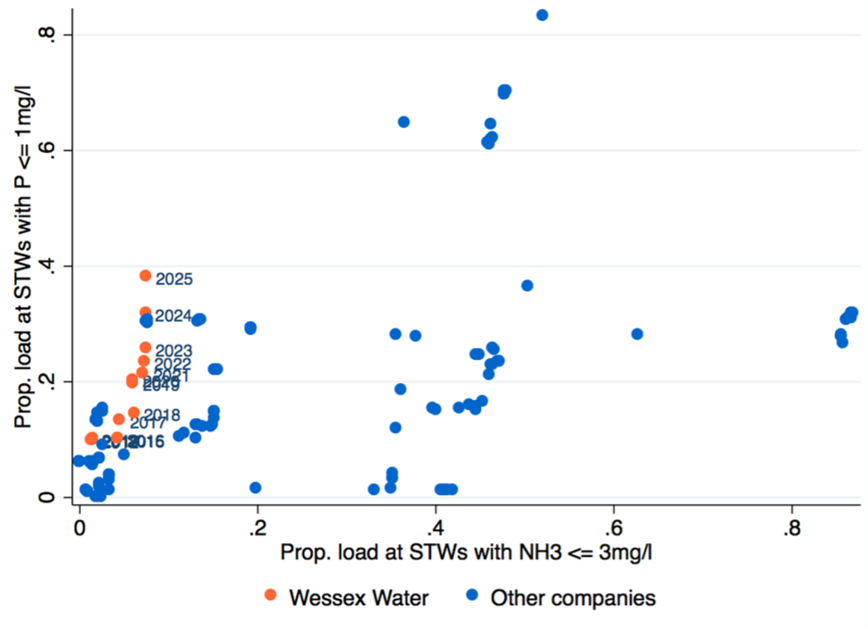
Ofwat's IAP assessment of enhancement expenditure for new phosphorus removal obligations considered capital expenditure alone; it did not consider operating expenditure. The enhancement allowance it made reflects this.

The historical costs (including opex) over the 2011-18 period, of sewage treatment processes that act to remove phosphorus, are included in the data used for the econometric modelling of base costs. In turn, there is some implicit allowance for the costs of phosphorous removal within the IAP allowances for base costs. However, this allowance is not sufficient for the additional opex required for the new phosphorus removal obligations.

The set of econometric models that Ofwat drew on for setting base cost allowances do not control for phosphorous removal. For example, they do not include a cost driver to reflect some measure of the tightness of phosphorous permits across companies' STWs.

The econometric models for base costs for the sewage treatment and for the bioresources plus business units do control for ammonia permits. They do so through the inclusion of a variable defined as the proportion of load treated at STWs with an ammonia permit less than or equal to 3 mg/l. This variable is not, however, a good proxy for the tightness of phosphorous permits. Across the industry, and drawing on data from 2011 to 2018, the correlation coefficient between the proportion of load treated at STWs with phosphorus permits below 1 mg/l and the proportion treated at STWs with ammonia consent below 3 mg/l is 0.49. This is illustrated in Figure 2-1, which charts the proportion of load treated at STWs with phosphorus permit below 1 mg/l against the proportion of load treated at STWs with ammonia permit below 3 mg/l. The figure shows annual data for all companies. The data points for Wessex Water are marked by orange dots, those of the remaining companies in blue.

Figure 2-1: Tightness of phosphorus (P) permits versus tightness of ammonia (NH_3) permits



A further aspect to consider – were one to take the view that, contrary to what the correlation coefficient and figure just reported suggest, the tightness of permit on ammonia does capture the tightness of permit on phosphorous – is how well the forecast of the cost driver relating to ammonia permit captures the tightening of permit across STWs with respect to ammonia and, by hypothesis, with respect to phosphorus. We do not consider that the forecasts used by Ofwat do this. Specifically, Ofwat forecasts that in each of the year in the period 2020-25 the share of load treated at STWs with ammonia permits below 3 mg/l is the value of that variable in 2017/18. That is to say, Ofwat's forecasts allow for no tightening of ammonia permits over the PR19 period. The implication is that even if tightness of ammonia permits were to be thought of as moving in line with tightness of phosphorous permits, the approach taken at IAP approach to base costs would not have made allowances to cover operating expenditure of new, or tightening of existing, consents over the 2020-25 period.

In the following sections we provide evidence to further justify our proposals for phosphorus removal as required by the WINEP.

2.1.2 Best option for customers

As described in Supporting document 5.1, our investment proposals for phosphorus removal are supported by the Environment Agency.

We engaged Atkins Ltd, international engineering consultants with particular expertise in this area, to undertake a technical review of our PR19 phosphorus removal programme. They reviewed and compared our chemical dosing standard and list of solutions provided against comparable UK water companies processes and standards, and known issues surrounding the operation and control of chemical dosing systems. They have affirmed that our asset solutions at STWs are consistent with those of the wider water industry (nationally and internationally) to target the various levels of phosphorus removal required. The full report from Atkins can be found in Appendix 5.1.C of Supporting document 5.1.

Our innovative catchment-wide permitting approach is supported by the EA and is being adopted by other water companies in AMP7. This approach provides flexibility with operational performance at STWs and minimises the amount of treatment process redundancy (with associated capex and opex costs) required to comply with more rigid targets.

As described in Appendix 5.1.F of Supporting document 5.1, our approach to catchment nutrient balancing has been to realise cost savings for our customers in place of a traditional asset solution for phosphorus removal. Our approach to catchment management and more recently the introduction of EnTrade has led to more efficient delivery of our water service and environmental obligations, saving customers over £80m as a result over the past ten years.

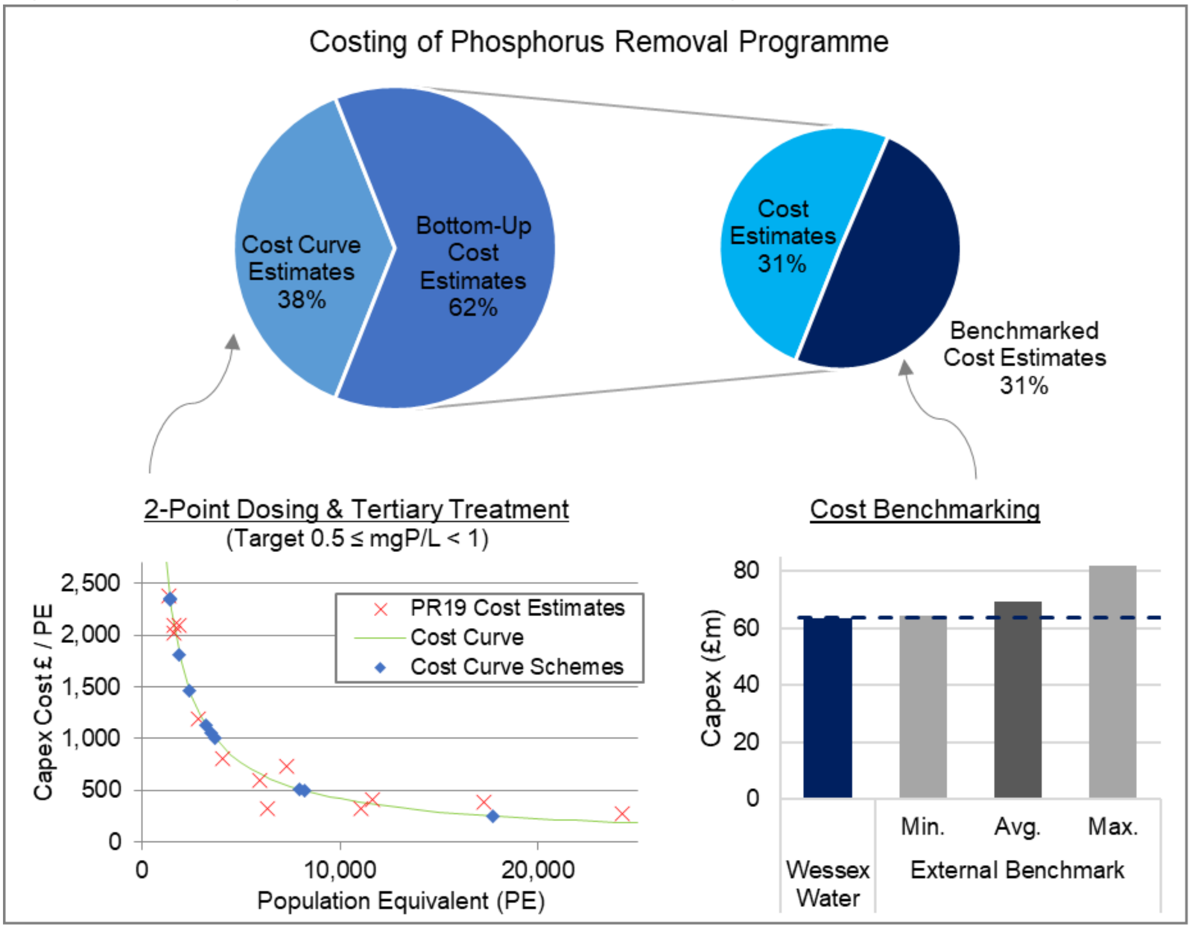
We recognise that the value and benefits arising from a catchment-based approach over an asset-based approach is not just financial. Asset solutions benefit from certainty of delivery but have a financial and carbon impact, whereas alternative land management and behavioural management solutions address diffuse issues as well as offering additional natural capital benefits, such as the potential for carbon lock up, soil improvements, reductions in other pollutants, water retention and improved biodiversity; but the benefits, obvious as they are, are difficult to quantify.

2.1.3 Robust and efficient costs

Asset solutions

Specific and detailed cost estimates have been developed by our in-house estimating team for those schemes of either 'green' certainty, more complex in nature (e.g. those trying to target tight phosphorus permits) or where there are synergies with other drivers, requiring appraisal work to allow us to promote the most appropriate holistic solution. This has resulted in detailed (bottom-up) estimates for two-thirds of our phosphorus removal schemes. These estimates have been used to derive cost curves for the remaining one-third of the programme. A representative sample of schemes (approximately half of those with specific estimates) has been benchmarked with external cost consultants. As can be seen in Figure 2-2 and as described in Supporting document 8.11 of our business plan submission in September 2018, we consider that our costs are robust and efficient.

Figure 2-2: Costing of our PR19 phosphorus removal programme



We engaged Chandlers KBS Ltd to undertake a financial review of our PR19 phosphorus removal programme. They assessed our costings approach to the overall programme.

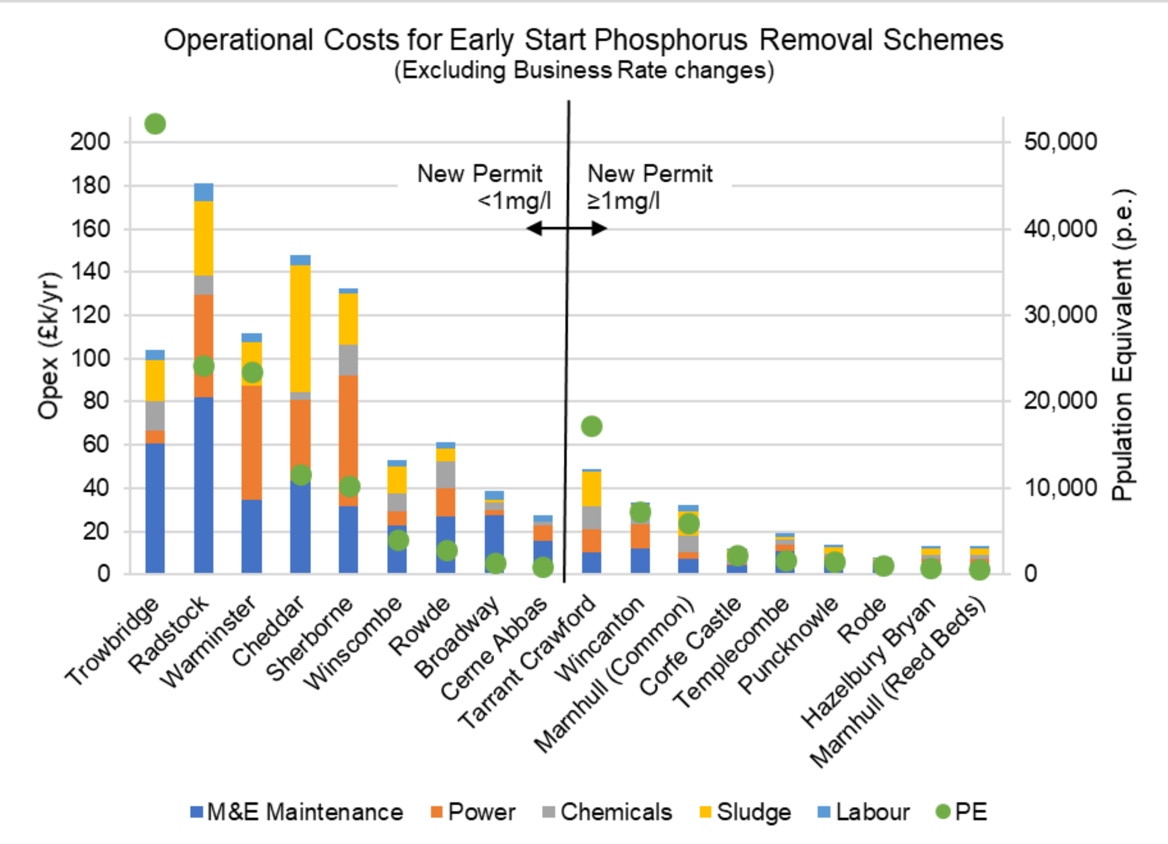
They maintain an in-house unit cost estimating database which is populated with costs sourced from a number of water companies. They affirmed that our costings were robust and representative. The full report from Chandlers KBS can be found in Appendix 5.1.D of Supporting document 5.1.

In the development of our PR19 proposals, we have continually reviewed ongoing AMP6 phosphorus removal projects, particularly as these schemes progress through their respective delivery stages (e.g. design, construction, operation). This has involved refining our PR19 solutions, scopes of work and cost estimates to ensure they are based on the most accurate and reliable information available.

Operational Costs

Each capital enhancement scheme will have an inherent ongoing operational cost. A breakdown of the annual operating and maintenance cost for the early start phosphorus removal schemes (those with a 22nd December 2021 regulatory completion date) is shown in Figure 2-3.

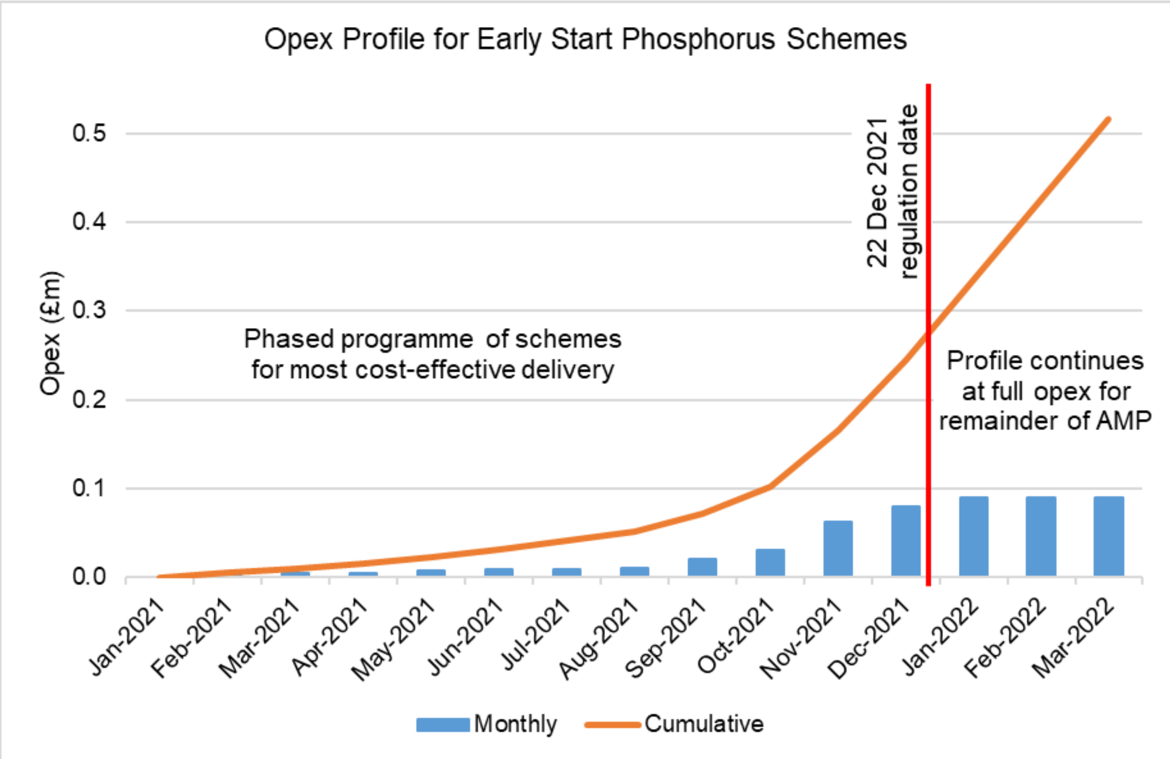
Figure 2-3: Operational costs breakdown for our early start phosphorus removal schemes



As can be seen from the figure, the scale of the additional opex is generally related to the size of the STW and the extent of the new obligations to be met, as well as site-specific issues. The opex is estimated through appraisal work and reviewing historic expenditure on similar sites or schemes. We have agreed staffing terms and rates with agencies and unions. Power supply contracts are tendered every five years, and are covered by the EU Procurement Directives. Similarly, chemical supply contracts are tendered every five years. They are based on volumes and delivery loads, i.e. 28 tonnes and tonnage/litres rates, although the rates can vary for certain products such as ferric sulphate due to site access or delivery size.

Operational costs are incurred from when a scheme is commissioned and operational. We have 18 early start phosphorus removal schemes. To benefit from efficiencies in construction and commissioning programmes, these schemes have to be phased to be completed through the year prior to December 2021, as shown in Figure 2-4.

Figure 2-4: Operational cost profile for our early start phosphorus removal schemes



Other phosphorus removal plants will be commissioned throughout the AMP to achieve their respective regulatory completion dates. To back-end load a programme so that all schemes become operational "just-in-time" to meet a common regulation date to minimise operational costs is impractical and inefficient. This approach would be subject to resource availability (e.g. labour) and incur significant additional capex costs, as well as putting permit compliance at risk due to programme slippages from construction risk realisation affecting the delivery profile.

<u>Operational Enhancement</u>

We have worked with the EA in the development of the WINEP. As described previously, our alternative approach to meeting the new obligations WINEP3 includes tightening permit limits on some existing phosphorus removal sites not included within the WINEP3, where this can be achieved by operational enhancement with minimal capital investment. This approach saves on capex by avoiding construction of new assets, but, by definition, requires opex to achieve it; it is, however, the most cost-effective on a whole life cost basis. Had we not taken this approach, then we would need to include capital investment for asset solutions to achieve tighter permits at other sites.

The increased opex associated with operational enhancements can be broken down as:

- Increased chemical dosing – required to achieve tighter phosphorus permits
- Increased sludge tankering and treatment – more sludge is generated
- Increased capital maintenance – assets are more intensively operated
- Increased staff time – processes are optimised beyond their normal operating regimes

Whilst there is an associated additional carbon cost with increased opex, this is similarly countered by the carbon saving through not building new assets.

As described in Supporting document 5.1, this operational enhancement approach – when coupled with our innovative catchment permitting approach – has allowed us to save £25m for phosphorus removal in the Bristol Avon catchment in AMP6 when compared to a conventional new capital assets approach.

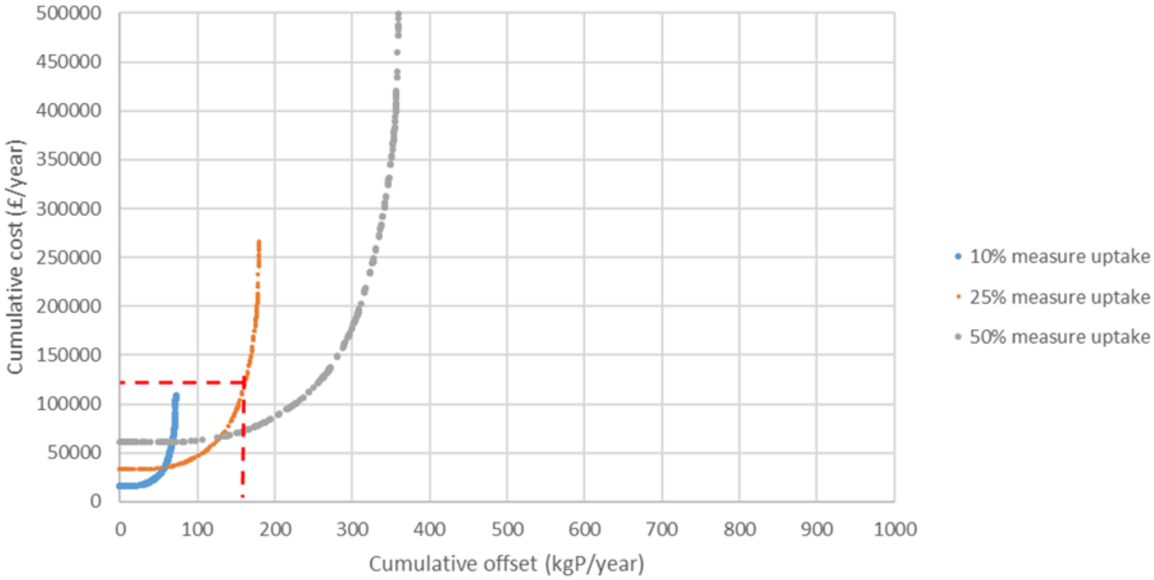
Catchment Nutrient Balancing

To meet the new phosphorus removal obligations in the Dorset Stour and Parrett catchments, we are proposing to adopt a holistic approach that will include catchment nutrient balancing. We have used Farmscoper for both the scoping and costing of our catchment nutrient balancing approach, as described in Appendix 5.1.F of Supporting document 5.1. Farmscoper is a decision support tool developed by ADAS on behalf of Defra that can be used to assess diffuse agricultural pollutant loads on a farm and quantify the impacts of farm mitigation methods on these pollutants.

In developing the potential and costing of our offsetting proposals, we have assumed a 25% mitigation measure uptake from farmers. We believe this to be a realistic assumption (i.e. not conservative nor optimistic) given our extensive experience of catchment offsetting for nitrates for drinking water compliance, as well as knowledge of these catchments and farming practices.

Figure 2-5 is an example result of the scoping for the Shreen sub-catchment in the Dorset Stour catchment. The amount of phosphorus removed per year (x-axis) is plotted against cost per year (y-axis). The three curves represent three levels of measure uptake. Each point on the curves represents the reduction individual measures have for different farm type/setting. The increasing steepness of the curves reflect the decreasing cost effectiveness of measures.

Figure 2-5: Scoped phosphorus offsetting for the Shreen sub-catchment



We have a very experienced in-house catchment team with a proven track record of delivering improvements in farming behaviour and practice. Our team of Catchment Advisors have been working for many years with farmers in the field. Indeed, many of our team come from farming backgrounds and we have a high rate of engagement across all of the catchments we work in, although – for various reasons – this is not always translated into uptake of measures. We acknowledge and accept that some farmers will not want to engage. This is particularly critical in small catchments where there are only a few farmers. Initial screening work has identified these catchments and we have excluded working in some of these areas.

As described in Supporting document 5.1, we are partway through a 5-year pilot in the Brinkworth Brook catchment investigating catchment nutrient balancing specifically for phosphorus offsetting. Whilst still in its early stages, this pilot has demonstrated a high level of farmer engagement and positive response to our proposals. Further details can be found in Section 6.

2.1.4 Customer protection

Under the Urban Waste Water Treatment Directive (UWWTD), STWs which discharge into designated sensitive areas are required to achieve specific phosphorus permits. Within the Wessex Water region, the Dorset Stour and River Isle (within the River Parrett catchment in Somerset) had been promoted as candidates for designation. We were notified by the EA on 4th September 2018 that these potential Sensitive Areas would be designated under the Urban Waste Water Treatment Regulations, and they were formally designated by Defra on 1st December 2018. The certainty status of the U_IMP2 drivers has changed from “amber” to “green” in WINEP4. Our plan submitted in September 2018 assumed these would be designated and thus that investment in PR19 would be required. Our cost adjustment mechanism for the remaining “amber” WFD improvement schemes as described in Supporting document 9.4 is still applicable.

Our proposed alternative approach for successful delivery of the WINEP3 requirements (i.e. alternative permits and catchment nutrient balancing), as presented in our plan and described more fully in Supporting document 5.1, has been agreed with the EA, although is not fully captured in the WINEP. The EA have advised that WINEP4 (due to be published 31st March 2019) will retain the WINEP3 permit limits, with an additional note against the phosphorus removal sites in the Parrett and Dorset Stour catchments whilst details of the catchment nutrient balancing approach is agreed both locally and nationally.

2.1.5 Conclusion

Ofwat's phosphorus removal enhancement feeder model uses the wrong number of our sites requiring improvement, and thus requires correction.

The model does not take into consideration the number of unique sites requiring improvements, the extent of the change in permit levels or site-specific requirements. Furthermore, no specific allowance for opex has been made, despite additional opex being integral to meeting these new environmental obligations and our promotion of operational enhancement in place of capital solutions.

We would request that, on the basis of the additional evidence provided above, the phosphorus removal costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

2.2 Nitrogen removal

This chapter should be read in conjunction with Chapter 3.2 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-3: Business plan table details for groundwater nitrogen removal and investigations

Table	Lines	Line Description
WWS2	17 / 64	WINEP ~ Nutrients (N removal)

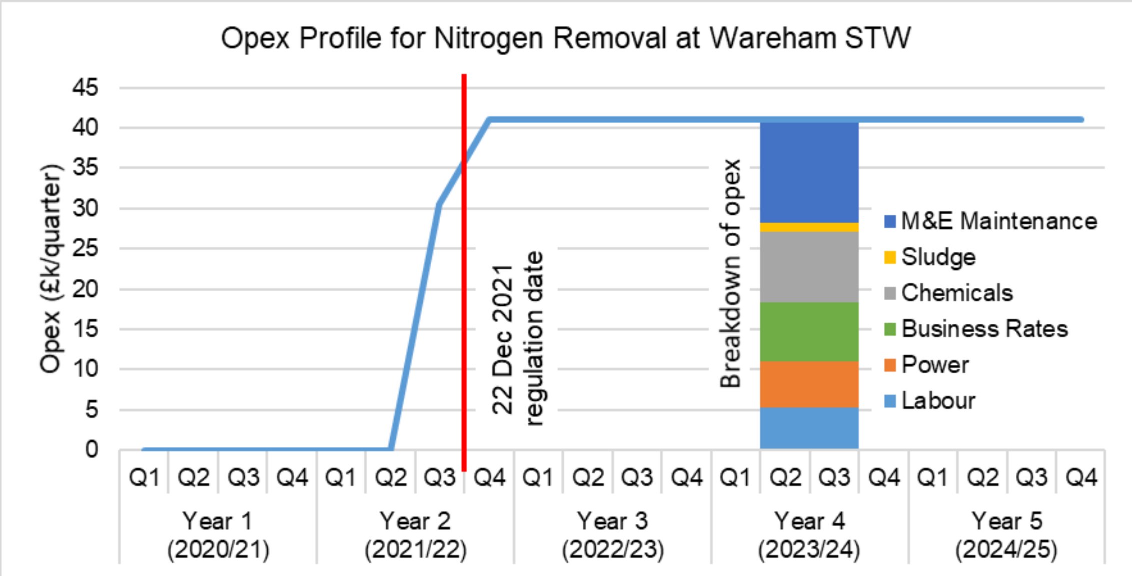
2.2.1 Ofwat's cost assessment

Ofwat have allowed in full our capex proposal for nitrogen removal at Wareham STW, which discharges to Poole Harbour. However, no specific allowance was made for opex. The scheme is for a new obligation with a regulatory completion date of December 2021. We do not consider that the base cost models will have included an implicit allowance in respect of this.

2.2.2 Robust and efficient costs

The annual operating and maintenance costs for the nitrogen removal scheme at Wareham STW is shown in Figure 2-6. The plant needs to be operational to achieve the WINEP regulatory date of December 2021.

Figure 2-6: Operational cost profile for nitrogen removal scheme



2.2.3 Conclusion

No specific allowance for opex has been made, despite additional opex being integral to meeting this new environmental obligation.

We would request that, on the basis of the additional evidence provided above, the nitrogen removal opex costs as submitted in our business plan in September 2018 are allowed in full.

2.3 Groundwater nitrogen removal and investigations

This chapter should be read in conjunction with Chapter 3.2 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-4: Business plan table details for groundwater nitrogen removal and investigations

Table	Lines	Line Description
WWS2	15 / 62	WINEP ~ Groundwater schemes
WWS2	16 / 63	WINEP ~ Investigations

Since our business plan was submitted in September 2018, we have agreed an alteration to the WINEP with the EA which affects our groundwater nitrate removal schemes. We provide below an update of the WINEP revisions and describe the subsequent impact on our business plan proposals.

2.3.1 Best option for customers

As described in Supporting document 5.1, five groundwater nitrate schemes had been identified in WINEP2: Collingbourne Ducis and Maiden Bradley STWs with DrWPA_ND drivers, and Hindon, Sixpenny Handley and Tilshead STWs with WFDGW_INV_GWQ drivers. We felt there was significant uncertainty at each of these sites as to both the extent of, and mechanisms involved in, potential nitrate groundwater contamination. We also considered that the capital and ongoing costs were disproportionate to the size of the STW. In place of capital solutions, we proposed to the EA undertaking investigation work during PR19, reviewing available evidence, undertaking targeted monitoring and, where appropriate, trialling new technologies to assess the impacts of these discharges and allowing evidence-based decision making to inform works required for PR24. Alongside this investigation work, it was proposed to undertake catchment management in the surrounding area to partially offset the perceived impact whilst the investigation is completed.

The EA accepted our proposals for WINEP3 for the three sites with the WFDGW_INV_GWQ drivers but not the two with the DrWPA_ND drivers. The associated proposals and costs to satisfy the WINEP3 requirements for these two schemes was submitted in our business plan in September 2018.

Subsequently, we have continued discussions with the EA to challenge the need and scope of the two DrWPA_ND schemes. This has resulted in both of these schemes also being changed to investigations, as tabled below:

Table 2-5: Updated groundwater nitrate investigations schemes for WINEP4

STW	Scheme Name	Driver Code	Investigation Scope
Collingbourne Ducis	Groundwater investigation	WFDGW_INV_GWQ	- Groundwater investigation - Technology trial
	N-offsetting trial	WFDGW_INV_GWQ	- Catchment management
Maiden Bradley	Groundwater investigation	WFDGW_INV_GWQ	- Groundwater investigation - Technology trial
	N-offsetting trial	WFDGW_INV_GWQ	- Catchment management

The investigation scopes for all five groundwater nitrate sites (Collingbourne Ducis, Maiden Bradley, Hindon, Sixpenny Handley and Tilshead STWs) have been agreed with the Environment Agency and Natural England, to satisfy the updated WINEP.

2.3.2 Robust and efficient costs

The WINEP has been updated with the change in groundwater nitrate removal schemes to investigation drivers, covering groundwater investigations (including technology trials) and catchment management.

The groundwater investigations will include hydrogeology assessments, new boreholes to better understand the impact of our STW discharges and subsequent quantification of nitrogen load from each STW to determine the target reduction for catchment management.

The technology trial costs have been derived through consultation and quotes from possible technology and process suppliers, with associated sampling and monitoring to ensure successful trials. With the change in driver and scope for Collingbourne Ducis and Maiden Bradley STWs, we will be undertaking groundwater investigations as per the other three sites, however we are not proposing additional technology trials.

The catchment offsetting trial is a separate WINEP line. Costs have been developed through our extensive experience of catchment delivery for drinking water compliance, as described previously in Section 2.1.3 and in Section 8 of Supporting document 5.1. Offsetting is targeted in a localised area around the discharge, with targets as evidenced by the groundwater investigations.

The following amendments are made to our plan, as shown in the below tables, resulting in a net reduction of £10.9m.

Table 2-6: Original business plan submission (September 2018) to achieve WINEP3

Table	Lines	Line Description	Capex (£m)	Opex in 2020-2025 (£m)	Totex in 2020-2025 (£m)
WWS2	15 / 62	WINEP ~ Groundwater schemes (associated with DrWPA_ND proposals at Collingbourne Ducis and Maiden Bradley	11.8	0.12	11.9
WWS2	16 / 63	WINEP ~ Investigations (associated with WFDGW_INV_GWQ proposals at Hindon, Sixpenny Handley & Tilshead)	2.7	0.03	2.7

Table 2-7: Revised business plan submission (March 2019) to achieve WINEP4

Table	Lines	Line Description	Capex (£m)	Opex in 2020-2025 (£m)	Totex in 2020-2025 (£m)
WWS2	15 / 62	WINEP ~ Groundwater schemes	-	-	-
WWS2	16 / 63	WINEP ~ Investigations (associated with WFDGW_INV_GWQ proposals at Hindon, Sixpenny Handley, Tilshead, Collingbourne Ducis & Maiden Bradley)	3.6	0.04	3.7

2.3.3 Conclusion

Subsequent to the business plan submission in September 2018, the environmental obligations have changed and we have amended our proposals accordingly. This has included a minor revision to our performance commitment for km of river improved (through the WINEP).

On the basis of the additional evidence provided above, the groundwater nitrogen costs are removed, with the alternative costs now transferred to the investigations line and allowed in full.

2.4 Conservation

This chapter should be read in conjunction with Chapter 3.2 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-8: Business plan table details for conservation schemes

Table	Lines	Line Description
WWS2	4 / 51	WINEP ~ Conservation

In this chapter we expand on our proposals for conservation enhancement in PR19. The schemes that form our PR19 conservation enhancement programme were described in three investment areas of our business plan submission in September 2018.

- Phosphorus and nitrogen removal (Supporting document 5.1, section 3.2)
  - Somerset Levels and Moors wetland restoration trial for nutrient reduction
  - Poole STW – Options appraisal to achieve proposed targets
- Surface water sewers (Supporting document 5.1, section 4.2)
  - Nailsea partnership project – Improving the quality of the surface water outfall discharging to Tickenham, Nailsea and Kenn Moor SSSI
  - Turbary Common mire investigation to improve surface water management
  - Ubley IUDM
  - Wadmore Lane IUDM
- Improving natural capital in rivers and on land (Supporting document 5.1, section 6)
  - Maximising opportunities for birds at STWs
  - Biosecurity measures for large STWs
  - Carry out and support catchment control measures including partnership working and innovative measures such as biocontrol

In the subsequent sections we provide clarity and further details of our proposals originally described within the phosphorus and nitrogen removal chapter of Supporting document 5.1. This chapter should be read in conjunction with Section 3.3 of this document for surface water sewers and Section 4 for improving natural capital for our complete conservation enhancement proposals.

2.4.1 Ofwat's cost assessment

The deep dive on conservation in our proposals received one pass and two partial passes, as follows:

- Best option for customers – partial pass
- Robustness and efficiency of costs – partial pass
- Customer protection – pass.

Ofwat have applied a 20% efficiency challenge on top of the company-specific efficiency challenge (3.5%) for this area of works, and have stated:

> *"We would need a clearer understanding of these additional conservation schemes in order to assess our view of costs."*

Ofwat had queries regarding (a) the lack of clarity in the information provided regarding identifying the various schemes and their costs, and (b) that the average of the costs of the two schemes they had sight of was high. Within the phosphorus and nitrogen removal section, we describe two schemes that contribute to our PR19 conservation enhancement programme as their primary driver.

Table 2-9: Conservation schemes covered in phosphorus and nitrogen removal section

Scheme	WINEP ID	Drivers	Capex (£m)
Somerset Levels and Moors wetland restoration trial for nutrient reduction	7WW300214	HD_IMP SSSI_IMP	6.334
Poole STW - Options appraisal to achieve proposed targets	7WW300208	HD_INV	0.211

In the following sections we provide evidence on our proposals for these two schemes.

2.4.2 Best option for customers

Somerset Levels and Moors wetland restoration trial for nutrient reduction

The WINEP requires us to contribute towards the creation of a managed wetland within the Somerset Levels and Moors (SLM) Ramsar site to reduce nutrients to the ditch system. Natural England have identified a site for the wetland on their land at Southlake Moor. The project will involve the design and creation of the managed wetland together with environmental monitoring pre and post wetland creation to assess the environmental and socio-economic benefits (water quality, flooding, archaeology, biodiversity, natural capital etc). We will work in partnership with Natural England, the Environment Agency and other stakeholders such as the local Internal Drainage Board to deliver this project, quantify its benefits and understand whether the approach is suitable for use elsewhere. A Project Steering Group (PSG) has been set up comprising representatives from stakeholders.

The PSG appointed RM Wetlands & Environment Ltd, who are a leading independent environmental consultancy on wetlands, to undertake initial feasibility work to help develop the scope of the PR19 proposals. The wetlands needs to be of sufficient size to meaningfully test the effectiveness of integrated multi-benefit wetland construction in terms of (a) phosphorus reduction on an ecologically relevant scale, and (b) the enhancement of biodiversity together with the associated opportunities for public enjoyment. RM Wetlands' appraisal concluded that a wetlands area of 55ha ($0.55km^2$) would be required to achieve an aspirational P target of 0.1 mg/l.

Environmental monitoring will be undertaken pre and post construction of the wetland. The requirements for this will be determined through the feasibility study, data review phase and as the design develops. A monitoring plan will be developed and agreed with the Project Steering Group. This is expected to include water quality and nutrients, neutral grassland and ditch plant communities, wetland bird communities and wider biodiversity and natural capital aspects.

Poole STW – Options appraisal to achieve proposed targets

The WINEP identifies the need for an options appraisal to achieve a tighter permit limit for nitrogen and phosphorus at Poole STW, due to the deterioration in water quality in Holes Bay in Poole Harbour. Given the potential scale of works, and that monitoring is ongoing in PR19, the EA have limited this appraisal to a desk study. Further feasibility work would be anticipated in PR24 with possible implementation of any improvement scheme later in PR24 or in PR29.

The scope to achieve the WINEP objective has been agreed with the EA and NE. It includes:

- a process assessment to identify the requirement and options required to meet the target N and P permits individually and also in combination
- preliminary sizing and layout of proposed treatment process extensions
- option cost estimates (comprising capex, opex and whole-life costing).

2.4.3 Robust and efficient costs

Somerset Levels and Moors wetland restoration trial for nutrient reduction

As part of the initial feasibility work, RM Wetlands also provided indicative constructive costs for the wetlands. The full project capex cost breakdown for the constructed wetlands is shown in the table below:

Table 2-10: Cost estimate breakdown for SLM constructed wetland (55 hectares)

Description	**Capex** (£k)
Construction costs	
Base construction costs:	
Earthworks to create wetland cells and dispose of spoil on site	1,050.0
Planting	1,020.0
Pipework and water control structures	130.0
Minor civils	50.0
Ancillaries	624.2
Site supervision, welfare facilities and mobilisation (25%)	675.0
Contractor Fees (7%)	236.3
Total Construction Value	3,611.3
Design (15%)	541.7
Third Party liaison (e.g. planning application, approvals and consultation)	500.0
Sampling / Monitoring	
Staff time	316.7
Monitoring equipment (autosamplers)	6.0
Water quality sampling analysis (36 samples/year, pre & post construction)	10.8
Ecological monitoring (12 invertebrate & 6 macrophytes samples/year)	17.4
Total Sampling / Monitoring Value	342.5
Project Management (5%)	262.3
Risk (15%)	826.2
Total:	6,334.0

By comparison, our constructed wetlands at Cromhall in AMP6 cost approximately £900k for a much smaller area of 0.7ha.

Poole STW – Options appraisal to achieve proposed targets

The range of options agreed with EA and NE to be considered under this appraisal include various treatment improvements and a potential tunnelled extension to the outfall. The former is likely to have an implementation cost in the range £60-80 million but has a significant risk concerning site availability, and the latter a cost range of £225-275 million. A desk study appraisal cost of £0.2m, which is significantly less than 0.5% of the potential implementation costs, should be considered as very efficient.

Conservation schemes

Table 2-11 provides a summary of all the schemes and costs that form our conservation proposals (WWS2 Line 4).

Table 2-11: Conservation schemes included in WWS2 Line 4: WINEP ~ Conservation drivers

Scheme	WINEP ID	Drivers	Capex (£m)
Phosphorus and Nutrient Removal (described in this section)			
Somerset Levels and Moors wetland restoration trial for nutrient reduction	7WW300214	HD_IMP SSSI_IMP	6.334
Poole STW - Options appraisal to achieve proposed targets	7WW300208	HD_INV	0.211
Surface water sewers (described in Section 3.3)			
Nailsea partnership project - Improving the quality of the surface water outfall discharging to Tickenham, Nailsea and Kenn Moor SSSI	7WW100055	SSSI_IMP	2.112
Turbary Common mire investigation to improve surface water management	7WW200440	HD_INV	0.739
Ubley IUDM	7WW300218	SSSI_IMP	2.112
Wadmore Lane IUDM	7WW200929	HD_ND	2.112
Improving natural capital in rivers and on land (described in Section 4)			
Maximising opportunities for birds at STWs	7WW200580	NERC_IMP1	0.319
Biosecurity measures for large STWs	7WW200078	INNS_ND	0.007
Carry out and support catchment control measures including partnership working and innovative measures such as biocontrol	7WW200167	INNS_ND	0.127

2.4.4 Conclusion

In response to Ofwat's uncertainty about which schemes contribute to our conservation proposals in PR19, we have supplied further information on the schemes to allow due assessment.

We would request that, on the basis of the additional evidence provided above, the partial passes from Ofwat's deep dive are turned to passes, and the conservation costs as submitted in our business plan in September 2018 are allowed for.

2.5 Ammonia and BOD removal

This chapter should be read in conjunction with Chapter 3.3 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-12: Business plan table details for ammonia and BOD removal

Table	Lines	Line Description
WWS2	20 / 67	WINEP ~ Reduction of sanitary parameters

In this chapter we expand on our proposals for reduction of sanitary parameters in PR19. In the first section we comment on the feeder model used by Ofwat in assessing our PR19 sanitary parameter reduction proposals. In summary, the enhancement feeder model does not take into consideration the number of unique sites requiring improvements, the extent of the change in permit levels or site-specific requirements. In the subsequent sections we provide evidence to further justify our costs for the sites requiring improvements. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our sanitary parameter reduction programme.

2.5.1 Ofwat's cost assessment

Ofwat's cost assessment is based on the results from their sanitary parameters enhancement feeder model. This provided a capex allowance of £20.3m compared to our business plan estimated capex cost of £32.6m.

Ofwat's feeder model uses "Population Equivalent" (from companies' table WWn4) and "Number of sites" (as estimated from the WINEP and/or company business plans) for sites with new or tightened sanitary parameters as the two explanatory variables driving the model. There are a wide range of efficiency ratios produced by each of the two models, which raises questions about their appropriateness.

We query the number of sites used by Ofwat in their assessment. We appreciate that we do not necessarily have sight of every company's obligations and proposals, however our own assessment from the WINEP of the number of sites being improved by water companies differs from Ofwat's estimate, as shown in Table 2-13.

Table 2-13: Assessment of sanitary removal improvements identified in WINEP

Company	Ofwat Model	Our assessment from WINEP					
		Permit change (or addition of UWWTD conditions)				Improvement needed	
		AmmN	BOD	UWWTD	Other	Number of Lines/ Schemes	Number of Sites
Anglian Water	24	6	3	16		9	8
Northumbrian Water	3	3				3	3
Severn Trent Water	73	53	19		1	73	62
South West Water	8	11	4	1		15	11
Southern Water	16	11	2	6		13	12
Thames Water	17	8	1	8		9	8
United Utilities	19	17	10			27	18
Wessex Water	10	7	3	1		10	7
Yorkshire Water	5	8	6			14	12

The majority of the sites identified in the WINEP with Urban Waste Water Treatment Directive (UWWTD) drivers for sanitary parameters requirements will already be operating to a tighter Water Framework Directive (WFD) permit standard. In these cases, the UWWTD driver relates to a change in sampling methodology rather than process improvements, so any inclusion in the model would detrimentally skew.

The feeder models also make no consideration of the extent of improvement required. We consider it more appropriate to model with the number of unique sites, and also the extent of any improvement, rather than the number of lines in the WINEP. The extent to which a consent is tightened has implications on the costs of investment to meet the tightened consent. Table 2-14 details changes in sanitary permits at our sites from the WINEP, with each dot representing a STW where the sanitary permit has been tightened and the arrow showing the extent of tightening.

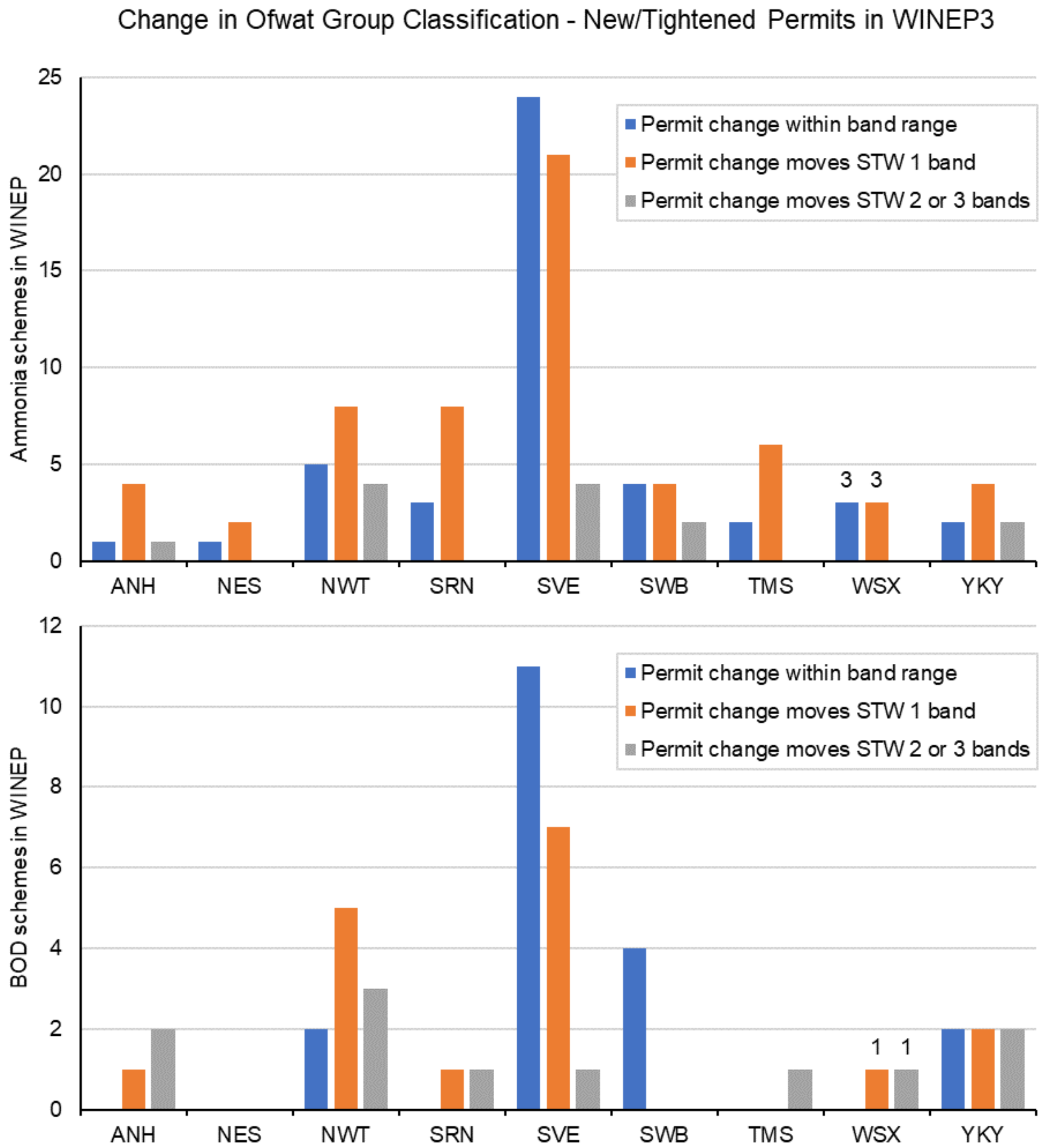
Table 2-14: Wessex Water WINEP3 changes in sanitary permits

Parameter	Bands				
BOD	≤7mg/l	>7 to ≤10mg/l	>10 to ≤20mg/l	>20mg/l	No permit
Current			●	●	
WINEP	●		●		
AmmN	≤1mg/l	>1 to ≤3mg/l	>3 to ≤10mg/l	>10mg/l	No permit
Current			●●●●	●●	
WINEP		●	●●●●●		

Figure 2-7 represents our interpretation of the WINEP for each company regarding permit changes at individual/unique STWs. For example, a site may have both a WFD_ND and WFD_IMP driver, where the permit for the WFD_ND driver is tightened further by the

WFD_IMP driver. The chart shows the degree to which there is a variation across companies on the extent of the tightening of consents (both AmmN and BOD) in their STWs.

Figure 2-7: WINEP3 changes in sanitary permits grouped by Ofwat classification ranges



The enhancement feeder model does not take into consideration the number of unique sites requiring improvements, the extent of the change in permit levels or site-specific requirements. In the following sections we provide evidence to further justify our proposals for ammonia and BOD removal as required by the WINEP.

Furthermore, no specific allowance was made for opex for these new sanitary parameter reduction obligations. We accept the possibility there is some implicit allowance for the opex to meet these new obligations in the base allowance, although the choice of cost drivers in those models and Ofwat's approach to forecasting cost driver (namely on load treated at STWs with ammonia consent <3mg/l) would suggest this may be limited.

2.5.2 Best option for customers

As described in Supporting document 5.1, seven STWs are identified in the WINEP3 as requiring tightening of their BOD and/or ammonia permits in PR19, as shown in Table 2-15.

Table 2-15: WINEP3 BOD and AmmN permits

Site	Driver Code	Driver Details	Current Permit	Proposed Permit
Castle Cary	WFD_ND	BOD	15 mg/l	6.5 mg/l
Gillingham	WFD_ND	Ammonia	8 mg/l	6 mg/l
Keynsham	WFD_ND	Ammonia	12 mg/l	10 mg/l
Radstock	WFD_ND	Ammonia	6 mg/l	4 mg/l
Shepton Mallet	WFD_IMP	Ammonia	6 mg/l	3 mg/l
Wells	WFD_ND	Ammonia	10 mg/l	9 mg/l
Yeovil	WFD_ND	Ammonia	15 mg/l	12 mg/l
Yeovil	WFD_ND	BOD	30 mg/l	12 mg/l
Yeovil	WFD_IMP	Ammonia	15 mg/l	4 mg/l
Yeovil	WFD_IMP	BOD	30 mg/l	14 mg/l

Given the need for treatment enhancements at our STWs, we have adopted the following approach to developing the best options:

- Assessment of the STW current treatment capacity and performance. Is there a "no-build" solution?
- Consideration of other WINEP or "growth" drivers at the STW. Is there an opportunity for synergies and associated efficiency savings?
- Consideration of longer-term strategies for the STWs. Is it appropriate to consider a "step-change" in treatment process in order to meet medium to long-term pressures on the STW?

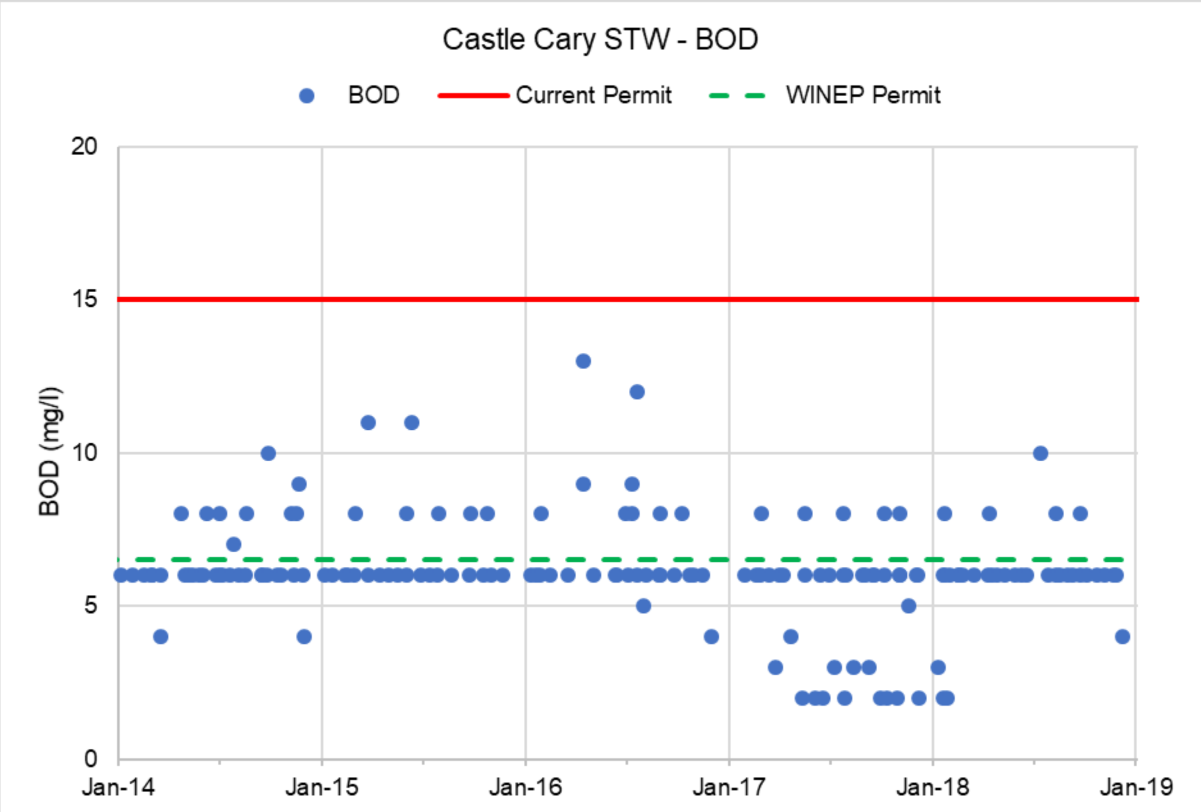
Details of how our above approach has been applied at these STWs as listed in Table 2-15 is explained on the following pages, noting that many have other drivers, such as phosphorus and supply-demand balance pressure, and appropriate options and purpose splits have been developed.

Castle Cary STW

Castle Cary STW is a works comprising primary tanks, rotating biological contactors (RBCs) providing secondary treatment, humus settlement tanks and tertiary grass plots. Additional treatment capacity was last provided in 2009/10 when the three old RBCs were replaced by five modern units. Other than routine capital maintenance there has been no significant investment at the STW since then.

The STW is well within its dry weather flow (permit) figure, with significant headroom available to accept growth in the base flow. Evidence from our sampling data for BOD shows that compliance with existing permit conditions is good, as shown in Figure 2-8. The EA have included the site in the WINEP for a tightened BOD permit to prevent deterioration of the receiving watercourse as this headroom is used up.

Figure 2-8: Final effluent BOD performance at Castle Cary STW



The permitted FFT is a relatively low multiple of the consented DWF. This, when combined with growth in the catchment, means the works is at risk of spilling to storm on dry days. We have agreed with the EA an increase in FFT as a quality driver, and there is also the introduction of a phosphorus permit, as below:

Table 2-16: Quality enhancement drivers identified in WINEP for Castle Cary STW

WINEP ID	Driver Code	Driver code Information	Completion Date	Old Permit	New Permit
7WW200168	U_IMP5	FFT	31/03/2023	2,203 m^3/d	2,687 m^3/d
7WW201060	HD_IMP WFD_ND WFD_IMPg	Phosphorus	22/12/2024	-	0.5 mg/l
7WW200174	WFD_ND	BOD	31/03/2025	15 mg/l	6.5 mg/l

To address the identified needs, additional secondary and tertiary treatment is required, as described in the table below. The existing grass plots are not appropriate to achieve the tightened BOD or new P permits, unless followed by a solids removal stage to remove any accumulated algal growth.

Table 2-17: Treatment options considered to meet WINEP requirements at Castle Cary STW

Need	Treatment Options
P (0.5mg/l)	New chemical dosing and solids removal: - Front & Back-End Chemical Dosing with Tertiary Solids Removal
BOD (6.5mg/l) FFT Increase (2,687 m^3/d) Growth	Improved secondary treatment: - Rotating Biological Contactor (RBC) - Submerged Aerated Filter (SAF) - Biological Filter (BF) Improved tertiary solids removal: - Aerated Sand filters (TASF) - Cloth Filters (TCF)

The site performs well against its ammonia permit. As described in Section 3.2.4 of Supporting document 5.1, when targeting low phosphorus permits, our proposed tertiary treatment technology for sites with good ammonia removal performance is a cloth filter. By evaluating combinations of the above options, we have been able to identify and promote the best option for customers.

Table 2-18: Options comparison at Castle Cary STW to meet all the enhancement drivers

Treatment Provision			
Phosphorus Removal	Front & Back-End Chemical Dosing		
Secondary Treatment	RBC	SAF	Biological Filter
Tertiary Solids Removal (TSR)	Tertiary Cloth Filter		
Treatment Provision			
Meets new P permit (0.5mg/l)	✓	✓	✓
Meets new BOD permit (6.5mg/l)	✓	✓	✓
Meets new FFT permit (2,687 m^3/d)	✓	✓	✓
Avoids additional pumping	✓	✗	✗
Avoids additional aeration power	✓	✗	✓
Best use of existing assets	✓	✗	✗
Capex (£m)	5.68	>5.68*	>5.68*
Lowest whole-life cost	✓	✗	✗

* Note: Based on a high-level assessment, and due to the additional capital and operating costs of pumping and aeration plant for these options.

The existing STW utilises the RBC process and has been set out with five RBCs and arrangements for a sixth RBC to be installed. It is therefore proposed that an additional RBC is chosen as the appropriate secondary treatment for FFT, along with front and back-end chemical dosing and a tertiary cloth filter for solids removal.

The costs have been apportioned between drivers as below:

Table 2-19: Cost apportionment between PR19 drivers at Castle Cary STW

	Percentage	Capex (£m)	Opex (£m/yr)
Quality Enhancement – FFT	16%	0.873	0.012
Quality Enhancement – Phosphorus	69%	3.927	0.093
Quality Enhancement – BOD	12%	0.698	0.010
Capacity Enhancement – STW Growth (capacity)	3%	0.175	0.002
	Total:	5.673	0.117

<u>Gillingham STW</u>

Gillingham STW is a works comprising primary tanks, stone media biological filters providing secondary treatment, humus settlement tanks and tertiary aerated filters providing improved ammonia removal. The STW had a major upgrade in AMP6 with a combined supply demand balance, quality and capital maintenance scheme, which will be completed by December 2019. During the planning of this scheme during PR14 there was an awareness of future permit tightening, and the design and arrangement of the new treatment process units was such that additional units (biological and hydraulic) could be readily incorporated in the future.

Gillingham STW also has a WINEP UWWTD U_IMP2 driver for phosphorus removal, however the site is already operating to a tighter WFD permit standard with nominal additional costs for the change in sampling methodology,

To achieve the tighter ammonia permit it is proposed the tertiary stage is extended with additional aerated sand filters, as shown below.

Table 2-20: Option considered to meet tightened ammonia permit at Gillingham STW

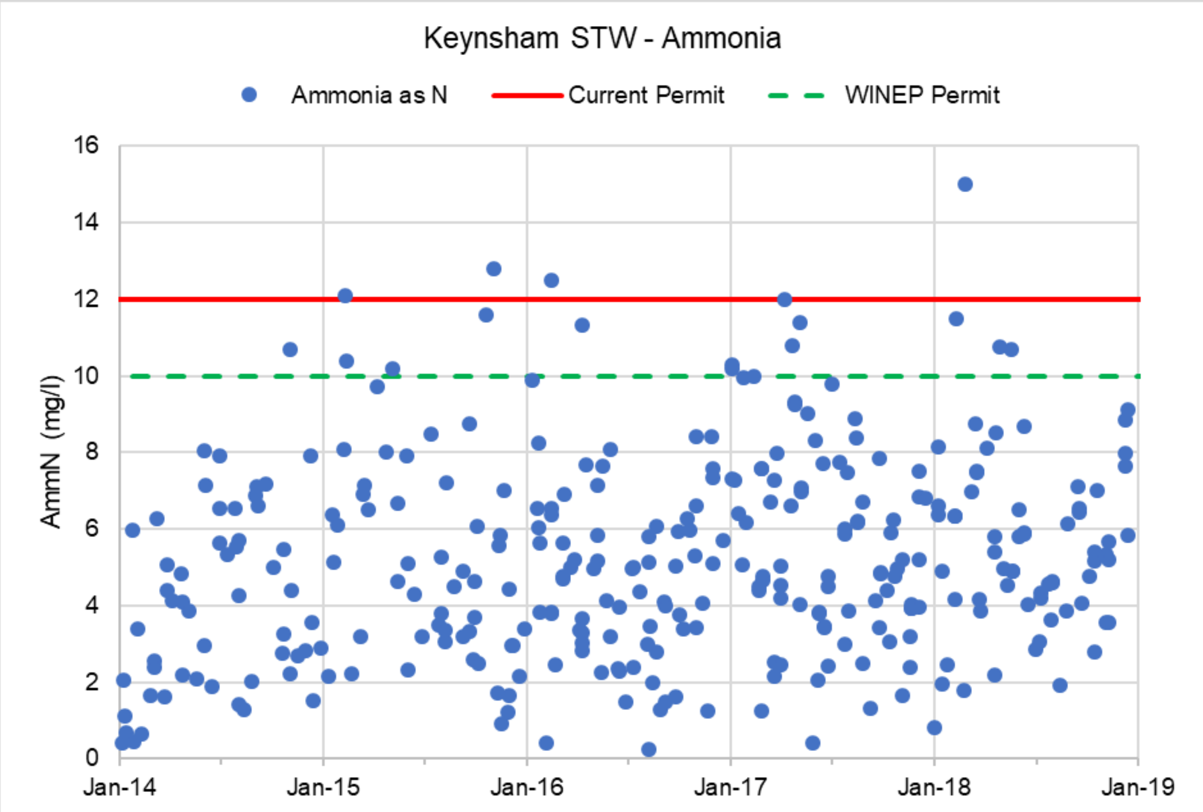
Option	Capital Cost (£m)	
	Total	Quality
Additional tertiary treatment – aerated sand filters	3.61	3.61

Keynsham STW

Keynsham STW is a conventional biological filter works with primary tanks, secondary filters and humus settlement tanks. There is also chemical dosing for phosphorus removal. Additional treatment capacity was last provided in 1989. Two additional filters were installed to add to the six original filters built in 1960. Since then investment at this STW has focussed on capital maintenance, with filter media being replaced on several filters, and quality enhancement to meet the introduction of a phosphorus permit (2mg/l) in 2004.

Evidence from our sampling data shows an increasing (deteriorating) trend in the levels of ammonia in the final effluent. The STW remains compliant, however it is approaching the limit of its treatment capacity, in particular the capacity of the biological filters to remove ammonia is becoming over-loaded. Historical and future planned growth in both residential and trade flows and loads will put additional pressures on the works.

Figure 2-9: Final effluent ammonia performance at Keynsham STW



The STW is well within its dry weather flow (permit) figure, with significant headroom available to accept growth in the base flow. The EA have included the site in the WINEP for a tightened ammonia permit to prevent deterioration of the receiving watercourse.

At 2020 the biological filters will be loaded at between 20-30% over their design capacity for AmmN removal to achieve the new WINEP permit level. The filters are within capacity for BOD removal, with considerable headroom available to achieve the unchanged BOD permit.

The existing treatment process uses conventional biological filtration which is a low energy, sustainable and effective process capable of achieving the proposed new permit standard.

A high-level comparison of the treatment options is summarised below:

Table 2-21: Options comparison at Keynsham STW to meet all the enhancement drivers

Option	Additional Secondary Biological Filters and Humus Tank	New Activated Sludge Process
Provides treatment capacity	✓	✓
Meets new AmmN permit	✓	✓
Utilises existing assets	✓	×
Smaller footprint (relative)	×	✓
Land purchase required	✓	✓
Capex (£m)	6.969	>10.0
Opex (£k/yr)	132	>500
Lowest whole-life cost	✓	×

The proposed solution to achieve the tighter ammonia permit is therefore to use the lower energy and more sustainable solution of biological filters and a humus tank.

The costs have been apportioned between drivers as below:

Table 2-22: Cost apportionment between PR19 drivers at Keynsham STW

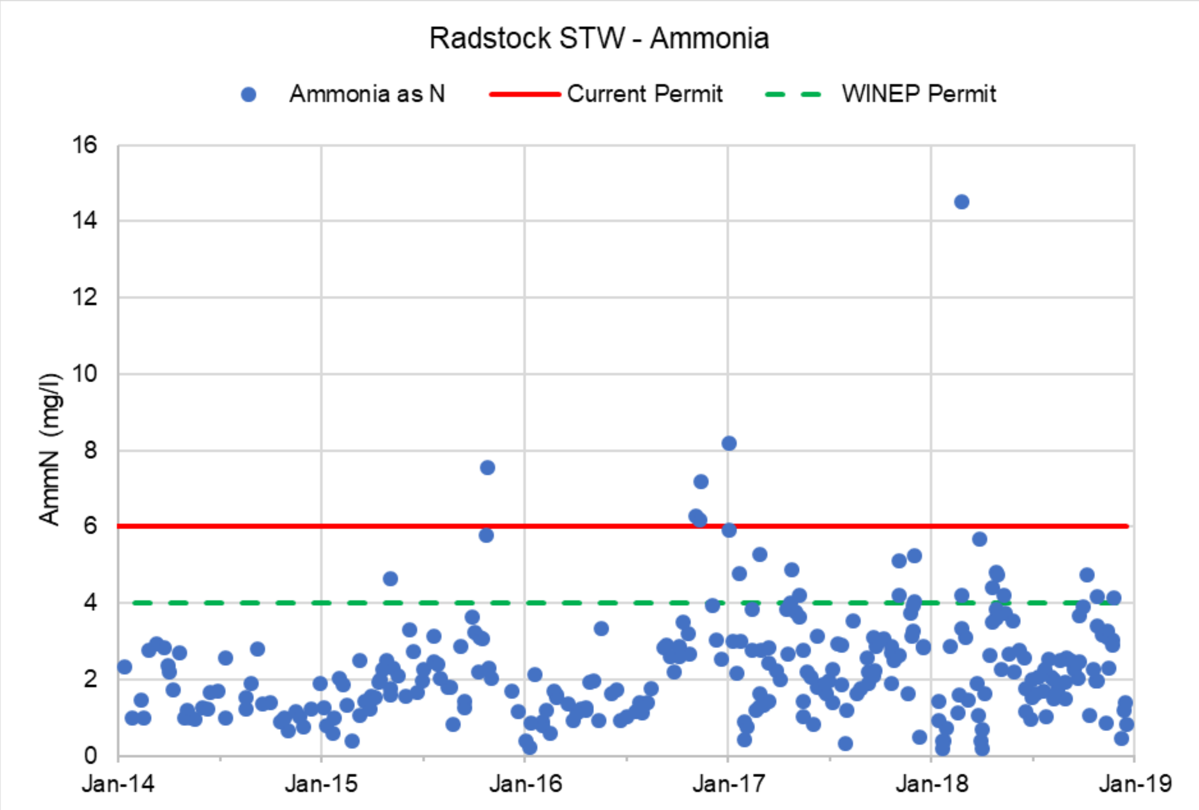
	Percentage	Capex (£m)	Opex (£m/yr)
Quality Enhancement – AmmN	90%	6.272	0.119
Capacity Enhancement – STW Growth (capacity)	10%	0.697	0.013
	Total:	6.969	0.132

Radstock STW

Radstock STW is a conventional biological filter works with primary tanks, secondary filters and humus settlement tanks. There is also chemical dosing for phosphorus removal. Additional treatment capacity was last provided in 1989, when new primary settlement tanks, new secondary biological filters (8 No.) and new humus settlement tanks were constructed. Since then investment at this STW has focussed on capital maintenance and quality enhancement, to meet the introduction of a phosphorus permit (2mg/l) in 2004.

Evidence from our sampling data shows an increasing (deteriorating) trend in the levels of ammonia in the final effluent. The STW remains compliant, however it is approaching the limit of its treatment capacity, in particular the capacity of the biological filters to remove ammonia is becoming over-loaded. Historical and future planned growth in both residential and trade flows and loads will put additional pressures on the works.

Figure 2-10: Final effluent ammonia performance at Radstock STW



The STW is well within its dry weather flow (permit) figure, with significant headroom available to accept growth in the base flow. The EA have included the site in the WINEP for a tightened ammonia permit to prevent deterioration of the receiving watercourse. Additionally, the WINEP requires a tightening of the phosphorus permit, as shown in Table 2-23.

Table 2-23: Quality enhancement drivers identified in WINEP for Radstock STW

WINEP ID	Driver Code	Driver code Information	Completion Date	Old Permit	New Permit
7WW200720	WFD_IMPg	Phosphorus	22/12/21	1 mg/l	0.7 mg/l
7WW200723	WFD_ND	Ammonia	31/03/25	6 mg/l	4 mg/l

As described in Section 3.2.4 of Supporting document 5.1, when targeting low phosphorus permits, our proposed tertiary treatment technology for sites requiring increased ammonia removal is aerated sand filters.

A high-level comparison of the treatment options is summarised below:-

Table 2-24: Options comparison at Radstock STW to meet all the enhancement drivers

Option	Tertiary Aerated Sand-filters	Additional Secondary biological filters	New Activated Sludge Process
Provides treatment capacity	✓	✓	✓
Meets new AmmN permit	✓	×	✓
Meets new P permit	✓	×	✓
Utilises existing assets	✓	✓	×
Capex (£m)	7.059	n/a	>10.0*
Lowest whole-life cost	✓	×	×

* Note: Based on a high-level assessment, and due to the additional capital and operating costs of pumping and aeration plant for this option.

The proposed solution to achieve the tighter ammonia and phosphorus permits is to take advantage of the synergies by providing a tertiary aerated filter stage.

The costs have been apportioned between drivers as below:

Table 2-25: Cost apportionment between PR19 drivers at Radstock STW

	Percentage	Capex (£m)	Opex (£m/yr)
Capacity Enhancement – STW Growth (capacity)	20%	1.412	0.039
Quality Enhancement – Phosphorus	60%	4.235	0.116
Quality Enhancement – AmmN	20%	1.412	0.039
	Total:	7.059	0.194

Shepton Mallet STW

There are multiple quality drivers at Shepton Mallet STW, including new/tightened permits for ammonia, phosphorus and chemical (zinc), as shown in Table 2-26.

Table 2-26: Quality enhancement drivers identified in the WINEP for Shepton Mallet STW

WINEP ID	Driver Code	Driver code Information	Completion Date	Old Permit	New Permit
7WW300211	WFD_IMP	Ammonia	22/12/2024	6 mg/l	3 mg/l
7WW300210	HD_IMP SSSI_IMP	Phosphorus	31/03/2025	2 mg/l	1 mg/l
7WW200776	WFD_IMP	Phosphorus	22/12/2024	2 mg/l	0.35 mg/l
7WW200778	WFD_NDLS	Chemical (zinc)	22/12/2022	-	48 µg/l
7WW200777	WFD_IMP	Chemical (zinc)	31/12/2024	-	42 µg/l

Further details of the options considered for Shepton Mallet STW can be found in Annex E. The proposed solution is to take advantage of the synergies provided by a new activated sludge plant.

Wells STW

Wells STW is a conventional biological filter works with primary tanks, secondary filters and humus settlement tanks. There is also chemical dosing for phosphorus removal, which was introduced in 2004.

The STW is well within its dry weather flow (permit) figure, with significant headroom available to accept growth in the base flow. The EA have included the site in the WINEP for a tightened ammonia permit to prevent deterioration of the receiving watercourse. Additionally, the WINEP requires a tightening of the phosphorus permit, as below:

Table 2-27: Quality enhancement drivers identified in WINEP for Wells STW

WINEP ID	Driver Code	Driver code Information	Completion Date	Old Permit	New Permit
7WW300219	HD_IMP SSSI_IMP	Phosphorus	31/3/25	2 mg/l	1 mg/l
7WW200962	WFD_ND	Ammonia	31/03/25	10 mg/l	9 mg/l

A high-level comparison of the treatment options to achieve the WINEP requirements is summarised below:

Table 2-28: Options comparison at Wells STW to meet all the enhancement drivers

Option	Upgrade Biological Filters	Upgrade Biological Filters + Operational Enhancement for P removal	New Moving Bed Biological Reactor (MBBR)	Convert existing stone media filter to plastic media filter
Provides treatment capacity	✓	✓	✓	✓
Meets new AmmN permit	✓	✓	✓	✓
Meets new P permit	×	✓	✓	✓
Utilises existing assets	✓	✓	✓	×
Capex (£m)	4.00	4.16	4.21	5.96
Opex (£k/yr)	20	194	189	164
Lowest whole-life cost	n/a	✓	×	×

The proposed solution is to take advantage of the synergies through operational enhancements to achieve the tighter phosphorus permit and upgrade the existing biological filters to achieve the tighter ammonia permit. This is the most efficient, sustainable and lowest whole-life-cost solution.

The costs have been apportioned between drivers as below:

Table 2-29: Cost apportionment between PR19 drivers at Wells STW

	Percentage	Capex (£m)	Opex (£m/yr)
Quality Enhancement – Phosphorus	4%	0.158	0.020
Quality Enhancement – AmmN	96%	3.999	0.050
	Total:	4.157	0.194

Yeovil STW

There are multiple quality drivers at Yeovil (Pen Mill) STW, including tightened permits for ammonia, BOD and phosphorus, as shown in Table 2-30.

Table 2-30: Quality enhancement drivers identified in the WINEP for Yeovil STW

WINEP ID	Driver Code	Driver code Information	Completion Date	Old Permit	New Permit
7WW201047	WFD_ND	Ammonia	31/03/2025	15 mg/l	12 mg/l
7WW201045	WFD_IMPg	Ammonia	22/12/2024	15 mg/l	4 mg/l
7WW201048	WFD_ND	BOD	31/03/2025	30 mg/l	12 mg/l
7WW201046	WFD_IMPg	BOD	22/12/2024	30 mg/l	14 mg/l
7WW201044	HD_IMP WFD_IMP SSSI_IMP	Phosphorus	22/12/2024	2 mg/l	0.65 mg/l
7WW201043	U_IMP6	Storm Storage	31/03/2025	-	-

Further details of the options considered for Yeovil STW can be found in Annex H. The proposed solution is to take advantage of the synergies provided by a new activated sludge plant.

2.5.3 Robust and efficient costs

Section 8 of our main business plan narrative submitted in September 2018 describes how we have ensured our proposals are efficient across all the price controls, as well as explaining how we estimate efficient costs for new projects. Supporting document 8.11 provides more detail. Through external benchmarking we have demonstrated that our cost estimates are efficient and competitive compared with the marketplace.

The proposals detailed in this section cover ammonia and BOD removal associated with discharges from sewage works. Many of the sites/schemes have other drivers, and costs have been appropriately allocated to their respective line drivers in the PR19 data tables as summarised in Table 2-31 below.

Table 2-31: Costs allocated to WWS2 Lines 20/67: WINEP ~ Reduction of sanitary parameters

Site	Parameter	Other Related Site/Scheme Drivers	Capex (£m)	Opex in 2020-2025 (£m)	Totex in 2020-2025 (£m)
Castle Cary STW	BOD	FFT, P & Growth	0.70	0.01	0.71
Gillingham STW	AmmN		3.61	0.01	3.62
Keynsham STW	AmmN	Growth	6.27	0.02	3.29
Radstock STW	AmmN	P, Growth	1.41	0.01	1.42
Shepton Mallet STW	AmmN	Chemical & P	3.63	0.08	3.71
Wells STW	AmmN	P	4.00	0.01	1.01
Yeovil STW	AmmN & BOD	P & Growth	12.99	0.21	13.20
		Total:	**32.6**	**0.3**	**33.0**

N.b. Due to rounding, some totals may not correspond with the sum of the separate figures.

2.5.4 Conclusion

Ofwat's sanitary parameter removal enhancement feeder model uses "Population Equivalent" and "Number of sites". It does not take into consideration the number of unique sites requiring improvements or the extent of the change in permit levels. Nor does the model consider specific site constraints as identified in our submission.

We accept the possibility there is some implicit allowance for the opex to meet these new obligations in the base allowance, although the choice of cost drivers in those models and Ofwat's approach to forecasting cost driver (namely on load treated at STWs with ammonia consent <3mg/l) would suggest this may be limited.

We would request that, on the basis of the additional evidence provided above, the sanitary parameter removal costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

2.6 Chemicals removal

This chapter should be read in conjunction with Chapter 3.4 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-32: Business plan table details for chemicals removal

Table	Lines	Line Description
WWS2	12 / 59	WINEP ~ Chemicals removal schemes

In this chapter we expand on our proposals for chemical removal in PR19. In the first section we comment on the feeder model and allocation of costs used by Ofwat in assessing our PR19 chemical removal proposals. In the subsequent sections we provide evidence to further justify our costs for the sites requiring improvements. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our chemical removal programme.

2.6.1 Ofwat's cost assessment

The deep dive on chemicals removal in our proposals received three passes, one partial pass and one fail, as follows:

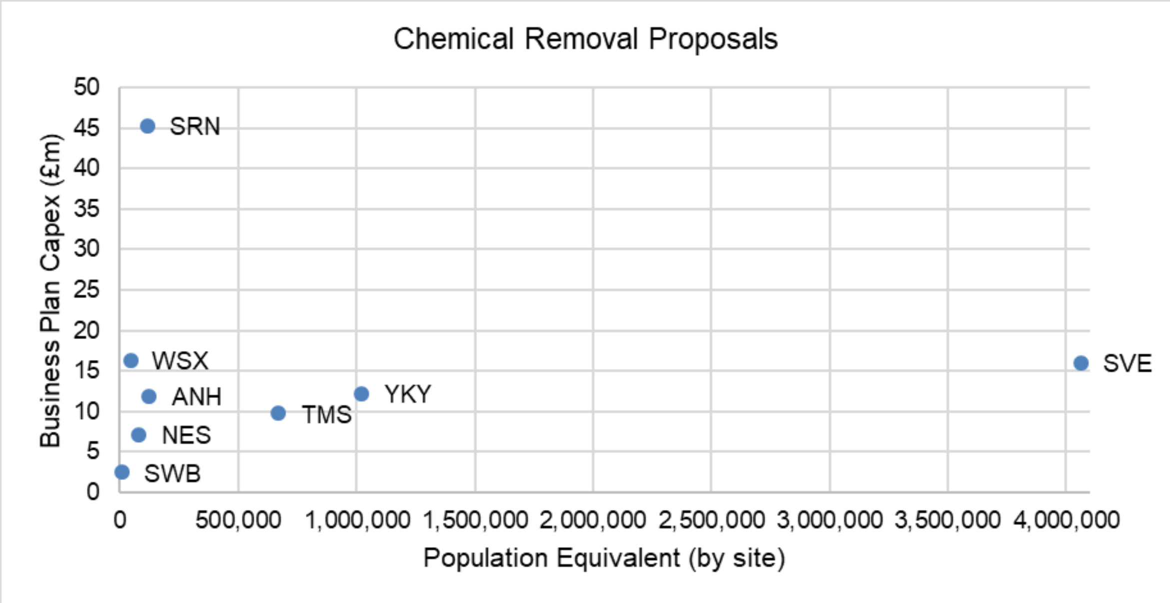
- Need for investment – pass
- Need for adjustment – pass
- Best option for customers – partial pass
- Robustness and efficiency of costs – fail
- Customer protection – pass.

Our plan includes for zinc removal improvements at two sites: Croscombe STW and Shepton Mallet STW, to satisfy the requirements of the WINEP. With regards to robustness and efficiency of costs, Ofwat state:

> *"The company are very high on a unit cost basis irrespective of the normalising factor used and this may be due to bias in the weighting of the costs at Shepton Mallet which is impacted by a range of enhancement drivers to chemicals removal. If so, the allowance set in this model will to some extent be offset by gains elsewhere."*

We consider there are deficiencies in the chemical removal enhancement feeder model which make it unrepresentative of the true costs of the work to Wessex Water. We have concerns on the robustness of the individual models. The models have poor fit to data, as indicated by relatively low R2 values (0.39-0.70) and illustrated in Figure 2-11, which shows a plot of capex versus population equivalent. Ofwat do not use the data from two companies in their models because they are outliers, one on costs and the other on population equivalent. However, even with these companies removed there still remains a lack of any clear relation between the variables.

Figure 2-11: Comparison of Costs and PE for different companies



In general, one would expect a scale variable to be the key cost driver in these cost models. However, when the scale variable has limited affect it would then suggest that either the wrong scale variable has been chosen, or that the things being compared across companies are simply too different between themselves.

The model does not take into consideration the specific chemical of interest to be removed, the site's existing performance and removal rate (noting many do not have existing permits), nor the required new permit level. Nor does the model consider specific site constraints as identified in our submission. Given this, it may be more appropriate for Ofwat to try to compile data at site specific level rather than at company level.

There are two principal EA driver codes for chemical removal:

- WFD_NDLS = Schemes to meet requirements to prevent deterioration so as to maintain standstill limits for chemicals.
- WFD_IMP = Pathway to achieve good chemical status. The WFD_IMP permits are a step-change beyond the WFD_NDLS limits.

The different chemicals required to be removed under a WFD_IMP_CHEM driver for the different water companies are shown in Table 2-33.

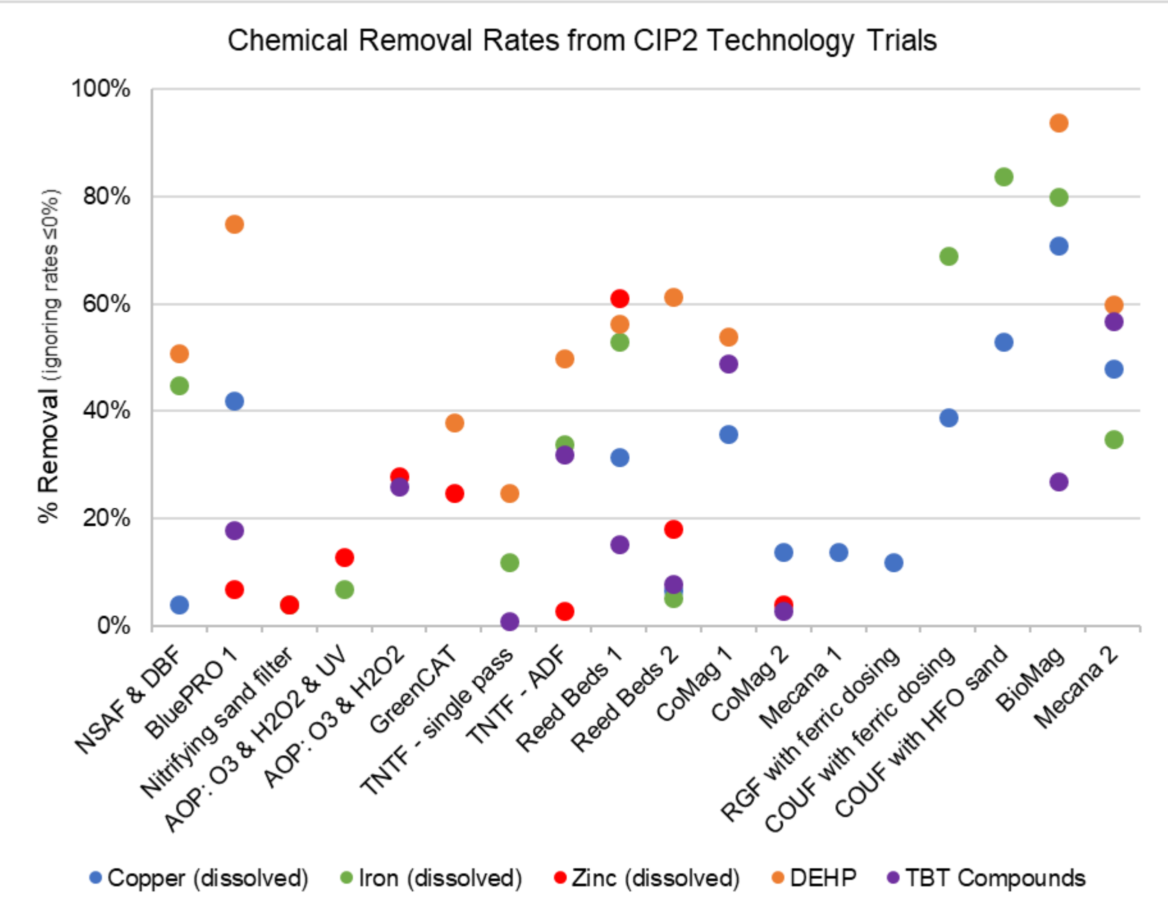
Table 2-33: Comparison of WINEP chemical removal schemes under WFD_IMP_CHEM drivers

Company	Copper (dissolved)	DEHP[1]	Iron (dissolved)	Tributyltin[2]	Zinc (dissolved)
Anglian Water	1	1			
Northumbrian Water			1		1
Severn Trent Water				2	2
South West Water				1	
Southern Water			1		
Thames Water	1				
Wessex Water					1

[1] DEHP = Diethylhexyl Phthalate
[2] TBT = Tributyltin and Tributyltin compounds (Tributyltin-cation)

As described in Supporting document 5.1, as part of the Chemical Investigations Programme 2 (CIP2), a series of pilot/demonstration scale treatment investigations were undertaken nationally. As can be seen from Figure 2-12, the process technologies to remove the above chemicals of interest are different, with some offering negligible or no removal for particular chemicals. Indeed, some chemical levels were observed to increase through the trial processes. Each of these technologies has different associated costs, and it is clearly inappropriate to apply an econometric model to determine allowances.

Figure 2-12: Observed chemical removal rates from CIP2 trials for WFD_IMP_CHEM chemicals



Shepton Mallet

The WINEP identifies two sites requiring chemical removal: Croscombe and Shepton Mallet STWs. Ofwat acknowledge the potential for costing bias with Shepton Mallet STW having a number of enhancement drivers in addition to chemical removal. We have proportioned the costs for these three enhancement drivers, as described in Annex E and summarised in Table 2-34.

Table 2-34: Cost apportionment between PR19 drivers related to Shepton Mallet STW

Driver	Shepton Mallet		Business Plan			
	Purpose Split (%)	Capex (£m)	Business Plan (£m)	Ofwat Allowance (£m)	Difference (£m)	Reduction (%)
Phosphorus	17.2%	3.63	174.5	151.5	-23.0	-13%
Ammonia	17.2%	3.63	32.6	20.3	-12.3	-38%
Chemical Removal	65.6%	13.83	16.3	7.5	-8.8	-54%
	Total:	21.09	223.4	179.3	-44.1	

For the chemical removal enhancement feeder model, Ofwat state:

> *"We base our capex allowance for this enhancement category on triangulating outputs of four cost models and the costs requested by the company, whichever is the lesser."*

For both the phosphorus removal and sanitary parameters enhancement feeder models, Ofwat state:

> *"Where a company's requested investment level is less than our modelled allowance, we use the company's business plan costs."*

As described in Sections 2.1 and 2.5 above, Ofwat's modelled allowance is less than our requested capex for all the enhancement drivers; we have been given the industry median value. As such, Ofwat's statement in their deep dive of our chemical removal proposals that, *"the allowance set in this model will to some extent be offset by gains elsewhere"* is contrary to the above statements, with the allowance not reflective of the true costs of the work to Wessex Water. The combined allocation for Shepton Mallet STW is £11.8m, for a £21.1m scheme.

We provide below additional evidence related to the best option for customers and robustness and efficiency of our costs for these investment proposals. We are having ongoing discussions with the Environment Agency regarding our proposals, and include information on customer protection should our proposals change from that submitted.

In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2. Our included operational costs are integral to the delivery of our chemicals removal programme. Indeed, Ofwat note:

> *"In the absence of any evidence to the contrary we are assuming that the only way of meeting the new WINEP obligations is by investment above that required to maintain base service to customers and the environment."*

Ofwat' set of econometric models do not control for the provision of service levels or performance related to the removal of chemicals relevant to this enhancement category. We do not consider that the base cost models will have included an implicit allowance for our new chemical removal obligations.

2.6.2 Best option for customers

As described in Supporting document 5.1, our investment proposals for chemicals removal involve construction of new assets at Shepton Mallet and Croscombe STWs, to meet new dissolved zinc permit limits. We have detailed our process selection methodology, including assessments of the various technologies available for the appropriate levels of zinc removal.

In Annex E we provide additional evidence to justify our proposed ASP option as the lowest whole life cost option for Shepton Mallet STW.

2.6.3 Robust and efficient costs

Capital Costs

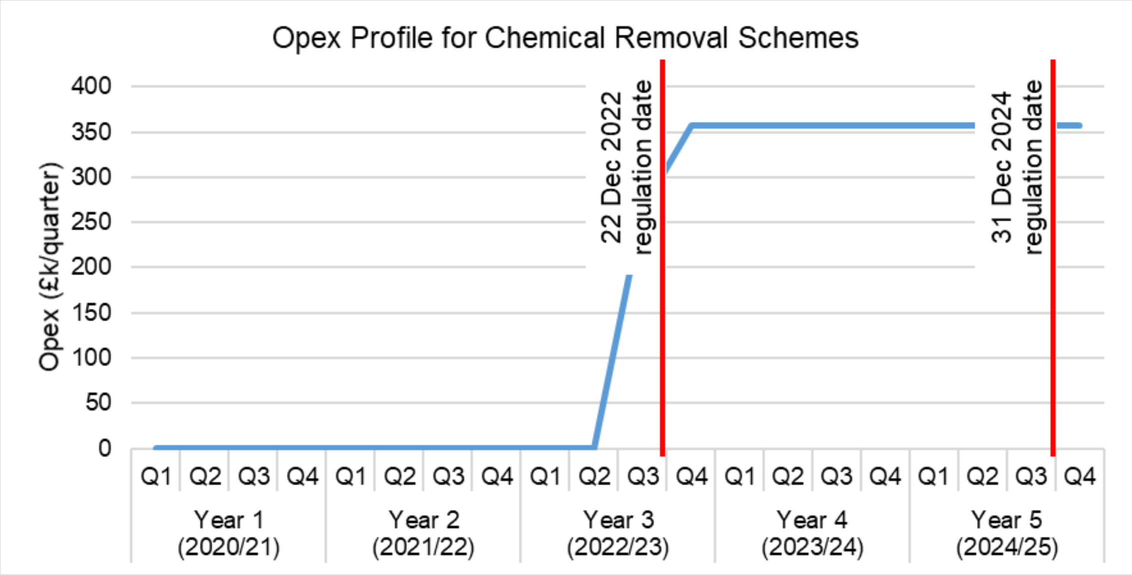
Improvement costs have been developed by:

- Utilising cost models provided as an output from CIP2, with site-specific adjustments (i.e. design, land purchase, ancillaries) to reflect full project out-turn costs.
- Validating costs through our in-house estimating team, with cost benchmarking at a programme level, confirming our costs to be robust and efficient.

Operational Costs

The annual operating and maintenance costs for the chemical removal schemes is shown in Figure 2-13. The chemical removal plants need to be operational to achieve the WINEP regulatory date of December 2022. As described in Annex E, the same treatment process is being proposed to achieve both the WFD_ND and WFD_IMP zinc limits at Shepton Mallet. This offers a more stable opex profile and avoids a significant step-change in ongoing operational costs ahead of December 2024 (e.g. chemical usage into AMP8) if a different process technology was implemented for the WFD_IMP limit.

Figure 2-13: Operational cost profile for chemical removal schemes



2.6.4 Customer protection

Customers will be protected if the investment is cancelled, delayed or reduced in scope through the following performance commitments and their associated ODI:
- E1: Treatment works compliance
- E10: Length of river with improved water quality through WINEP delivery.

Our current plan includes for zinc removal improvements at Croscombe and Shepton Mallet STWs, to satisfy the requirements of the WINEP. Croscombe is 2.5 km downstream of Shepton Mallet; both works discharge to the River Sheppey in the Brue and Axe catchment. In terms of average flow Shepton Mallet is more than 40 times bigger than Croscombe. We have proposed to the EA that the Croscombe scheme is dropped and additional zinc removal is carried out at Shepton Mallet to give the equivalent river water quality improvement.

There is a marginal increase in costs for the increased enhancements at Shepton Mallet, however we believe these to be offset by the benefits of our alternative approach:

- A capital and an associated ongoing operating cost saving by not constructing a chemical removal plant at Croscombe STW.
- Reduced construction carbon, environmental and social cost by avoiding construction at Croscombe, with associated reduced ongoing carbon footprint due to avoided power and chemical consumption.
- At least the same environmental improvement, with the 2.5 km stretch of river between the works receiving a slightly greater improvement than from the WINEP3 proposals.

We have undertaken STW effluent and river water quality modelling based on the bioavailable zinc environmental quality standards to develop our alternative pro rata tightening of the dissolved zinc permits. To remove a scheme from the WINEP the EA require us to set out the benefits and cost savings to take to Defra for agreement. Our model report and supporting information was passed to the EA on 23rd January 2019.

The EA are currently considering this alternative approach, however we do not expect a decision to be made in time to inform WINEP4 (to be issued March 2019) or our response to Ofwat's IAP (March 2019). If our proposal is acceptable to the EA – and subject to sufficient funding allocation – then we propose to protect customers by making the following adjustments to our plan:

Table 2-35: Cost comparison of alternative chemical removal proposals

Site	Capex (£m)	Opex (£m/yr)	Opex in 2020-2025 (£m)	Totex in 2020-2025 (£m)
Currently included in our plan				
Croscombe STW	2.4	0.15	0.4	2.8
Shepton Mallet STW	13.8	1.27	3.1	16.9
Alternative proposal				
Croscombe STW	-	-	-	-
Shepton Mallet STW	14.0	1.33	3.2	17.2
Potential customer saving:	2.2	0.09	0.3	2.5

The saving stated above is an estimate and will need to be reviewed on receipt of EA's response to our proposals. Aspects that could affect the value include the exact zinc permit required at Shepton Mallet (and thus the level of treatment required) as well as whether additional sampling/monitoring will be required at Croscombe STW or in the river. This potential saving is also predicated on our costs for Shepton Mallet STW being allowed in full.

This change would also have an impact on our performance commitment *E10 Length of river with improved water quality through WINEP delivery*, which is based on the lengths in WINEP3. In the WINEP Croscombe has a length of 6 km and a completion date of Dec 2022. Therefore, if the EA agree to drop the scheme the performance commitment level would need to be reduced by 6 km for each of the last three years 2022-23 to 2024-25.

2.6.5 Conclusion

Ofwat's chemical removal enhancement feeder model does not take into consideration the specific chemical of interest to be removed (which has a significant impact on the cost), the site's existing performance and removal rate (noting many do not have existing permits), nor the required new permit level. Nor does the model consider specific site constraints as identified in our submission. Furthermore, no specific allowance for opex has been made, despite additional opex being integral to meet these new environmental obligations.

We would request that, on the basis of the additional evidence provided above, the partial pass and fail from Ofwat's deep dive are turned to passes, and the chemicals removal costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

2.7 Flow capacity

This chapter should be read in conjunction with Chapter 3.5 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-36: Business plan table details for increasing flow capacity

Table	Lines	Line Description
WWS2	9/56	WINEP ~ Schemes to increase flow to full treatment

In this chapter we expand on our proposals for increasing flow to full treatment in PR19. In the first section we comment on the feeder model, and highlight our concerns of the impact of one very large and one large scheme (which have particular engineering challenges), and which due to their size and particular characteristics, adversely skew the results of the model. In the subsequent sections we provide evidence to further justify our costs for the sites requiring improvements. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our increasing flow to full treatment programme.

2.7.1 Ofwat's cost assessment

Ofwat's cost assessment is based on the results from their flow to full treatment enhancement feeder model. This provided a capex allowance of £48.5m compared to our business plan estimated capex cost of £79.9m.

We consider there are deficiencies in this enhancement feeder model, which make it unrepresentative of the true costs of the work to Wessex Water. This is due to the impact of one very large and one large scheme which have particular engineering challenges, and which, due to their size and particular characteristics, skew the results of the model adversely against Wessex Water. These schemes are:-

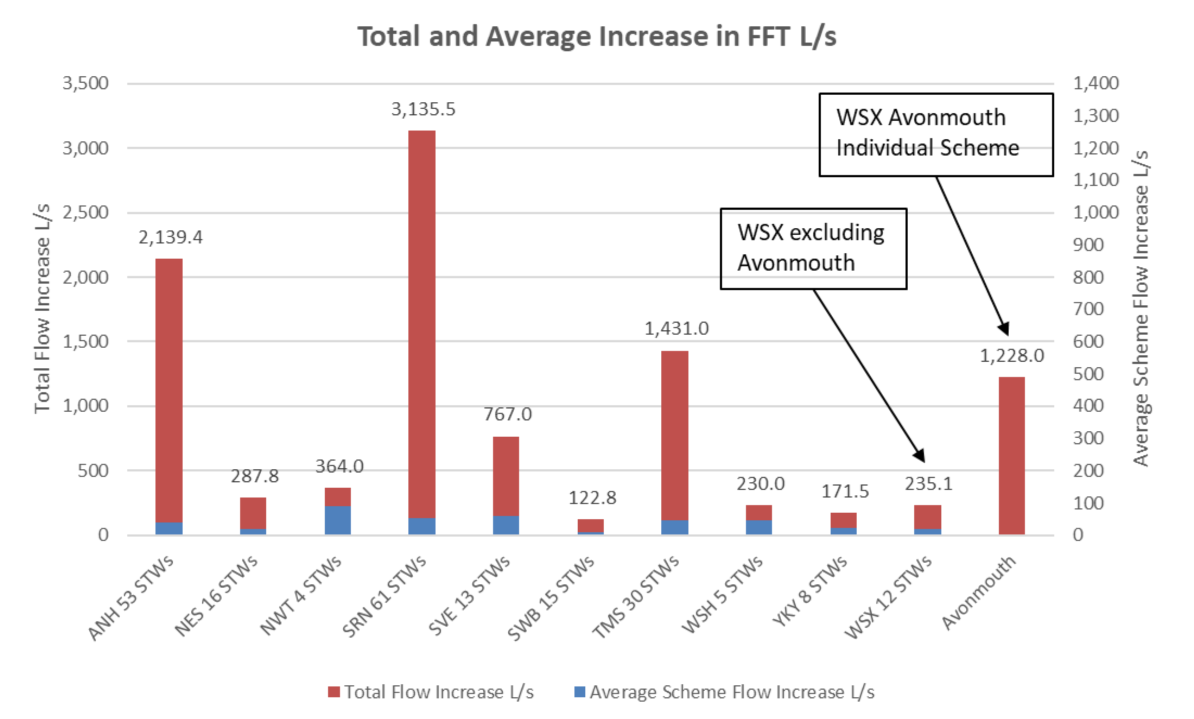
Table 2-37: Specific FFT increase schemes included in our plan

WINEP ID	Scheme	Shortfall in FFT	Capex (total) (£m)	Capex (U_IMP5) (£m)
7WW200045	Avonmouth	1,228 l/s	46.02	43.72
7WW200053	Bath (Saltford)	154 l/s	22.20	21.09

Ofwat's feeder model uses "Number of schemes in business plan" and "Shortfall in FFT(l/s)" as the two parameters driving the model. The numbers for Wessex Water are 13 (No.) and 1,461.3 (l/s) respectively.

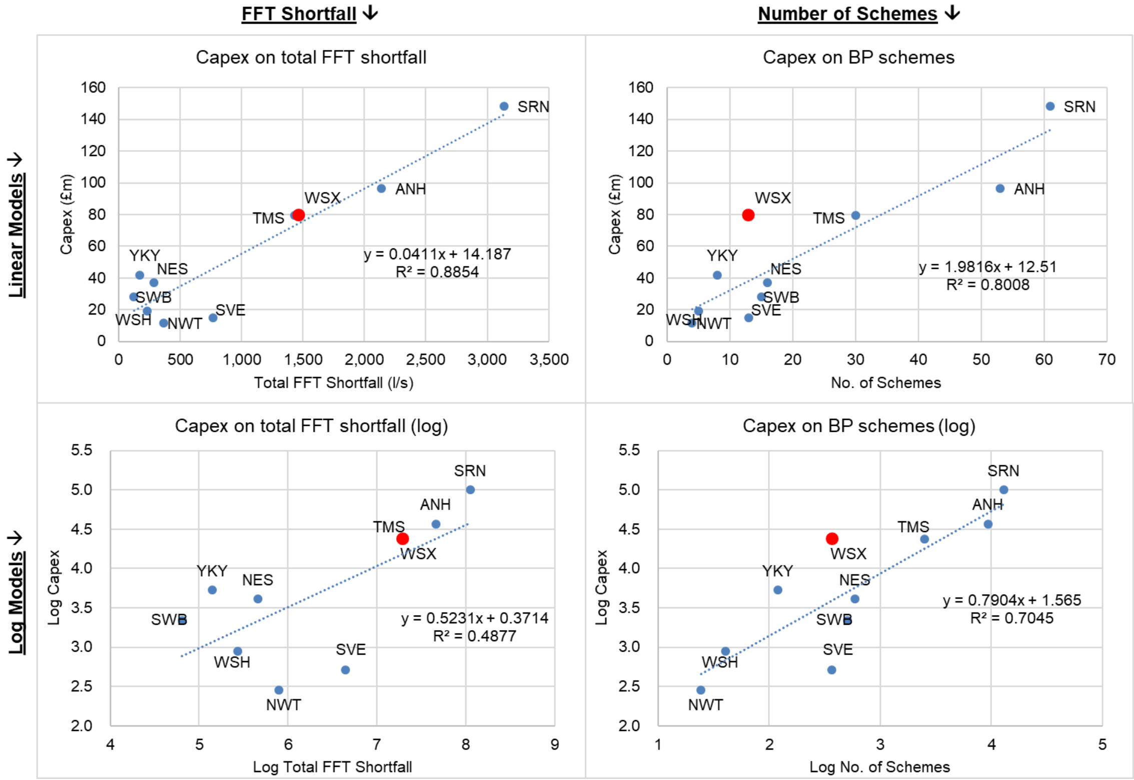
As shown in Figure 2-14, the project at Avonmouth represents 84% of the total FFT shortfall across the whole of Wessex Water. This FFT shortfall alone is significantly greater than that for the whole shortfall at six other WaSCs (NES, NWT, SVE, SWB, WSH, and YKY). The shortfall at our Saltford STW alone represents an FFT shortfall which is greater than 50% of the total shortfall at four other WaSCs (NES, SWB, WSH and YKY). These two large schemes distort the profile of our FFT schemes compared to that for the other WaSCs, and makes our average FFT shortfall some 2.6 times greater than the average shortfall of the other nine WaSCs. This affects the results of the two Ofwat models which use number of schemes, rather than shortfall as a driver, and which are hence adversely skewed against our set of FFT schemes (see Figure 2-15). We therefore suggest that the models based on number of schemes should not be used.

Figure 2-14: Total and average increase in FFT for different WaSCs



We also note that the linear models have a better fit with higher R^2 values than the log models, as shown in Figure 2-15. We have some difficulty in understanding Ofwat's rationale for using these log-standardised models for deriving predicted costs. For example we note that the log graph on Capex on total FFT shortfall has a coefficient of 0.523 which implies a doubling of FFT provision should only increase capex by 52%. Although we expect to make economies of scale at both asset and programme level we do not consider the 52% result to be credible.

Figure 2-15: Ofwat model charts for FFT shortfall and number of schemes



We consider that scale and nature of works required to meet an obligatory increase in flow capacity to be very site specific. Ofwat modelling takes no account of individual site characteristics such as the stringency of the permit or the quantum of flow capacity headroom that might already exist at a site. Both Avonmouth and Saltford STWs are already at capacity with respect to hydraulic flow and there is no headroom available to help accommodate any increase.

For the reasons explained above, and expanded further below, we consider that the combined triangulated result from the Ofwat feeder model is not valid for the nature, size and profile of the AMP7 FFT flow schemes in Wessex Water. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2. We acknowledge that there may have been an implicit allowance in the opex base models, however we cannot find evidence of this in relation to FFT increases. We explain below why these additional opex costs are integral to the delivery of our flow capacity increase programme.

2.7.2 Robust and efficient costs

<u>Avonmouth STW</u>

Our STW at Avonmouth is by far the largest STW in our region, and one of the ten largest in England & Wales. It serves a population equivalent of approximately 800,000. Due to the size of the STW and the scale of the planned works required to increase the FFT by over 35%, a detailed appraisal was carried out and associated cost estimates prepared, to confirm the most cost-efficient solution for this scheme.

Further details of the background and appraisal of this scheme are provided in Annex B.

The existing STW is at the limit of its hydraulic capacity and the obligatory increase of 1,228l/s requires the construction of an additional treatment stream. Several treatment options were considered at a high level and two options were appraised and costed in more detail. Activated sludge is the “go to” treatment process for large treatment works in urban areas, and, to the best of our knowledge, is the treatment process utilised at all STWs of this size in the UK. Our appraisal compared two types of activated sludge (ASP) treatment processes, conventional ASP and Sequencing Batch Reactors (SBR). A comparison of the costs is given below, with further detail included in Annex B.

Table 2-38: Treatment options at Avonmouth STW for the increased FFT WINEP driver

Option	Option 1 4no. SBRs	Option 2 ASP
Provides hydraulic capacity to meet new FFT	✓	✓
Provides treatment capacity to 2025	✓	✓
Permits future expansion on site for future growth	✓	✗
Scheme Capex (£m)	46.02	80.84
Opex (£k/yr)	778	850
Lowest whole-life cost	✓	✗

The build-up of the scope and cost estimates is shown in Table 2-39 below.

Table 2-39: Cost estimate breakdown and external benchmarking for Avonmouth STW

	Wessex Water Internal Estimate Option 1 – SBRs (£k)	External Cost Consultant Option 1 – SBRs (£k)	Wessex Water Internal Estimate Option 2 – ASP (£k)
<u>Construction Value</u>			
Civil work items Labour, Plant, Material & Subcontract packages	16,652	17,107	36,524
Mechanical and Electrical work items Labour, Plant, Material & Subcontract packages	9,598	9,246	12,718
Supervision and Prelims	5,287	5,630	6,530
Contractor Fees	1,907	2,434	2,788
Total Construction Value:	33,699	34,417	58,561
Design	4,451		8,363
Project management	1,851		3,234
Third party	477		557
Risk (15%)	5,796		10,123
Total Scheme Cost:	46,020	46,353*	80,840

* With pro-rata addition of design, project management, third party and risk.

There are particular engineering challenges in constructing works on this site. These include:

- Very poor ground conditions: all structures and large pipelines require piling
- Congested site: routes for cross-site pipelines are difficult and involve multiple crossings of existing services.
- Sensitive Area: the site proposed for the new works is adjacent to a Scheduled Ancient Monument, which will require extra protection during the construction works.

Section 8 of our main business plan narrative submitted in September 2018 describes how we ensured our proposals were efficient across all the price controls, as well as explaining how we had estimated efficient costs for new projects. Supporting document 8.11 provides more detail. Through external benchmarking we have demonstrated that our cost estimates are efficient and competitive compared with the marketplace.

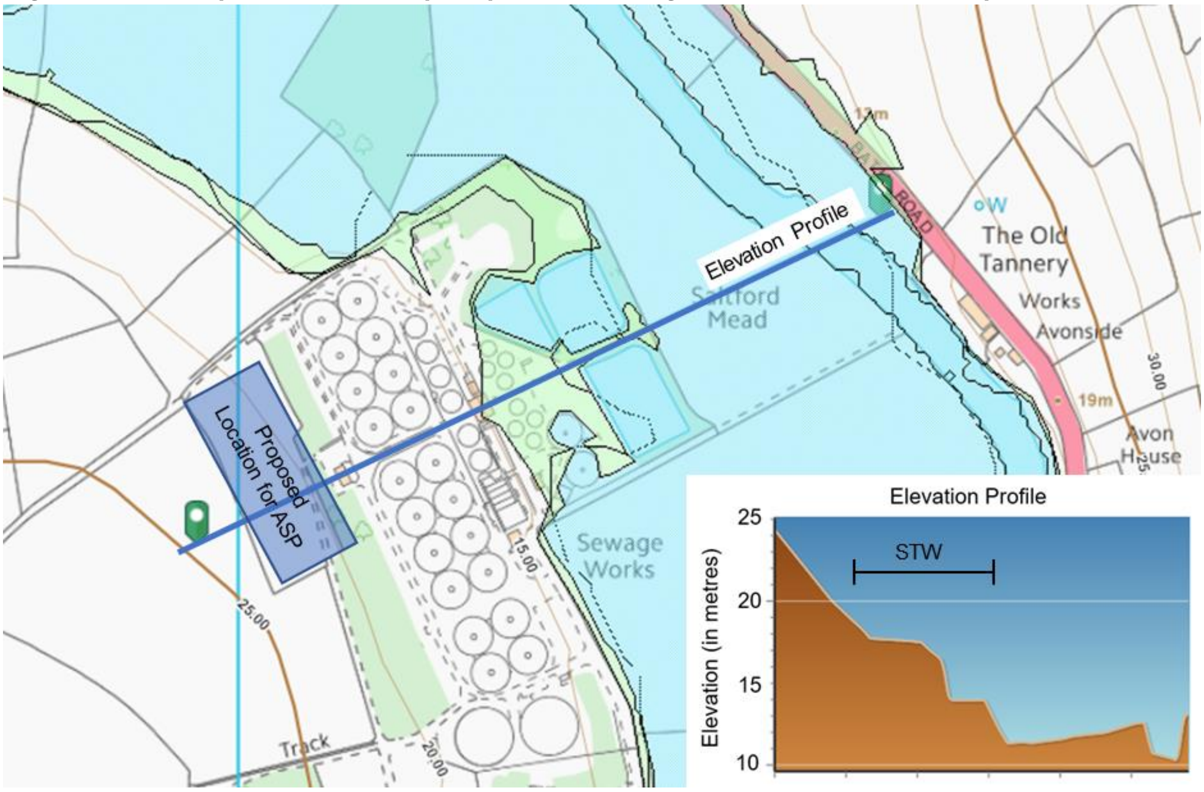
<u>Saltford (Bath) STW</u>

Our STW at Saltford serves a population equivalent of 118,271 and is our fourth largest STW. It is located just west of Bath, and is adjacent to a County Wildlife Site, with an Area of Outstanding Natural Beauty to the north, east and south and an SSSI to the west. The existing access to the site is poor, along a narrow road through the village of Saltford and past many listed old buildings. The topography of the “spare” land available on the site is elevated and sloping and generally not favourable for construction of the new treatment stream. The above factors all add to the cost for construction of the proposed new treatment stream required to provide the additional 154 l/s capacity at this STW. Details of the impact of these factors is included in Annex D and summarised below.

Access – A report from our Engineering & Construction team in 2018 concluded that it was not practical to plan construction of this major new treatment stream on the basis of using the existing access. This was the same conclusion that was reached in 2002 when the last major scheme (Bath CSO project) was constructed at the site. In the previous case a temporary access and temporary river crossing were constructed to provide access for the heavy vehicles and materials required for the construction project. In the current case we have taken a longer term and more strategic view and are planning to provide a permanent new access, including a new bridge across the river. This will help to secure access for potential further schemes in AMPs 8, 9 and beyond. Annex D summarises the appraisal of options that was carried out to identify an acceptable and cost-effective new access route. The cost of this new access has been estimated at £3.5 million, with this cost proportioned between our flow to full treatment, STW Growth and Capital Maintenance business plans. The cost attributed to the FFT driver is equivalent to the cost of providing a temporary access only.

Site Topography – Saltford STW is located at the edge of the flood plain of the Bristol Avon. The site is currently terraced, as shown in Figure 2-16, with the primary settlement tanks and an array of biological filters at ~17.3mAOD (above ordnance datum) and the humus settlement tanks at the lower end of the site at ~13.7mAOD. This lower portion of the site is subject to occasional flooding. The new extension to the site will be located to the south west of the current site to avoid building in the flood plain. As can be seen, building in this location requires significant excavation and groundworks, similar to the terracing historically undertaken at the site.

Figure 2-16: Site plan of Saltford (Bath) STW showing constraints to future expansion



Environment Agency Flood Zones:

Zone 3 – High Probability – Land having a 1 in 100 or greater annual probability of flooding

Zone 2 – Medium Probability – Land having between a 1 in 100 and 1 in 1,000 annual probability of flooding

Further details of the background and appraisal of this scheme are provided in Annex D. A summary comparison of the costs is given below.

Table 2-40: Treatment options at Saltford STW for the increased FFT WINEP driver

Option	New Activated Sludge treatment stream	New Secondary MBBR treatment stream	New Secondary biological filters treatment stream	New nitrifying MMBR tertiary treatment stage.
Provides treatment capacity	✓	✓	✓	✓
Meets new FFT permit	✓	✓	✓	×
Fits on existing site	✓	✓	×	✓
Utilises existing assets	✓	✓	✓	✓
Capex (£m)	22.20	23.51	Not feasible	Fails to provide hydraulic capacity
Opex (£k/yr)	600	668		
Lowest whole-life cost	✓	×	×	×

Operational Costs

As described in Section 3.5 of Supporting document 5.1, increases in permit FFT reduces the frequency of spills to storm tanks but results in the need for additional treatment capacity and increased hydraulic capacity at the STW. To meet our WINEP requirements, treatment processes have been appropriately designed to treat these additional flows, with an inherent ongoing operational cost. Also, at times of low flow, and particularly with small works, there is the need to provide sufficient recirculation flow to prevent media from drying out and adversely affecting biological treatment capabilities.

Opex estimates for the processes have been derived for each of our schemes. Actual operating costs are related to the specific processes on each site, which are required to meet site-specific sanitary and phosphorus permits.

With respect to our largest schemes at Avonmouth and Saltford STWs, the opex costs have been profiled as shown in Table 2-41.

Table 2-41: Additional opex for Avonmouth and Saltford STW FFT increase schemes

	Total Scheme Opex (£k/yr)	**Opex proportioned to U_IMP5**	**U_IMP5 Opex** (£k/yr)	**Forecast Completion Date**	**Opex in 2020-2025** (£k)
Avonmouth STW	778	95% (5% to growth)	739	Jan 2025	128
Saltford STW	600	95% (5% to growth)	570	Jan 2023	1,299

Operational costs are incurred from when a scheme is commissioned and operational. To benefit from efficiencies in construction and commissioning programmes, our IMP5 schemes are phased to be completed through AMP7.

To back-end load a programme so that all schemes become operational "just-in-time" to meet a common regulation date to minimise operational costs is impractical and inefficient. This approach would be subject to resource availability (e.g. labour) and incur significant additional capex costs, as well as putting permit compliance at risk due to programme slippages from construction risk realisation affecting the delivery profile.

2.7.3 Conclusion

Ofwat's flow to full treatment enhancement feeder model has deficiencies that make it unrepresentative of the true costs of the work to Wessex Water. This is due to the impact of one very large and one large scheme which have particular engineering challenges, and which, due to their size and particular characteristics, skew the results of the model against Wessex Water. Furthermore, no specific allowance for opex has been made, despite additional opex being integral to meeting these new environmental obligations.

We would request that, on the basis of the additional evidence provided above, the flow capacity increase costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

2.8 Storm storage capacity

This chapter should be read in conjunction with Chapter 3.5 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-42: Business plan table details for increasing storm tank capacity

Table	Lines	Line Description
WWS2	10 / 57	WINEP ~ Storage schemes at STWs to increase storm tank capacity

In this chapter we expand on our proposals for increasing storm tank in PR19. In the first section we comment on the feeder model. In the subsequent sections we provide evidence to further justify our costs for the sites requiring improvements. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our increasing flow to full treatment programme.

2.8.1 Ofwat's cost assessment

Ofwat's cost assessment for storm storage is based on their storm tank capacity enhancement feeder model. This capital expenditure model uses two independent explanatory variables: the number of separate schemes and the total additional storage volume provided. This provided a capex allowance of £20.9m compared to our business plan estimated capex cost of £26.6m; a reduction of 21.5%.

Two models were developed based on the explanatory variables:-

i) Model 1 – a single explanatory variable log model using storage volume
ii) Model 2 – a two explanatory variable log model using number of schemes and storage volume (which captures volume of required work as well as economies of scale).

The cost allowance was derived from a weighted triangulation, with a 25% model 1 / 75% model 2 weighting bias. Ofwat further explain that:-

> *"The weak element of the model is the significance of the In(schemes) coefficient. The significance is relatively low, although not very low. For that reason we triangulate the results with model 1, which is similar to model 2 except <u>it excludes the weak element of model 2</u> – the number of schemes. The 75:25 weighting in favour of model 2 reflects our judgement on the relative strength of the models."*

We consider there are deficiencies with this approach such that the model result does not properly reflect the true costs of work for Wessex Water. This is mainly reflected in the selection of the weighting criteria. We note that the critical p-value for storage volume is 0.0001. This contrasts with the critical p-value of 0.26 for number of schemes in model 2. We therefore consider that the low correlation of the number of schemes variable does not adequately explain economies of scale and is not improving the models, so therefore should be excluded.

It is not clear how one goes from a hypothesis that there are economies of scale at a scheme level – a very plausible hypothesis – to the functional form used by Ofwat in Model

2. We are unable to see how Model 2 is able to capture the existence or not of economies of scale at scheme level. Given the above, we query the justification provided by Ofwat to giving more weight to Model 2.

Additionally, Ofwat undertook a deep dive assessment on our storm tank capacity programme, which received four passes and one partial pass, as follows:

- Need for investment –pass
- Need for adjustment –pass
- Management control – pass
- Robustness and efficiency of costs – partial pass
- Customer protection – pass

Our plan only partially passed the "Robustness and efficiency of costs" assessment where Ofwat have stated that:-

> *"WSX engaged 5 different cost consultants to assess the efficiency of their costs. Across the enhancement programme WSX's costs were 17% lower than the consultant's mean and 23% below the consultants' median estimate. However, our own benchmarking analysis which takes account of economy of scale points shows that for this particular enhancement line WSX's costs are above the industry average."*

As previously mentioned, it is not clear how Ofwat's models do take account of economies of scale at site level, and that value of comparison of actual vs modelled costs is questionable when the quality of the models themselves is questionable. Our comparative assessment of the unit costs for all WaSCs based on the cost of providing additional storage, in £/m^3 of volume provided, is shown in Table 2-43 below. This shows that, contrary Ofwat's statement above, the our unit cost of £1,901/m^3 represents the industry's median value, and is lower (9.1%) than the industry mean average cost of £2,901/m^3.

Table 2-43: Comparative assessment of the unit costs for providing additional storage

Company	Capex £m	Storage m^3	Capex £/m^3
ANH	112.813	47,720	2,364
NES	0.947	266	3,560
NWT	69.384	60,364	1,149
SRN	128.590	52,475	2,450
SWB	15.341	5,229	2,934
TMS	30.596	34,232	894
WSH	5.731	4,935	1,161
WSX	**26.609**	**13,995**	**1,901**
YKY	46.214	26,472	1,746
SVE	3.249	3,108	1,046
HDD	0.076	20	3,800
		Mean cost:	**2,091**
		Median cost:	**1,901**

Ofwat have applied a further arbitrary reduction of 5% for efficiency savings on top of the modelled cost adjustment reduction, which does not appear to have any justification.

We provide below additional evidence showing our costs to be robust and efficient.

2.8.2 Robust and efficient costs

A representative sample of our storm capacity schemes have been externally assessed by consultants, as shown in Table 2-44. When considered at programme level, we consider this shows our costs to be robust and efficient, although we note that there is a range of costs between us and the two cost consultants at individual scheme level.

The pricing was based on the same schedules of work. By interrogating the estimates, we attribute some of the differences to be due to lack of knowledge on the specific sites in question, in particular reduced allowances for temporary overpumping and commissioning requirements.

Table 2-44: External benchmarking of construction values of storm storage schemes

Site Name	Permit Storage Volume (m^3)	Required Storage Volume (m^3)	Wessex Water (£k)	External Cost Consultant 1 (£k)	External Cost Consultant 2 (£k)
Gillingham	581	1,267	937.8	921.7	695.8
Ringwood	961	1,136	1,026.7	763.4	674.8
Marnhull Common	300	400	700.3	526.3	450.5
Milverton	-	111	470.6	432.6	408.3
Yeovil (Pen Mill)	2,662	3,392	1,619.0	2,130.1	1,647.2
Holdenhurst	19,000	30,000	6,113.6	6,150.7	6,854.0
Total:			10,868.0	10,924.8	10,730.7
Programme difference:			-	+0.5%	-1.3%

Design, project management and risk have been benchmarked as a separate exercise, as detailed in Supporting document 8.11.

2.8.3 Customer Protection

Five of our schemes were identified as being ‘amber’ certainty in WINEP3. Since the issue of WINEP3, storm storage requirements have been finalised and now all of Wessex Water’s storm schemes are identified as being ‘green’.

2.8.4 Conclusion

Ofwat’s storm tank capacity enhancement feeder model has deficiencies that make it unrepresentative of the true costs of the work to Wessex Water. We consider that the low correlation of the number of schemes variable does not adequately explain economies of scale. We cannot find justification for how the log functional form that includes this variable can, even in theory, capture scheme-level economies of scale.

We would request that, on the basis of the additional evidence provided above, Ofwat revise their modelling approach such that capex allowances are set with reference to Ofwat's estimates from their Model 1 alone.

2.9 Flow monitoring

This chapter should be read in conjunction with Chapter 3.5 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-45: Business plan table details for flow monitoring

Table	Lines	Line Description
WWS2	7 / 54	WINEP ~ Flow monitoring at sewage treatment works

In this chapter we expand on our proposals for flow monitoring in PR19. In the first section we comment on the feeder model, and clarify the number of our sites requiring flow monitoring improvements and confirm our allocation of flow monitoring investigations to this driver line. In the subsequent sections we provide evidence to further justify our proposed costs, and explain how we have undertaken a detailed review of scope of works and individual site-specific requirements in the build up of our proposals. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our increasing flow to full treatment programme.

2.9.1 Ofwat's cost assessment

Ofwat's cost assessment for flow monitoring at STWs is based on their flow monitoring enhancement feeder model. This provided a capex allowance of £3.2m compared to our business plan estimated capex cost of £14.6m; a reduction of 78.1%.

Ofwat's initial review of business plans has identified our submission for the U_MON4 FFT flow monitoring driver as being greater than the industry median cost. Ofwat's assessment for U_MON4 permit FFT being:

> *"We assess the investment for this line using the median value from a unit cost model of capex requested for the reported number of monitors for flow monitoring at STWs. The model provides an allowance per company based on the median unit cost."*

For Wessex Water they also state:

> "*Highest unit cost. Significantly above UQ. Concerns that their number of schemes is incorrect."*

We confirm that our number of improvement schemes to meet the U_MON4 requirements is 63, as stated in our original plan submission, although we have also included the costs of U_INV2 investigations against this driver. We do not have full sight of other water company proposals to verify, or otherwise, the allocation of their U_INV2 investigations, which would detrimentally skew the modelling.

As commented above, the median cost would be significantly downward skewed by companies including their number of investigations as well as their number of improvements. Using the median cost of all company submissions of £50.1k per scheme does not take due consideration of whether they are an improvement or an investigation, or the scale/extent of any improvements.

Following receipt of Ofwat's IAP challenge we have explored further the reasons for our comparatively high unit cost compared to other companies.

Our scope of works has been identified from detailed site investigations at a representative sample of 60% of the 48 STWs needing works required to obtain full MCerts certification for permit FFT assessment. In many cases it involves major modifications to inlet structures, diversion of return flows, additional pumping stations, and installation of new flow measurement instruments. These elements of work are costly and, as a result, our average cost is £231.0k per installation. For Poole STW it is estimated that £1.5m will be required to obtain MCerts certification for FFT assessment. This is due to the need to divert and pump multiple return flows and the need to measure these return flows, as described further below.

In AMP4 there was a requirement to install MCerts flow measurement at STWs to measure daily flows. This was installed to report daily total flows rather than to confirm instantaneous permit FFT compliance as required by the current AMP7 U_MON4 flow driver. In adopting the most cost-effective solutions, we installed the flow measurement solutions at the inlet works only where significant and expensive construction and modification would not be required. Where inlet installations would have involved major works it was decided to install flow meters at the works outlet, which was a lower cost alternative. The AMP7 U_MON4 requirement to accurately measure and control FFT is driving a re-location of many of these outlet flow monitoring installations to the inlet works. In most cases this requires the significant and costly re-engineering works which we had previously sought to avoid. We do not have sight of the detailed proposals from other companies, but there is the real potential that some may have relocated more of their installations in AMP4, and incurred the expensive re-engineering costs at that time.

The UKWIR flow project 18/WW/21/17 considered the potential to use existing outlet MCerts flow meters. This investigation concluded that it may be possible to use outlet flow meters but further work would be required to confirm this. It did confirm that where there are inter-stage pumping, intermittent discharges or other flow controls within the process stream on site that the <u>existing outlet flow measurement would not be acceptable</u> for the confirmation of permit FFT compliance. As a result, we have identified 63 flow measurement installations that will be required at the STW inlet or last in line permit FFT controlling sewerage pumping station during the AMP7 period. There are an additional 165 schemes which will be investigated (under the U_INV2 driver) to determine whether they can be used for flow measurement for permit FFT compliance assessment, or whether a new MCerts flow measurement installation will be needed at the works inlet in AMP8.

We understand some water companies have installed inlet flow measurement in AMP6 as part of a Flow4 driver. The EA has stated that these Flow4 driver installations could be used for U_MON4 permit FFT compliance. By including these U_MON4 sites in the WINEP but with nominal or no associated cost, this effectively reduces the average installation cost for some water companies significantly lower than those where new installations are required at every site.

The estimated cost for the U_MON4 FFT driver installations within our business plan range from £26k to £1.6m. The cheaper installations being for the "last in line overflow" at sewage pumping stations which control the full flow to treatment. We have identified 15 flow meters under this category. These will require the installation of a flow measurement device within a chamber on the pumping station rising main, cable ducts and cabling, power supply to the flow unit, telemetry and updating of individual site SCADA systems, MCerts certification and documentation for EA permitting applications.

Table 2-46: Range of options and costs for delivering U_MON4 and U_INV2 drivers

	Number of STWs	Cost Range £m	Average Capex £m	Total Capex £m
Investigations:				
U_INV2 MCerts investigations	165	-	0.002	0.330
Improvements:				
Terminal SPS last in line overflow	15	-	0.026	0.383
STWs requiring installation of MCerts flow measurement within an existing inlet structure only.	0	-	-	0
STWs requiring diversion of return flows as well as inlet flow measurement.	29	0.025 to 0.250	0.153	4.437
STWs requiring a combination of inlet flow measurement, new pumping stations, inlet channels and flumes, and diversion of return flows using pumping stations etc.	19	0.266 to 1.585	0.495	9.405
Investigations (U_INV2)	**165**	**-**	**0.002**	**0.330**
Improvements (U_MON4)	**63**	**-**	**0.226**	**14.225**

The above table shows the wide variety in the average costs of schemes, depending on what options is being applied to them. In the following section we provide evidence to further justify our costs for the sites requiring improvements. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our phosphorus removal programme.

2.9.2 Robust and efficient costs

The installation of inlet flow measurement is a PR19 WINEP requirement with driver U_MON4. This is required to confirm FFT (flow to full treatment) flow compliance for each sewage treatment works (STW) with a permit FFT, and for last in line sewage pumping stations controlling FFT. All FFT flow controls will be assessed using certified MCerts flow measurement to a required accuracy of ±8%, with flow measurement installed as close as possible to the storm overflow. To obtain an MCerts certificate the flow measurement needs to comply with British Standard BS3680 4c, and have no flows returned upstream of the flow measurement device. It will be certified by independent assessors. If any return flows are discharged upstream of the MCerts FFT flow meter, then these will need either to be relocated so that the discharge is downstream, or the flows will need to be measured by an additional MCerts certified flow meter. Our proposals include for full compliance with MCerts requirements.

Our business plan has identified 63 new installations for MCerts flow measurement where the existing flow measurement will not be capable of complying with EA MCerts requirements for permit FFT assessment. These are all included as green lines in the WINEP. An additional 165 existing flow measurement installations located at STWs inlets and outlets will be investigated during AMP7 to determine whether they can be used for permit FFT compliance assessment. Again, these are included in the EA WINEP as green, and are identified with a U_INV2 flow driver.

<u>Capital Costs</u>

The recent UKWIR report ref: 18/WW/21/17 states that the installation of MCerts flow monitors at treatment works inlets would be very expensive, an extract from this report states: -

> ***4.3.5.2 Cost of meeting EA requirements for FFT monitoring (Q2.6)***
> *Costs of meeting future EA requirements for FFT monitoring could be very large – one company reported an estimated cost of £300million. Four other companies estimated costs ranging from £11m to £45m.*
> *Two other companies indicated that this would be a major expenditure, although they did not yet have a numerical estimate.*
> *Nine respondents (including some who had not commented on the likely magnitude of the expenditure) commented on what they expected to be the principal sources of cost of meeting future EA requirements for FFT monitoring. The consensus from the survey results (reinforcing comments made by Steering Group members at the project startup meeting) is that re-engineering WwTW inlet works civil structures would be the biggest expense; all nine respondents mentioned this as a major factor. New flow meters, new pumping stations, and relocation of liquor returns, were also noted as factors although flow meter equipment is recognised to be a much smaller expense than (say) rebuilding a flow measurement structure.*

Table 2-47 on the following pages provides a breakdown of cost and works required for a sample of MCerts flow installations, to meet the WINEP U_MON4 requirements and to obtain independent MCerts certification. It is noted that there are significant variations in costs between STWs, which are a result of site-specific requirements. There are a few installations that have a relatively high cost, namely Gillingham, Dorchester and Poole. These installations are more complex and involve multiple flow streams with return flows that need to be diverted or independently measured. All of these are required to enable flow measurement within ±8% accuracy. Further details of these are presented below.

Table 2-47: Sample of scope of works and costs for meeting MCerts requirements

STW Name	Permit FFT L/s	M&E £m	Civil £m	Design, PM, Overheads £m	Total £m	Scope of works
Bourton	6.8	0.022	0.151	0.016	0.189	FFT and Storm measurement flumes, flow meters, power and telemetry, over pumping temp works.
Chideock	10.0	0.014	0.136	0.014	0.164	Flume, flow meter, power and telemetry, over pumping temp works.
Corfe Castle	12.0	0.015	0.124	0.013	0.152	Magflow with washout, diversion of return flows, power and telemetry, over pumping temp works.
Cranborne	9.1	0.102	0.291	0.034	0.427	Magflow meter, pumping station and rising main for humus return flows, mains power to STW (200m) as none on site presently.
Dorchester	195.0	0.163	0.599	0.095	0.857	Two inlets on site. Need to combine flows, new flow meter, pumping station and rising main with flow monitor for return flows, move ferric dosing point, power and telemetry, over pumping temp works. See below for more details and site plan.
Fovant	10.6	0.012	0.151	0.016	0.179	New flume with flow meter, power and telemetry, over pumping required for construction of new flume.
Gaunts Common	6.0	0.101	0.262	0.031	0.394	Magflow meter on rising main, diversion of return flows requires pumping station and rising main, power and telemetry, over pumping temp works.
Gillingham	76.0	0.100	0.298	0.035	0.433	Inlet pumping station with magflow meter, rising main, emergency high level overflow, power and telemetry. See below for more details and site plan.
Holt	7.3	0.111	0.236	0.029	0.376	New pumping station and rising main and flow meter, storm flow meter to deduct from total flows, power and telemetry, over pumping temp works.
Holwell	2.8	0.011	0.132	0.014	0.157	New inlet channel required with flume and storm overflow with flow meter, telemetry and over pumping temp works.

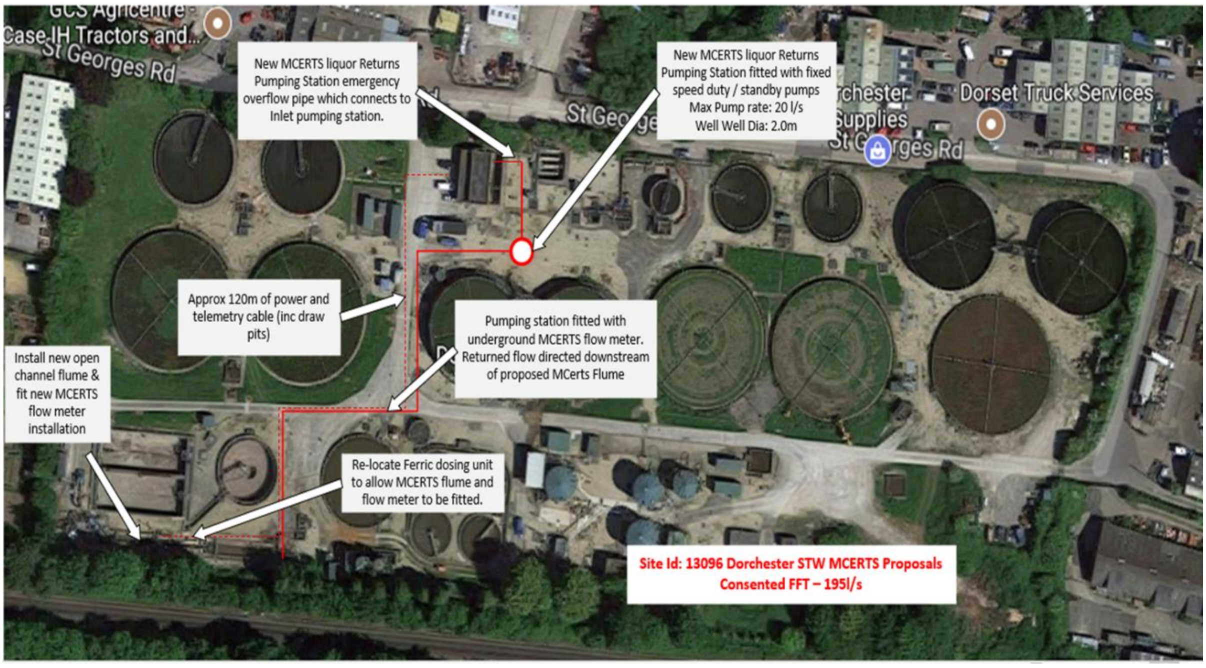
STW Name	Permit FFT L/s	M&E £m	Civil £m	Design, PM, Overheads £m	Total £m	Scope of works
Lytchett Minster	55.0	0.019	0.068	0.008	0.095	Two flow meters, cabling and cable ducts, power supply and telemetry.
Maiden Newton	11.0	0.029	0.220	0.024	0.273	Raise inlet to install flow measurement flume on FFT and storm flows, raise balancing tank height, power and telemetry, over pumping during construction.
Mere	24.6	0.012	0.172	0.018	0.202	New flume and flow meter, diversion of return flows, power and telemetry, over pumping temp works.
Milborne St Andrew	37.0	0.102	0.233	0.028	0.363	New flume and flow meter, separate out storm flows and return liquors by new pumping station, power and telemetry, over pumping temp works.
Poole	1,220.0	0.320	1.066	0.200	1.586	Multiple overflow, drainage, recycled and backwash flows (from 16 sources) to be collected and diverted, pumping stations and rising mains, inlet flow meter and flow meters on proposed rising mains, power and telemetry, over pumping temp works. See below for more details and site plan.
Toller Porcorum	4.03	0.022	0.144	0.016	0.182	Magflow on remote pumping station, flume and measurement on storm flow line, power and telemetry, tankering and over pumping temp works during construction.
Weymouth	900.0	0.018	0.285	0.030	0.333	Multiple return flows, new inlet flow measurement, power and telemetry, over pumping temp works.

Dorchester STW

There are two inlets to this treatment works as flows enter the works in two separate locations. To measure and control FFT flows the inlet flows need to be combined and measured downstream of the existing inlet screens, all return flows also need to be separately measured and deducted from the proposed inlet flow meter. The work required to provide MCerts FFT flow assessment at this treatment works includes: -

- Installation of flow measurement downstream of screens, includes a new flow measurement flume and ultrasonic flow meter.
- Collection of return liquor flows, new pumping station, rising main and flow measurement.
- Diversion of phosphorus dosing point.
- Power supply and telemetry cabling and ducts
- MCerts certification for permit FFT assessment.
- Update of SCADA system.
- Amendment of schematics to identify flow measurement locations within the MCerts certification documentation.

Figure 2-17: Dorchester STW MCerts



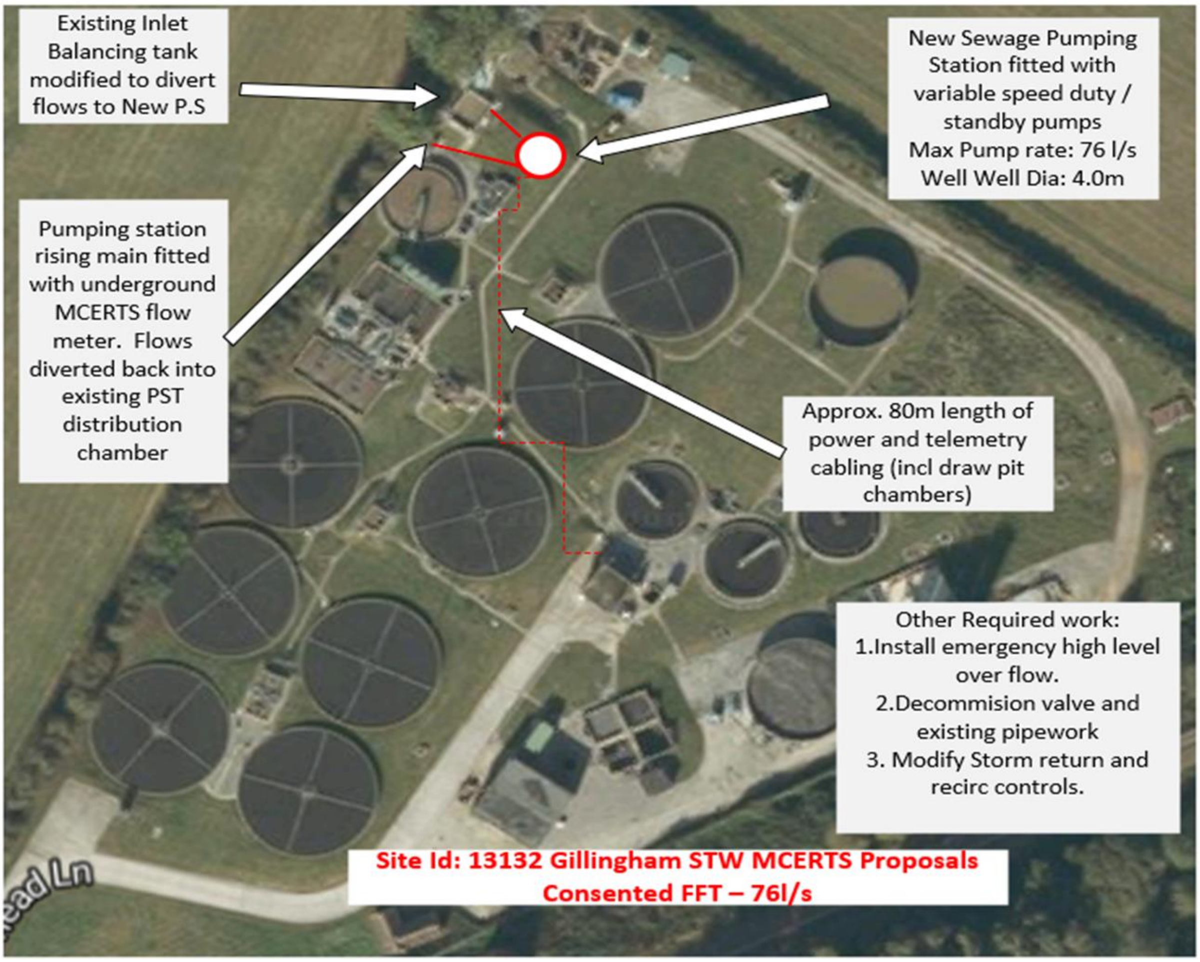
The existing MCerts installation was installed at the works outlet due to there being two separate inlets, pumped flows, hydraulic backing up of channels and other process equipment being in the way of the installation.

Gillingham STW

The proposed solution is to build an inlet pumping station so that FFT flows can be measured using a magflow meter on the proposed rising main, the works required include: -

- New inlet pumping station (76L/s) with variable speed pumps and rising main.
- Installation of magflow meter on rising main to measure FFT flows.
- Emergency high level overflow on proposed pumping station and pipeline to primary tank distribution chamber to ensure hydraulic security.
- Storm return and recirculation flow control.
- MCerts certification for permit FFT assessment.
- Update of SCADA system.
- Amendment of schematics to identify flow measurement locations within the MCerts certification documentation.

Figure 2-18: Gillingham STW MCerts

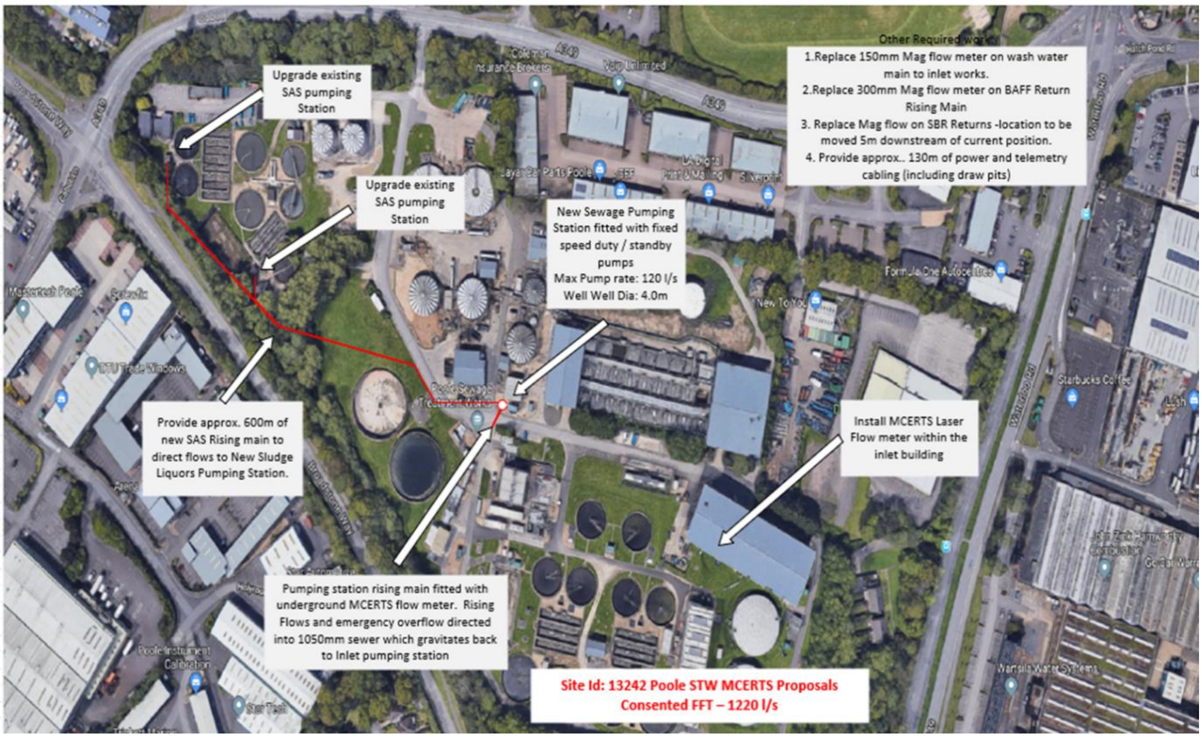


Poole STW

The existing outlet flow measurement installation does not comply with the permit FFT MCerts requirements as flows are presently returned upstream of all potential locations for an inlet flow measurement device. This treatment works has multiple treatment process streams and each of these will require the diversion of return flows, the solutions identified include new pumping stations to divert flows and flow measurement of each return flow. The return flows that need to be intercepted and diverted, and additional works include: -

- Installation of new laser flow meter within the inlet flow channel.
- Western treatment stream SAS returns – 2nr SAS pumping stations (two streams), rising mains and flow measurement.
- Demon plant – installation of flow measurement of return flows
- Storm return flows – installation of flow measurement of return flows
- Sludge liquor returns – pumping station, rising main and flow measurement.
- Flow measurement for Densadegs, Biofor and transfer pumping station return flows.
- Temporary over pumping during construction.
- MCerts certification for permit FFT assessment.
- Update of SCADA system.
- Amendment of schematics to identify flow measurement locations within the MCerts certification documentation.

Figure 2-19: Poole STW MCerts



The existing MCerts flow meter was installed at the works outlet due to the complexity and number of return flows being passed back to the works inlet pumping station. As identified above the cost to divert and measure these flows was excessive for the requirement to only enable the measurement of daily flows. Measurement of FFT flows was not a requirement in the AMP4 flow measurement driver scheme.

A summary of our costs for each of the 63 schemes, to comply with the WINEP U_MON4 driver requirements is listed in Table 2-48. This demonstrates the variety of what is behind each scheme, and highlights deficiencies if an average unit cost model were used.

Table 2-48: U_MON4 schemes and costs

Location	Permit FFT L/s	Total Estimate £m	
All Cannings – Horton SPS	5.6	0.026	
All Cannings SPS	8.5	0.026	
Bishops Lydeard STW	28.0	0.358	
Bradford on Tone STW	17.0	0.173	
Brinkworth STW	7.8	0.173	
Broadway STW	10.0	0.173	
Chideock STW	10.0	0.164	
Collingbourne Ducis SPS	20.0	0.026	
Compton Bassett STW	17.5	0.358	
Corfe Castle STW	12.0	0.152	
Cranborne STW	9.1	0.427	
Cranmore STW	6.0	0.173	
Cromhall – Jubilee Lane SPS	12.0	0.026	
Crowcombe STW	3.1	0.173	
Dorchester Louds Mill STW	294.0	0.857	See above for work items
Draycott STW	7.9	0.358	
Erlestoke STW	7.0	0.173	
Fordingbridge STW	79.2	0.255	
Fovant STW	10.6	0.179	
Gaunts Common STW	6.0	0.394	
Gillingham STW	76.0	0.433	See above for work items
Glastonbury STW	160.0	0.858	
Great Wishford STW	17.7	0.358	
Hardington Manderville STW	7.5	0.173	
Holt STW	7.3	0.376	
Holwell STW	2.8	0.157	
Hornsey Bridge – West Camel SPS	3.5	0.026	
Hornsey Bridge – Marston Magna SPS	4.0	0.026	
Hornsey Bridge – Yeovilton SPS	5.0	0.026	
Hurdcott STW	38.9	0.173	
Ilton STW	15.0	0.031	
Kilve STW	7.4	0.133	
Lavington Woodbridge STW	31.0	0.173	
Luckington STW	3.4	0.173	
Lytchet Minster STW	55.5	0.095	

Location	Permit FFT L/s	Total Estimate £m	
Maiden Newton STW	11.0	0.273	
Milborne St Andrew STW	37.0	0.363	
Nether Stowey STW	26.7	0.133	
North Petherton STW	31.0	0.173	
Palmersford STW	452.0	0.358	
Pewsey STW	50.8	0.536	
Poole STW	1,220.0	1.586	See above for work items
Porlock STW	21.7	0.051	
Rode STW	6.1	0.358	
Sherston STW	7.3	0.358	
Shroton SPS	9.6	0.026	
Stanton Drew STW	11.0	0.173	
Stourton Caundle STW	2.6	0.173	
Studland – Wadmore Lane SPS	11.0	0.026	
Sturminster Newton STW	39.0	0.026	
Tetbury STW	48.6	0.026	
Toller Porcorum STW	4.03	0.182	
Wanstrow SPS	7.0	0.026	
Wareham STW	96.5	0.460	
Wellington STW	153.0	0.173	
Weston super Mare STW	1,050.0	0.255	
Weymouth STW	900.0	0.333	
West Huntspill – Sloway Lane SPS	130.0	0.026	
Wool – Bovington Terminal SPS	55.0	0.026	
Wool – East Burton SPS	22.0	0.026	
Wool – East Knighton SPS	11.0	0.026	
Wool – West Lulworth SPS	15.9	0.026	
Wrington STW	32.0	0.173	
U_INV2 investigations		*0.330*	
Total		**14.555**	

Operational Costs

All of the 63 sites identified for improvement under the U_MON4 flow monitoring driver have existing MCerts certified flow meters. In the cases where these are being replaced by individual flow meters at the front-end there will not be any additional operational costs for the monitors themselves and, as such, we are not requesting additional opex for these schemes. However, sites requiring additional monitoring will require opex to ensure the additional meters are correctly calibrated and certified, and sites with new pumping arrangements will also require opex.

2.9.3 Conclusion

Ofwat's flow monitoring enhancement feeder model has deficiencies that make it unrepresentative of the true costs of the work to Wessex Water. We have clarified the number of our sites requiring flow monitoring improvements and confirm our allocation of flow monitoring investigations to this driver line. Other companies may not have adopted this approach and thus detrimentally skewed any average unit costs from the model.

We consider a cost allowance based purely on the industry average costs is not an appropriate approach. A detailed review of scope of works and individual site-specific requirements are needed to determine the true costs of service provision. Our scope of works have been identified from detailed site investigations of the works required to obtain full MCerts certification for permit FFT assessment.

Furthermore, no specific allowance for opex has been made, despite additional opex being integral to meet these new environmental obligations. Our opex submission for this driver is for additional opex incurred over and above that needed to meet existing flow monitoring obligations.

We would request that, on the basis of the additional evidence provided above, the flow measurement costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

2.10 Event duration monitoring

This chapter should be read in conjunction with Chapter 3.5 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 2-49: Business plan table details EDMs at STWs

Table	Lines	Line Description
WWS2	6 / 53	WINEP ~ Event Duration Monitoring at intermittent discharges

In this chapter we expand on our proposals for event duration monitoring in PR19. In the first section we comment on the feeder model and query some costs presented by other companies, including some as being clearly insufficient to meet the scope of works required. In the subsequent sections we provide evidence to further justify our proposed costs, and explain how we have undertaken a detailed review of scope of works and individual site-specific requirements in the build up of our proposals.

2.10.1 Ofwat's cost assessment

There are two Environment Agency drivers for Event Duration Monitors (EDMs):

- U_MON1 – 307 EDMs on overflows to the environment are included in AMP7 WINEP for monitoring spills to the environment from network CSOs and from STW storm tanks (See Section 3.1)
- U_MON3 – 228 EDMs on STW overflow and last in line overflows used to control FFT.

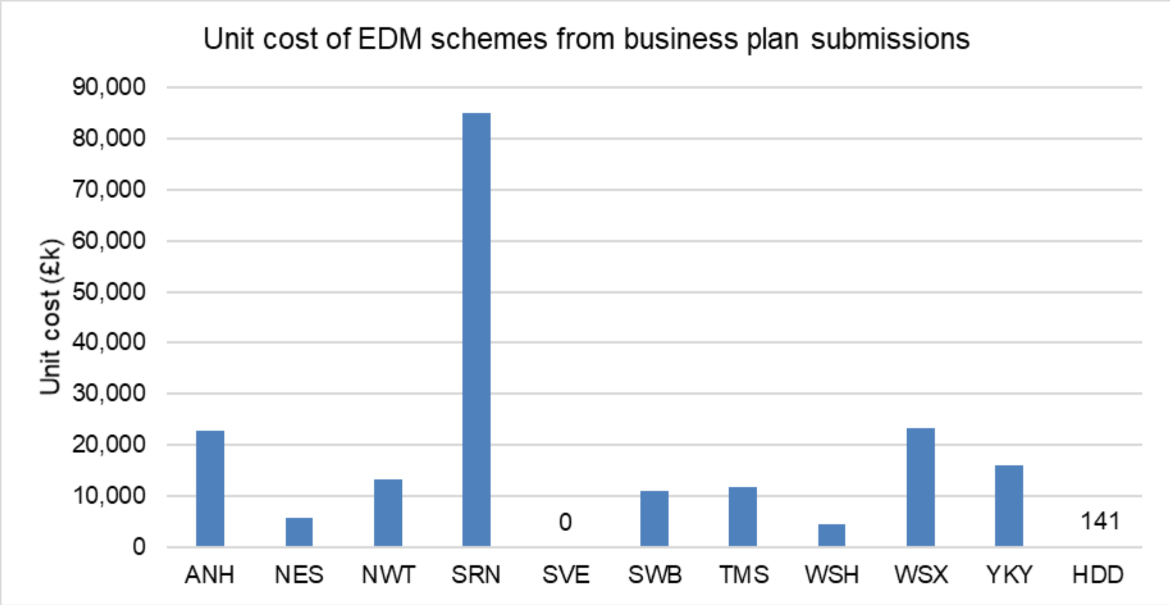
Under the U_MON3 driver, we propose to install 228 EDMs at our STWs or last in line overflows that are used to control permit Flow to Full Treatment (FFT); these are required to support the PR19 U_MON4 FFT flow measurement driver.

Ofwat's IAP review of business plans has identified our submission for EDMs as being greater than the industry median capex, so Ofwat's proposal is to allow only 54% of the capex included in our PR19 business plan. Ofwat's assessment for EDMs being:-

> *"We assess investment for this line using the median unit capex value calculated from the capex requested for the reported number of intermittent discharge sites with event duration monitoring. Where a company's requested investment level is less than the median unit cost we use the company's business plan costs."*

As shown in Figure 2-20, there is a significant variation in unit costs from business plan submissions (and updated following subsequent clarifications with Ofwat to inform the models).

Figure 2-20: Unit costs of U_MON1 and U_MON3 EDM schemes



The median cost of all company submissions is £12,548 per installation, with the average mean cost being £15,357. We note that the cost per installation for one company (HDD) are clearly insufficient at £141 per installation; this either requires further investigation or removal from this assessment. The costs per installation for NES and WSH are also low and we query their scope of works proposed; similarly the cost for SRN is excessive although if the Ofwat assessment of number of installations required is correct then the cost per installation for SRN would reduce to £13,473.

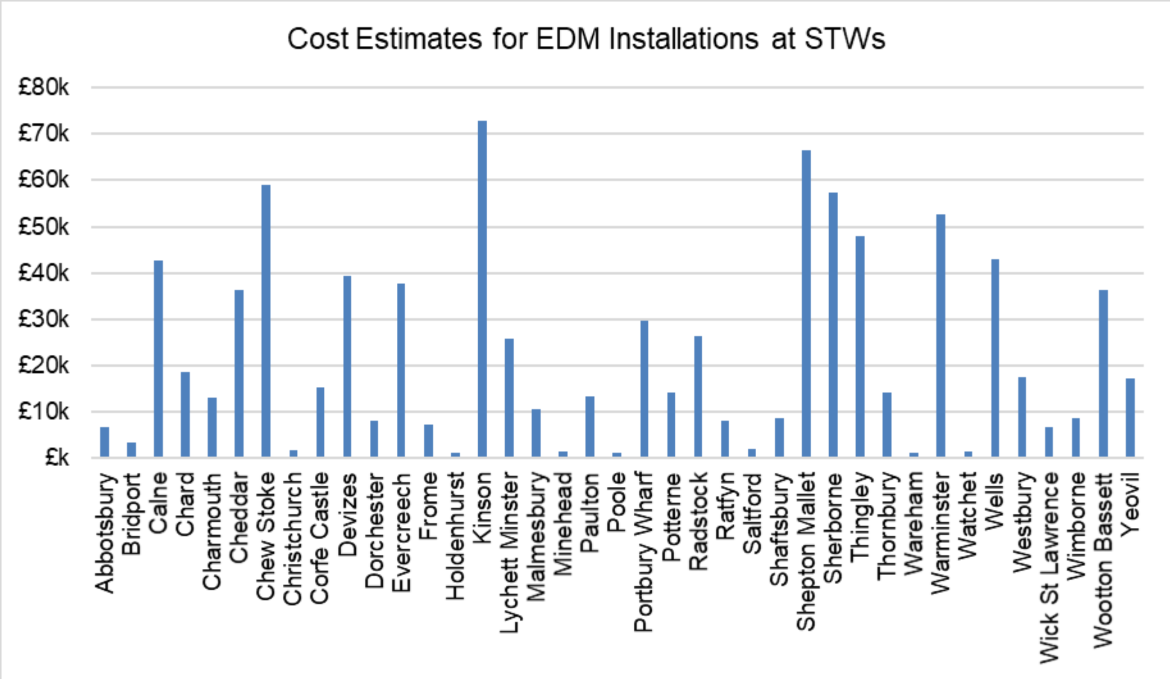
As part of our costs we have included Environment Agency permit application costs at £1.96m within the U_MON1 and U_MON3 drivers; reporting software for confirming FFT compliance is also included at £0.114m. These costs are additional to the installation of the EDM requirement and need to be allowed within Ofwat's assessment, removing these from our costs would result in an average cost of £19,518 per installation. We are uncertain which companies included the additional costs of permit applications for the new EDMs against this driver.

2.10.2 Robust and efficient costs

For the EDMs installed in the network during AMP6 we have been using battery power packs with spill data transmitted over the mobile network. We have experienced reliability issues with these wireless instruments, however the cost to install wired power or telemetry connections would be prohibitive. Our proposal is to continue this approach for network EDMs (U_MON1), however for EDMs located at STWs (U_MON3) we propose to hardwire the instruments given the reliability concerns, particularly as these monitors will be used to confirm FFT compliance.

Specific costings were undertaken for 39 STWs as a representative sample of the 228 STWs requiring EDM installations, as summarised in Figure 2-21.

Figure 2-21: Cost estimate for sample of EDM installations



The following paragraphs provide a summary of the works required for some of the sites identified above, covering the range in costs.

Shepton Mallet STW: *(£66.7k)*

- Telemetry outstation – No upgrades required. Use existing available spare inputs on the main Telemetry PLC and software programming.
- Spill to Storm tanks on the inlet channel –
  - After the Screens – New ultrasonic instrument
  - After the Control Penstocks – New ultrasonic instrument

  Both instruments to be cabled back to the main Telemetry Building. New cable ducts and cable containment, with cables run along tray onside of inlet channel to link the above two instruments (c.50m).
- Spill to river from the Storm tanks – Existing unit, re-commissioning only.

Chew Stoke STW: *(£59.0k)*

- Telemetry outstation – Expand the existing outstation analogue input card to an eight channel and wire to conditioning terminals
- Spill to Storm tanks on the inlet channel after the Screens – New ultrasonic instrument, to be cabled back to the Screen MCC kiosk, PLC and to use available spare inputs. Use existing cable containment.
- Spill from Storm tanks No.1-3 to river – New ultrasonic instruments required for each tank, to be cabled back to the Main MCC, PLC and to use available spare inputs. New cable ducts and cable containment.
- Spill from Storm tanks No.4-6 to river and Spill to the River from the “Final Storm to River” outlet chamber – New ultrasonic instruments required for each tank and chamber, to be cabled back to the Telemetry building. New cable ducts and cable containment.

Radstock STW: *(£26.2k)*

- Telemetry outstation – Additional input card to be installed into the Telemetry PLC and software programming
- Spill to the Storm tanks after the Screen – New ultrasonic instrument, to be cabled back to the Inlet Building. Use existing cable containment.
- Spill to the river from the Storm Tanks – New ultrasonic instrument, to be cabled back to the Inlet building. New cable ducts and cable containment.

Chard STW: *(£18.4k)*

- Telemetry outstation – No upgrade required.
- Spill to the Storm tanks after the inlet channel Screens – New ultrasonic instrument, to be cabled back to the Inlet MCC. Use existing cable ducts, with small amount of tray work..
- Spill to river – Existing ultrasonic, no work required.

Holdenhurst STW: *(£0.9k)*

- Telemetry outstation – No upgrade required.
- Inlet spill to Storm – Existing ultrasonic, digital alarm only wired on channels A and B.
- Spill to river – Existing ultrasonic, no work required.

Poole STW: *(£0.9k)*

- Telemetry outstation – No upgrade required.
- Existing spill to Storm – Existing ultrasonic, no work required
- Storm spill to harbour – Existing ultrasonic, no work required
- Site flow to harbour – Existing, flow meter, no work required.

The costs above also include for commissioning and updating site record drawings and documentation. For those STWs that we have not specifically reviewed we have made a cost allowance for surveys to establish the most appropriate location for the EDMs.

<u>Permit Applications</u>

We have liaised with the EA to obtain a robust estimate for our permit application costs. Where there is the need to make permit changes as a result of another enhancement driver on the site, we have sought to align delivery dates and rationalise permit costs. The total number of EDMs to be installed is 535, which relates to 480 individual permit applications.

2.10.3 Conclusion

Ofwat's event duration monitoring enhancement feeder model has deficiencies that make it unrepresentative of the true costs of the work to Wessex Water. We query some of the costs submitted by other companies, calling into question the robustness of the model. It is not clear whether or not other companies have included the Environment Agency permit fee costs, which make up 15.8% of our capex costs.

We would request that, on the basis of the additional evidence provided above, the event duration monitoring costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

3. Improving river water quality – intermittent discharges

3.1 Event duration monitoring

This chapter should be read in conjunction with Chapter 4.1 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 3-1: Business plan table details for EDMs in the network

Table	Lines	Line Description
WWS2	6/53	Event duration monitoring

There are two Environment Agency drivers for Event Duration Monitors (EDMs):

- U_MON1 – 307 EDMs on overflows to the environment are included in AMP7 WINEP for monitoring spills to the environment from network CSOs and from STW storm tanks
- U_MON3 – 228 EDMs on STW overflow and last in line overflows used to control Flow to Full Treatment (See section 2.10).

Ofwat's IAP model combined both EDM spilling to the environment (U_MON1) and spilling into storm tanks (U_MON3) together into one model. The 535 EDMs on the WINEP include both drivers. Please see Section 2.10 above for the combined response.

3.2 Frequent spilling overflows

This chapter should be read in conjunction with Chapter 4.1 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 3-2: Business plan table details for improving frequently spilling overflows

Table	Lines	Line Description
WWS2	11/58	Storage schemes in the network to reduce spill frequency

In this chapter we expand on our proposals for improvement to frequent spilling overflows (FSO) in PR19. In the first section we comment on the feeder model, noting our programme for improving FSOs has the largest number of improvements compared to other companies, but the model does not consider economies of scales at individual site level. We also confirm our inclusion of FSO investigations against this driver and recommend that the costs are reviewed and modelled separately to better reflect the extent (and scale) of investigations and improvements. In the subsequent sections we provide evidence to further justify our costs for the sites requiring improvements.

3.2.1 Ofwat's cost assessment

Ofwat's IAP model is based on company requested capex and volume of storage each company is planning to construct at overflows. However, these line definitions include drivers other than frequent spilling overflows (as was correctly noted in Welsh Waters submission). Other WaSC programmes are less clearly documented, so detail cannot be understood. Wessex Waters costs include one overflow improvement that is not a FSO.

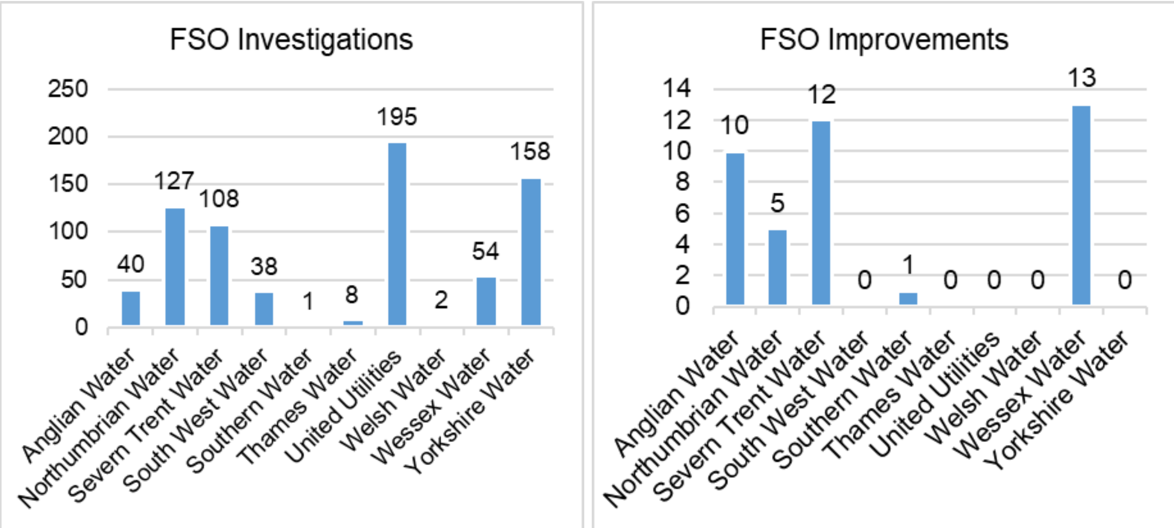
The Ofwat model does not take into account economies of scale at the level of individual sites, which is where one might think there could be economies of scale, especially given that the metric is measure of volume. Our programme for improving FSOs has the largest number of improvements (13), whereas other companies have very low number of improvement schemes. For example, Northumbrian Water stated in Table WWS2 that they propose to make five improvements providing c10,000m^3. We included 13 schemes to provide the same volume.

By way of reinforcing the need to consider economies of scale at site level in the models, we make mention of our proposals to provide additional storm storage at Holdenhurst STW under the WWS2 'WINEP ~ Storage schemes at STWs to increase storm tank capacity' driver (refer to Section 2.8). We have construction cost estimates for providing an additional storage of 11,000m^3 at Holdenhurst STW in the range £6.1-6.8m (refer to Table 2-44). Our internal cost estimate to deliver the total scheme (including design, third party, project management and risk) is £9.4m, which would be under Ofwat's allowance. If we only had 5 schemes to deliver the cost would be nearer the modelled £18m but because we are delivering 13 small schemes, we appear expensive due to the dis-economies of scale.

We also note that the Thames Water tideway project is not included in this unit rate analysis, presumably due to the different scale of their multibillion pound project.

Costs for both improvements and investigations have been included in our FSO programme, with the number of schemes shown in Figure 3-1, as identified in the WINEP. These numbers differ from Ofwat's own assessment of the number of sites in network at which new or additional storage is provided, as this line definition includes drivers other than frequent spilling overflows and also providing new or additional storage capacity is not necessarily the solution to meeting the WINEP FSO specific improvement requirement.

Figure 3-1: Number of FSO Improvements and Investigations in the WINEP



It is possible that some of the observed differences in costs across companies may be due to differences in how costs on investigations have been reported. For completeness, our capex costs against Ofwat WWS line 11 are broken down as:

- FSO Improvements = £19.429 (13 schemes)
- FSO Investigations = £3.167 (54 schemes)
- Sandy Lane (Rockley Sands) PS CSO = £0.633m (refer to Section 4.1.4 of Supporting document 5.1)

We have included Rockley Sands against the Ofwat line as, whilst not an FSO scheme, it is for improvements at an overflow to reduce spill frequency and is included in the WINEP. It is possible that other companies have also included non-FSO schemes against this line. Had we only included our FSO Improvements against this line, our capex allowance based on the current model would have been in line with the industry median. We thus suggest that Ofwat seek clarification from water companies on what they have included in their business plan submissions, and subsequently allocate and re-model appropriately dependent on the extent (and scale) of investigations and improvements.

We provide evidence below to further justify our costs for our FSO programme.

3.2.2 Robust and efficient costs

We have developed options and cost estimates for each of the 13 FSO schemes, rather than using unit costs. These are detailed in Annex I where we provide an example appraisal. These appraisals consider both traditional and sustainable solutions.

We also included the costs of the 54 FSO investigations into Table WWS2. This includes some large costs, such a Bath where we are expected to need to undertake an Urban Pollution Management (UPM) type study. This will include a water quality modelling, which will require water quality sampling. This study will cost c£0.8m, based on our Bristol UPM study that we undertook to inform the AMP5 unsatisfactory overflow programme of improvements.

We have agreement in principle forms (measure specification forms) agreed with the Environment Agency for the FSO improvement programme. These specify the amount of detail the study is likely to entail, including whether expensive sampling and UPM type appraisal are likely. We have 3 FSOs that are considered complex and will require a UPM style investigation, including sampling water quality.

Costs for both improvements and investigations have been included in our FSO programme. Other WaSC may have allocated some of these costs in their investigations lines.

3.2.3 Non-WINEP frequent spilling overflow

Sections 3.2.1 and 3.2.2, above, were discussing the FSO listed in the WINEP.

We have set ourselves a bespoke performance commitment on delivering more improvements to FSO than this:

- E9: Reduce frequent spilling overflows (non-WINEP)

The ODI type for this performance commitment was challenged in Ofwat's IAP (WSX.OC.56) for having a reward only. It is defined as an out-performance only ODI because we cannot get an under-performance since our target number is zero. We set our under-performance target at zero because we may not identify any newly identified FSOs in the next few years, so we cannot commit to delivering any improvements above and beyond those named for improvement on the WINEP.

However, we have defined this performance commitment as a mechanism to enable us to deliver more than the statutory obligations named on the WINEP, i.e. to improve more overflows than are listed on the WINEP if there is an environmental need or other benefit. For any FSOs that we improve above and beyond the WINEP numbers, we will get a reward, which will fund the delivery of the additional improvement.

Improvements made under this performance commitment ODI reward, will be subject to the nationally agreed cost benefit tests that forms part of the Storm Overflow Assessment Framework, as described in Section 4.1 of Supporting document 5.1.

Our customers have expressed a very high valuation of river quality improvement. This was explicitly detailed in our MaxDiff customer surveys and implicitly included in the other surveys as summarised in Document 1.1. Further details can be found in Section 8.9 of Supporting document 3.1.A, with an extract below:

> Customer research:
>
> - SDS Research – 86% of people thought we needed to do more to reduce the number of spills
> - Maxdiff - Although bathing waters do not have a large direct impact on customers, attracted a high WTP.

We have agreed with the EA that a similar sign-off process will be applied to these non-WINEP schemes, as for the WINEP schemes.

3.2.4 Conclusion

Ofwat's spill frequency enhancement feeder model does not take into account economies of scale at individual site level. Our programme for improving FSOs has the largest number of improvements (13) in the WINEP compared to other companies, and we also include our costs for investigations and another CSO improvement against this driver.

We would request that, Ofwat seek clarification from water companies on what they have included in their business plan submissions, and subsequently allocate and re-model appropriately dependent on the extent (and scale) of investigations and improvements.

On the basis of the additional evidence provided above, we consider our spill frequency costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

Regarding the performance commitment, we do not propose to change the ODI type.

3.3 Surface water sewers

This chapter should be read in conjunction with Chapter 4.2 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 3-3: Business plan table details for conservation schemes

Table	Lines	Line Description
WWS2	4 / 51	WINEP ~ Conservation

In this chapter we expand on our proposals for conservation enhancement in PR19. The schemes that form our PR19 conservation enhancement programme are described in three investment areas of our business plan submission in September 2018.

- Phosphorus and nitrogen removal (Supporting document 5.1, section 3.2)
    - Somerset Levels and Moors wetland restoration trial for nutrient reduction
    - Poole STW – Options appraisal to achieve proposed targets
- Surface water sewers (Supporting document 5.1, section 4.2)
    - Nailsea partnership project – Improving the quality of the surface water outfall discharging to Tickenham, Nailsea and Kenn Moor SSSI
    - Turbary Common mire investigation to improve surface water management
    - Ubley IUDM
    - Wadmore Lane IUDM
- Improving natural capital in rivers and on land (Supporting document 5.1, section 6)
    - Maximising opportunities for birds at STWs
    - Biosecurity measures for large STWs
    - Carry out and support catchment control measures including partnership working and innovative measures such as biocontrol

In the subsequent sections we provide clarity and further details of our proposals originally described within the surface water sewer chapter of Supporting document 5.1. This chapter should be read in conjunction with Section 2.4 for phosphorus and nutrient removal and Section 4 for improving natural capital for our complete conservation enhancement proposals.

3.3.1 Ofwat's cost assessment

The deep dive on conservation in our proposals received one pass and two partial passes, as follows:

- Best option for customers – partial pass
- Robustness and efficiency of costs – partial pass
- Customer protection – pass.

Ofwat have applied a 20% efficiency challenge on top of the company-specific efficiency challenge (3.5%) for this area of works, and have stated:

> *"We would need a clearer understanding of these additional conservation schemes in order to assess our view of costs."*

Ofwat had queries regarding (a) the lack of clarity in the information provided regarding identifying the various schemes and their costs, and (b) that the average of the costs of the two schemes they had sight of was high. Within the improving river water quality through intermittent discharges section, we have four schemes that contribute to our PR19 conservation enhancement programme as their primary driver. Each scheme is targeting different site-specific issues.

Table 3-4: Conservation schemes related to improving intermittent discharges

Scheme	WINEP ID	Drivers	Capex (£m)
Nailsea partnership project - Improving the quality of the surface water outfall discharging to Tickenham, Nailsea and Kenn Moor SSSI	7WW100055	SSSI_IMP	2.112
Turbary Common mire investigation to improve surface water management	7WW200440	HD_INV	0.739
Ubley IUDM*	7WW300218	SSSI_IMP	2.112
Wadmore Lane IUDM*	7WW200929	HD_ND	2.112

* The Ubley IUDM scheme is referenced in Section 3.2 of Supporting document 5.1 however, along with Wadmore Lane IUDM, the costs were included in the summary table for Section 4.2.

In the following sections we provide further evidence on our proposals for the two Integrated Urban Drainage management (IUDM)schemes. Details of Nailsea and Turbary Common projects can be found in section 4.2 of Supporting document 5.1

3.3.2 Robust and efficient costs

The Integrated Urban Drainage management (IUDM) schemes are to undertake separation schemes in the catchment to reduce flows arriving at overflows, to improve their performance in a sustainable manner. The WINEP entries includes both appraisal and construction of the most cost-efficient schemes.

Our cost allowance for these AMP7 schemes are based on similar schemes we delivered in in AMP5 and are delivering in AMP6.

In AMP5 we had a similar line for undertaking separation in Weston-Super-Mare – see the case study below. This project removed a river that was connected into the combined sewer. A new surface water pumping station was constructed to pump the river storm response into the newly constructed ‘super pond’. The extension of the super pond was a partnership scheme, where we worked in partnership with North Somerset and the Environment Agency. The scheme cost of £3m, was mostly for the separation of the river, which was significantly more than we estimated, mainly due to poor ground conditions. As well as the wet well requiring piles, which was expected, all the manholes also required piling due to the soft ground.

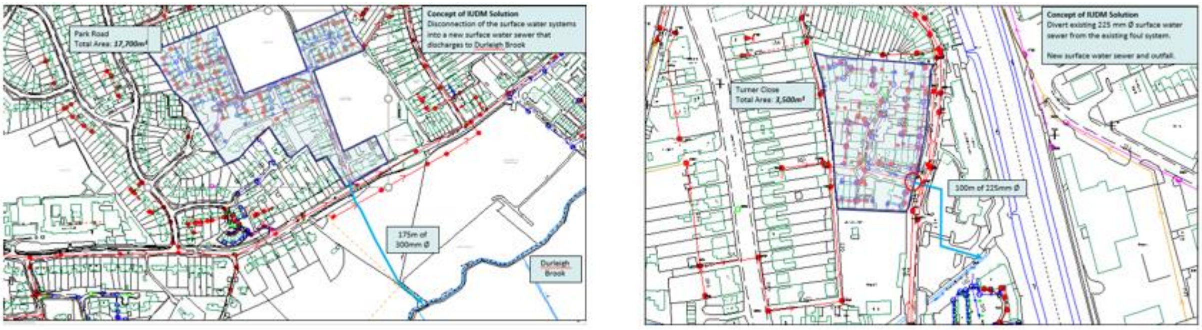
Case study: Weston super Mare super pond (Extract from Supporting document 5.7)

In Weston-super-Mare, the Environment Agency and the planners at North Somerset council took the opportunity of ensuring SuDS were applied successfully by combining the drainage from several development sites into one large 'superpond'. The pond would add more benefits such as biodiversity and amenity benefits for the local communities by having public walks and fishing areas, than having several smaller SuDS. Wessex Water oversized this pond that we could remove a watercourse from our combined sewer and divert the flows into the pond instead.

Figure 3.10 Weston super Mare SuDs

We have a line in the AMP6 National Environmental Plan for Bridgwater IUDM. The scope that we agreed with the EA (see Annex J) agreed that the maximum spend on this project should be £2m, which was set at a value considered to be cost beneficial. See Figure 3-2 for examples of what we are delivering by March 2020.

Figure 3-2: Examples of separation schemes being constructed in AMP6



The separation schemes we are undertaking in Bridgwater are schemes that ideally should have been undertaken when the developments were built. The developers laid separate sewers on their development site but, rather than extending the surface water sewers to discharge to the river, the developers simply connected both foul and surface water flows into the nearest combined sewer. We are now trying to reverse that process of urbanisation and are realising the costs associated with this. One scheme, shown in Figure 3-2, extends the surface water sewer by gravitating flow to the river. The other example shown in Figure 3-2 requires a pumping station to lift the surface water flows into the tidal River Parrett. The latter scheme alone is almost costing £1m to construct.

We have regular meetings with the Environment Agency who review[1] the IUDM solutions we promote for construction and agree which schemes are cost beneficial. We also have milestones agreed in the AMP7 Measure Specification Forms to ensure the IUDM options are appraised and costed in sufficient time to allow discussion and agreement of the schemes, so the agreed programme of works can be delivered by March 2025. The schemes will be subject to the CIRIA B£ST cost benefit analysis and will be signed-off by the Environment Agency once the agreed solutions are constructed.

3.3.3 Conclusion

In response to Ofwat's uncertainty about what schemes contribute to our conservation proposals in PR19, we have supplied further information on the schemes to allow due assessment.

We would request that, on the basis of the additional evidence provided above, the partial passes from Ofwat's deep dive are turned to passes, and the conservation costs as submitted in our business plan in September 2018 are allowed in full.

[1] For scheme on the WINEP

3.4 Pollution reduction

This chapter should be read in conjunction with Chapter 4.3 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 3-5: Business plan table details for improving frequently spilling overflows

Table	Lines	Line Description
WWS2	34/81	Pollution reduction strategy

In this chapter we expand on our pollution reduction strategy for PR19 that we submitted in our September 2018 submission WSX06 Pollution Reduction Cost Adjustment Claim provided in Supporting document 8.10.A. This chapter should be read in conjunction with document 8.10.A and also our *IAP response Appendix 7 – Minimising sewer flooding*.

Since submitting our plan in September, we have developed further the work required to implement the step change in reducing pollution and blockage incidents. We have grouped pollution reduction with flooding incidents (internal and external) and branded this as our 'Escape of Sewage reduction programme' for AMP7 delivery. This programme is detailed in our IAP response *Appendix 7 – Minimising sewer flooding*. We have made sure we have not double counted our costs to deliver these programmes.

3.4.1 Ofwat's cost assessment

We submitted our pollution reduction strategy as Cost Adjustment Claim (CAC) WSX06 (document 8.10.A). The deep dive into the CAC received two passes, three partial passes and one fail, as follows:

- Need for investment –pass
- Need for adjustment – fail
- Management control – partial pass
- Best option for customers – partial pass
- Robustness and efficiency of costs – partial pass
- Customer protection – pass.

The assessment of the overall quality for IAP scoping was a partial pass, with the following reasoning:

> *"The company is planning to improve its performance relating to pollution incidents beyond the expected benchmark level. They evidence a range of feasible approaches with costs but <u>do not present detailed programmes of work</u>. However the claim <u>fails the need for adjustment</u> as funding to deliver performance beyond the benchmark level is provided through <u>ODI out-performance payments</u>."*

In the following sections we expand on our pollution reduction strategy in PR19, and specifically address Ofwat's queries identified in their deep dive of this CAC.

3.4.2 Need for investment

The deep dive passed our need for investment, responding:

> "WSX aims to achieve a 25% reduction in pollution incidents, from an already upper quartile position, in order to deliver the expectation of WISER 'to minimise all pollution incidents and target zero serious (category 1 and 2) pollutions'. This will be achieved through a number of interventions on the sewerage network to tackle sewer blockages and rising main bursts, for example. Base and enhancement allowances are made to manage the sewerage network in both."

Ofwat's deep dive acknowledged that our Pollution Reduction Cost Adjustment Claim aimed to provide a further step change reduction in the number of pollutions incidents beyond our current industry leading position. Our submission aimed to achieve zero significant pollutions and a 40% reduction in pollution incidents. It recognised that we were already industry leading and the Water Industry Strategic Environmental Requirements (WISER) challenge was for the industry to achieve 40% reductions.

Ofwat's IAP recalculated the upper quartile position using the September submission data from all WaSCs. This IAP upper quartile position was calculated to be 19 incidents per 10,000 km of sewers, which is less onerous than our proposed 17 incidents/1000km. Ofwat's IAP action WSX.OC.30 requests us to reset our targets to reflect their calculated profile.

Therefore, we have reset our pollution target profile to match Ofwat's upper quartile profile ending in 19 incidents / 1000km by 2025 and we have reduced the costs accordingly, acknowledging a lower investment is needed for the lower target:

Table 3-6: Amended pollution reduction target following IAP

Pollution reduction CAC Costs (£m)	September 2018 submission	Reduction to allow for lower target	March 2019 submission
Capex (WWS2 L34)	23.8	10.5	13.3
Opex (WWS2 L81)	4.1	1.8	2.3

Our Totex submission in our IAP response is £15.6m, which is significantly lower than our September submission of £27.9m to reflect the lowering of the UQ target.

3.4.3 Need for adjustment

The deep dive failed our need for adjustment, responding:

> *"The claim is rejected as the company is funded to deliver performance beyond the benchmark level through ODI out-performance payments."*

To reflect Ofwat's calculation of the upper quartile position we have updated our target profile to match Ofwat's UQ profile and we have reduced the CAC for this resubmission (Table WWS2, Line 34).

To achieve this improvement, above our already industry leading position, is a big challenge. We do not consider that this improvement can be delivered through our base cost allowance. Ofwat did recognise that both base and enhancement allowances are required, when they passed our need for investment (see Section 3.4.2 above).

A step change on pollution reduction is a statutory requirement (see WISER) and we require more funding to be able to deliver this. Receiving rewards from the ODI mechanism will not provide investment when the ODI thresholds are set at the very challenging targets.

We do not believe that the Ofwat base cost models include sufficient allowance for enhancement capex and opex for future upper quartile levels of service. Our proposed ODI outperformance will not fund us to make this step change to Ofwat's UQ position, unless we significantly relax our outperformance payment thresholds.

We therefore do not consider that Ofwat's models allow for the step change required to achieve the upper quartile position. For more discussion regarding ODI out performance payments, please refer to our general Response to the IAP, section 3.4, and Appendix 3, section 8.2.

3.4.4 Management control

The deep dive partially passed our management control, responding:

> *"Performance in this area will be impacted by sewer misuse and groundwater inundation. However these challenges are not unique to WSX and are, at least partially, within their control through customer education and sewer rehabilitation programmes"*

We agree sewer misuse is a major factor in causing pollutions. Sewer flooding 'other causes' in Appendix 7 details how we are targeting sewer misuse and Appendix 7 also details how we are proactively targeting jetting at repeat locations. These are summarised in Section 3.4.5 below.

Groundwater inundation affects only three of the WaSCs so is not in Ofwat's model. Our CAC includes an increased allowance for groundwater infiltration sealing to reduce the risk of inundation.

3.4.5 Best option for customers

The deep dive partially passed our options, responding:

> *"WSX presents a range of options to reduce pollution events including enhanced data analysis, customer engagement, sewer cleaning programmes, rising main maintenance and enhanced instrumentation. However the evidence supporting the targeting of these interventions to deliver cost-effective outcomes in specific locations could be significantly improve."*

We already have processes to proactively inspect and clean (jet) sewers prone to blocking, for example flat sewers or siphons. However, to achieve the improved performances required by the WISER, in terms of pollution and flooding, we need a step change.

We have held over the past year a series of pollution reduction workshops to identify better ways of working, as well as highlighting the need to do more of the same (e.g. more jetting). We have also established a 'escape of sewage' team, whose roles will be to focus on more proactive and targeted interventions.

One gap we identified was that repeat incidents, especially pollution incidents were not formally being written up. We are now doing this which includes recommendations to reduce the risk of future incident recurring. See Annex K for a description of our Sewerage Investigation Assessments (SIA) process. The explains how we are using our Engineering department (to complement our Operational team) so that more assessment to the root cause and potential mitigation measures can be made.

In addition, we have grouped similar proactive operational activities to more focus in preventing escape of sewage – regardless of the cause. As most escape of sewage results in flooding, this is described in more detail in *Appendix 7 Minimising sewer flooding.*

However, pollution incidents are often caused by external flooding so there are synergies with the flooding and the pollution reduction strategies. This was explained in our September submission and we proportioned costs between pollution reduction CAC and the flooding reduction programme, as recognised in the deep dive response *'Further overlaps to other programmes have been removed'* for costs in Section 3.4.6 below.

Table 3-7 summarises our escape of sewerage reduction plan. This includes more proactive targeting of these interventions, including:

- Rising main monitoring
- Review of pollution incident with Sewer Managers and Asset Strategy teams
- Sewerage investigation assessments
- Improving the log and capture of pollution incidents
- Escape of sewage team – this has recently been established to give more proactive focus on preventing flooding and pollution incidents.
- Expansion of the Operational hotspots models to provide a focus more of pollution incidents
- Predicting frequent flooding locations so we can monitor sewer performance in vulnerable locations and respond to incidents before they occur.

Table 3-7: Our escape of sewage reduction plan – summary

	Proactive	Reactive	Reporting
Underway (2018/19)	**Rising main monitors** • Monitors installed to try and identify rising mains at risk of bursting (ongoing programme into AMP7) **Pollution Training for operational staff including sewerage crews/CSTs** • Toolbox talks/workshop regarding pollutions (to be attended every two years) • Training on formal EA sample procedures **Sewerage Investigation Assessments (SIAs)** • Scope of works undertaken by the High-Level Assessment (HLA) team to be expanded – using existing datasets to focus investigations to identify appropriate proactive interventions	**Pollution reviews** • Review of incidents with Sewerage Managers to be undertaken to identify any lessons to be learnt and examine opportunities to challenge pollution classification **Third-party environmental support** • Establish framework for the provision of environmental impact surveys etc.	**Review of existing pollution reporting processes** • Review, consolidation and initial improvement to existing pollution log & data capture
Short-term (2019/20)	**Escape of sewage team** • Focus on the management of activities leading to a reduction of escape of sewage incidents **Additional sewer cleaning** • Amount of sewerage proactively jetted will increase as a result of SIAs **Additional R&M works** • Additional R&M interventions as a result of SIAs **Development of escape of sewage risk model** • Development of GIS model to analyse available data to direct focus of pro-active investigation **EDM** • Early start on AMP7 EDM delivery where CSOs have pollution history **Behavioural Engagement/PR plan** • Customer engagement plan regarding sewer misuse to be developed • Behaviour engagement technician to develop engagement programme, tools etc.	**Review of repeat incidents on fixed assets** • 33 STWs, SPSs and CSOs responsible for multiple repeat pollutions – have the issues at these sites been resolved? If not, what works are required? **Operations equipment** • Do sewerage crews have the appropriate equipment? Is existing equipment being utilised? **Review of incident response** • Is our general response appropriate? Are the correct processes in place? How is over-pumping managed? Is our communication good both internally and externally? **Development guidance for specific causes** • Development of additional guidance/tools/training for specific causes for both crews & CSTs **CSU call handling**	**Pollution incident data capture** • Detailed specification of data capture and reporting system – project to be delivered in 2020/21

	Proactive	Reactive	Reporting
	SPS performance analytics • Analytics tool monitoring to identify out of character SPS performance **WRc research project – blockages** • Research project examining the underlying cause of blockages **Pre-Bathing season maintenance** • Review that critical maintenance is undertaken before the start of the bathing season **Air-valve maintenance** • Locate and inspect all air-valves on critical crossings and undertake critical maintenance	• Audit of how flooding, and pollution incidents are handled – are all incidents reported and dealt with correctly **Rainfall Visualisation** • Interpretation of CSO alarms using rainfall data to determine whether the "spill" is a result of the CSO working as expected or whether operational investigation is required	
Medium-term (AMP7)	**Background environmental surveys** • No knowledge of environmental status around sites – what level do we need to achieve post-incident? **Rising main replacement programme** Prioritisation of rising main replacements **Visualisation** • Upgrade existing telemetry systems to help identify where proactive interventions are appropriate **In-sewer monitoring** • Install and use of monitors to instruct when preventative interventions should be undertaken – catchment trial **Yellow Fish project** • Community engagement project to raise awareness of misconnections and river pollution – currently on adhoc basis, roll-out as a permanent option	**Additional CST/crew resource** • For particular sewerage job types, crews allowed additional time to identify underlying cause on first instance **Enhanced over-pumping resilience** • Investigate enhancing response provided by existing contractor	**Improve self-reporting** • PR exercise & hotline for customers to report pollutions to ourselves rather than the EA • Water Rangers – volunteers trained in identifying pollutions walking regular hot spot routes **Improving self-reporting – pollution site signage** • Public information signage describing how to report a pollution **Pollution incident data capture** (Information Services (IS) project Phase 1) • Update Wast incident form (WIF) form to capture incident data from the sewerage crews • Develop pollution App for non-sewerage disciplines **Pollution Register** (IS project Phase 2) • Replacement for pollution log

3.4.6 Robustness and efficiency of costs

The deep dive partially passed our costs, responding:

> *"WSX claims that the costs of this programme were built up by using the historical information available, including cost of additional labour, installation of additional equipment and costs to modify and alter the existing network. Past trends or known unit rates for existing activities were used to build up the cost too. Further overlaps to other programmes have been removed. However, WSX does not clearly set out the opportunity of future cost efficiencies."*

There are potential for future cost efficiencies, which we have considered in the build up of our costs:

- We are anticipating that new innovative technology such as quick sewer inspections from manholes will become more common place. This will potentially replace having to use CCTV to identify the location of blockages. This is more promising than the SewerBatt technology.
- Event Duration Monitoring will provide information that we will be able to use to reduce the risk of pollution from overflows.
- We will also install more in-sewer monitors to monitor the performance of the sewerage system at locations that are prone to pollution from external flooding. Low-cost technology is being developed that may made this more affordable. Currently we are using EDM technology, which costs £19k each installation.

It could be that other innovation (such as monitors integrated into manhole covers) could make data within the sewerage system far more accessible and affordable. However, we do not think this technology will yield results on the ground until AMP8.

As mentioned in Section 3.4.3, we do not believe that the Ofwat base cost models include sufficient allowance for enhancement capex and opex for future upper quartile levels of service. For our revised pollution targets we request £13.3m capex and £2.3m opex, as detailed in Table 3-6.

3.4.7 Customer protection

The deep dive passed our need for investment, responding:

> *"Customers are protected by a common performance commitment with incentive and penalty payments for out and under performance against the Pollution Cat 1-3 UQ threshold."*

Pollution reduction is a statutory requirement. We have set our performance commitment to improve our performance above our already industry leading position.

3.4.8 Conclusion

Ofwat's IAP recalculated the upper quartile position using the September submission data from all WaSCs. This IAP upper quartile position was calculated to be 19 incidents per 10,000 km of sewers which is less onerous than our proposed 17 incidents/1000km.

In response, we have reset our target to 19 incidents / 1000km and have reduced the costs accordingly, acknowledging a lower investment is needed for the lower target.

Our Totex submission in our IAP response is £15.6m, which is significantly lower than our September submission of £27.9m to reflect the lowering of the UQ target.

We do not believe that the Ofwat base cost models include sufficient allowance for enhancement capex and opex for future upper quartile levels of service. Our proposed ODI outperformance will not fund us to make this step change to Ofwat's UQ position, unless we significantly relax our outperformance payment thresholds.

We would request that, on the basis of the change in target and the additional evidence provided above, the pollution reduction costs as now submitted are allowed in full.

4. Improving natural capital in rivers and on land

This chapter should be read in conjunction with Chapter 6 of
Supporting document 5.1 – Protecting and enhancing the natural environment.

Table 4-1: Business plan table details for conservation drivers

Table	Lines	Line Description
WWS2	4 / 51	WINEP ~ Conservation

In this chapter we expand on our proposals for conservation enhancement in PR19. The schemes that form our PR19 conservation enhancement programme are described in three investment areas of our business plan submission in September 2018.

- Phosphorus and nitrogen removal (Supporting document 5.1, section 3.2)
    - Somerset Levels and Moors wetland restoration trial for nutrient reduction
    - Poole STW – Options appraisal to achieve proposed targets
- Surface water sewers (Supporting document 5.1, section 4.2)
    - Nailsea partnership project – Improving the quality of the surface water outfall discharging to Tickenham, Nailsea and Kenn Moor SSSI
    - Turbary Common mire investigation to improve surface water management
    - Ubley IUDM
    - Wadmore Lane IUDM
- Improving natural capital in rivers and on land (Supporting document 5.1, section 6)
    - Maximising opportunities for birds at STWs
    - Biosecurity measures for large STWs
    - Carry out and support catchment control measures including partnership working and innovative measures such as biocontrol

In the subsequent sections we provide clarity and further details of our proposals originally described within the improving natural capital in rivers and on land chapter of Supporting document 5.1. This chapter should be read in conjunction with Section 2.4 for phosphorus and nutrient removal and Section 3.3 for surface water sewers for our complete conservation enhancement proposals.

4.1.1 Ofwat's cost assessment

The schemes that form our PR19 conservation enhancement programme are described in three investment areas of our plan:

- Phosphorus and nitrogen removal (Supporting document 5.1, section 3.2)
- Surface water sewers (Supporting document 5.1, section 4.2)
- Improving natural capital in rivers and on land (Supporting document 5.1, section 6)

The deep dive on conservation in our proposals received one pass and two partial passes, as follows:

- Best option for customers – partial pass
- Robustness and efficiency of costs – partial pass
- Customer protection – pass.

Ofwat have applied a 20% efficiency challenge on top of the company-specific efficiency challenge (3.5%) for this area of works, and have stated:

> "We would need a clearer understanding of these additional conservation schemes in order to assess our view of costs."

Ofwat had queries regarding (a) the lack of clarity in the information provided regarding identifying the various schemes and their costs, and (b) that the average of the costs of the two schemes they had sight of was high. Within the improving natural capital in rivers and on land section, we describe three schemes that contribute to our PR19 conservation enhancement programme as their primary driver, as shown in Table 4-2.

Table 4-2: Conservation schemes covered in improving natural capital section

Scheme	WINEP ID	Drivers	Capex (£m)
Maximising opportunities for birds at STWs	7WW200580	NERC_IMP1	0.319
Biosecurity measures for large STWs	7WW200078	INNS_ND	0.007
Carry out and support catchment control measures including partnership working and innovative measures such as biocontrol	7WW200167	INNS_ND	0.127

In the following sections we provide evidence on our proposals for these three schemes.

4.1.2 Best option for customers

Maximising opportunities for birds of at STWs

In February 2016, Defra brought in additional guidance for competent authorities to halt the steep decline of bird species by taking steps to provide and protect their habitats. This WINEP objective requires us to look primarily at our STWs and their use by bird species of conservation concern as identified in studies by other water companies, British Trust for Ornithology (BTO) and the Royal Society for the Protection of Birds (RSPB). The project will identify the practical measures needed to enhance sites in order to maximise migratory, breeding and over-wintering success for identified bird species. The work will focus on 10 STWs as a representative sample of our sites, and enhancement measures will be installed to demonstrate the principles to the business.

Biosecurity measures for large STWs

We will develop invasive plant identification guides for use by our operators at our larger STWs. This will be used to help inform potential proposals at these sites for PR24.

Carry out and support catchment control measures including partnership working and innovative measures such as biocontrol

In the delivery of this WINEP objective, we will work with partnership organisations to control invasive non-native species (INNS) and, where practicable, eradicate from our sites. The focus will be on controlling INNS at sites where the potential for re-infestation is low. We are also discussing with the Centre for Bioscience and Agriculture International (CABI) regarding the most efficient way of supporting their research into biocontrol.

4.1.3 Conclusion

In response to Ofwat's uncertainty about what schemes contribute to our conservation proposals in PR19, we have supplied further information on the schemes to allow due assessment.

We would request that, on the basis of the additional evidence provided above, the partial passes from Ofwat's deep dive are turned to passes, and the conservation costs as submitted in our business plan in September 2018 are allowed in full.

5. Improving bathing and shellfish waters

This chapter should be read in conjunction with Chapter 7 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 5-1: Business plan table details for UV disinfection (or similar)

Table	Lines	Line Description
WWS2	21 / 68	WINEP ~ UV disinfection (or similar)

In this chapter we expand on our proposals for UV disinfection in PR19, related to two schemes:

- West Huntspill STW – improving bathing waters
- Corfe Castle STW – improving shellfish waters

Ofwat's cost assessment is based on the results from their UV disinfection enhancement feeder model. Given the distinct nature of the two schemes, Ofwat assessed costs of each separately through a deep dive, and we respond to that assessment taking each in turn; in section 5.1 and 5.2. However, we have some concerns common to both assessments, which we discuss first.

Ofwat's cost assessment

We consider there are deficiencies in the UV disinfection enhancement feeder model which makes it unrepresentative of the true costs of the work to Wessex Water. Our three main areas of concern or clarification are:

i) Our population equivalent (PE) provided for West Huntspill STW was not correct in our business plan submission in September 2018. We have corrected this in our re-submission, which shows £/PE below industry median.
ii) The above point notwithstanding, it is inappropriate to set allowances by reference to industry average (or median) cost per scheme, because schemes are not homogenous, and comparison is not on a like-for-like basis.
iii) We have queries about some of the data reported by other companies and which Ofwat's analysis relies on.

<u>Population Omission (West Huntspill STW)</u>

We have discovered an omission in the population figure stated in our data table WWn4 submitted in September 2018, where the population equivalent (p.e.) attributed to West Huntspill STW was inadvertently excluded. The definition for Line 24 of data table WWn4 is:-

> *"Population equivalent served by STWs at which there are new or tightened consent conditions for microbiological parameters to meet the requirements of the EU Shellfish Waters or revised Bathing Water Directives, delivered in the report year and for which capital costs are reported in WWS2 line 21."*

Although the capital costs for the West Huntspill STW schemes were included in WWS2 line 21, the associated p.e. was not included in WWn2 line 24. This has been corrected in our latest submission, and is summarised in Table 5-2 below:

Table 5-2: Correction of populations in Line 24 of data table WWn4

Site	P.E.
West Huntspill STW	49,205
Corfe Castle STW	1,646
Total:	50,851

Treatment

We consider there are deficiencies in the UV disinfection enhancement feeder model which makes it unrepresentative of the true costs of the work to Wessex Water. The model costs are biased towards implementing solely UV disinfection processes rather than considering disinfection as a whole for the treatment process, as required to meet the environmental obligations. It is also unclear from our view of the national WINEP or publicly available sections of other company business plans what level of disinfection is being provided at each site. Each STW has a different level of disinfection required, which is dependent on the receiving bathing or shellfish water and any dilution credit afforded to the STW effluent from the receiving waterbody.

The level of enhancement required also depends on the existing treatment type and performance of the works. The EA allow the required reduction to be achieved through a combination of conventional treatment, disinfection and dilution or dispersion. We discuss specific site needs for West Huntspill STW and Corfe Castle STW in the following chapters.

Given the limited number of sites identified for improvements, differing disinfection requirements, and differing performance of the existing site processes with respect to disinfection, we do not consider that schemes (and their costs) can be compared directly.

Population

We query some of the population data on which the industry mean and median unit costs have been based, as identified in Table 5-3. We include the APR 2018 figures as part of our analysis to evaluate populations per site, although we acknowledge that there could be slight discrepancies depending on the year of interest (i.e. 2018 for APR2018 but year of scheme implementation for the PR19 tables).

Table 5-3: Comparison of population equivalents allocated to UV disinfection

Site	Driver	Discharge	P.E. Sources PR19 2018 Table WWn4	 APR 2018 Table 4O*
<u>Anglian Water</u>				
Southwold STW	BW_ND	Continuous	69,862 *(see Note 1)*	n/a
Walton STW	BW_IMP3	Intermittent		n/a
<u>South West Water</u>				
Gorran Churchtown STW	BW_IMP3	Continuous	54	n/a
Kenn & Kennford STW	SW_ND	Continuous	819	n/a
<u>Southern Water</u>				
Millbrook	BW_ND	Continuous	204,598	140,030
Slowhill Copse	BW_ND	Continuous		64,040
<u>United Utilities</u>				
Carlisle STW	SW_ND SW_IMP	Continuous + Intermittent	230,086 *(see Note 2)*	113,020
<u>Wessex Water</u>				
Corfe Castle STW	SW_ND SW_IMP	Continuous	1,646	n/a
West Huntspill STW	BW_IMP1	Continuous	47,370	47,370

* Table 4O lists STWs with a p.e. >25,000

We have two queries specifically related to population data provided to Ofwat.

1. Anglian Water's profile in WWn4 of *Current population equivalent served by STWs with tightened/new UV consents* (Line 24) reports improvements on PE which, based on our calculations, suggests two sites, as shown below:

   Table 5-4: Anglian Water's P.E. profile for UV schemes

Dates	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	Total
P.E. served by tightened/ new UV consents	36,703	9,824	0	0	23,335	69,862

   We are unclear on the populations associated with Southwold and Walton STWs or details of the proposed schemes. However, given that neither sites are listed in Table 4O of APR2018 and using the regulatory completion dates and DWF permits stated in the WINEP, our assumption is that the 9,824 p.e. in 2021/22 relates to Southwold STW (date 31/03/2022) and the 23,335 p.e. in 2024/25 relates to Walton STW (date 31/03/2025). Thus the p.e. figure stated in 2020/21 does not appear to correlate with enhancements as identified in the WINEP and costed against WWS2 Line 21.

2. The related WINEP requirements for United Utilities' Carlisle STW are for disinfection improvements to the continuous final effluent and either additional storage or disinfection for storm flows. In their business plan, the company describe the best value solution for the storm flows to be a UV disinfection plant. Whilst noting that two disinfection plants will

be required to treat the separate final effluent and storm streams, we query the inclusion of doubling of the p.e. as served by the STW for the two discharges.

We accept that we do not have full sight of details of each scheme, however our understanding of these areas as described above question the robustness and validity of Ofwat's UV disinfection model in comparing companies' proposals.

In the following sections, we provide further evidence for our proposals at West Huntspill and Corfe Castle STWs.

5.1 Bathing waters

This chapter should be read in conjunction with Chapter 7.1 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 5-5: Business plan table details for UV disinfection (or similar)

Table	Lines	Line Description
WWS2	21 / 68	WINEP ~ UV disinfection (or similar)

5.1.1 Ofwat's cost assessment

The deep dive on UV disinfection in our proposals related to improving Bathing Waters (West Huntspill STW) received three partial passes and two fails, as follows:

- Need for investment – partial pass
- Need for adjustment – partial pass
- Best option for customers – fail
- Robustness and efficiency of costs – fail
- Customer protection – partial pass.

Ofwat have stated that,

> *"Capex requested is extremely high for West Huntspill STW as the solution is a new ASP plant to improve the quality of effluent before it reaches the existing old UV plant, rather than building a new UV plant or upgrading the existing plant."*

In contrast they also noted:

> *"If the solution mirrored other companies, and we used the EA's PE estimate, West Huntspill STW would not have an excessive unit cost."*

We have investigated the reason for the difference between these two statements and discovered an omission in the population figure stated in our data table WWn4, where the population equivalent attributed to West Huntspill STW was inadvertently excluded. The definition for Line 24 of data table WWn4 is:-

> *"Population equivalent served by STWs at which there are new or tightened consent conditions for microbiological parameters to meet the requirements of the EU Shellfish Waters or revised Bathing Water Directives, delivered in the report year and for which capital costs are reported in WWS2 line 21."*

Although the capital costs for the West Huntspill STW microbiological improvement project were included in WWS2 line 21, the associated population equivalent was not included in WWn2 line 24. This has been corrected in our latest submission. The addition of the 49,205 p.e. for West Huntspill reduces the calculated unit cost from £2,329,514/p.e. to £75,389/p.e. which is below the (revised) median value of £83,025/p.e.

Ofwat have stated that ,

> *"A solution to poor bathing water quality is required under WINEP, with a suggestion that West Huntspill STW treated effluent is a contributing factor, but there is limited evidence that this chosen solution is the best option for customers. We would want to see the evidence from catchment investigations before accepting the proposed*

> *solution. At this stage, we are allowing a small proportion of the requested capex for further investigations and for further analysis / evidence of need, best option and cost efficiency."*

A capex allowance of £0.5m has been included for investigations based upon the above. In the following sections we provide additional evidence related our investment proposal.

5.1.2 Need for investment

We stated in section 7.1.2 of our Supporting document 5.1 that the bathing water at Burnham Jetty North has been classified as poor for the last four years and that further improvements to the discharge from our West Huntspill STW have been identified in the WINEP and are required early in AMP7.

Ofwat judged the need for investment as a Partial Pass, but commented that:

> "*While there has been an increase in domestic and trade effluent waste entering West Huntspill STW, compliance is currently ok. Even if bacteriological removal through the works has declined, we are not convinced West Huntspill STW is necessarily the reason for the poor water quality, considering that the EA suggests land management is an alternative option."*

<u>Land Management option</u>

In the development of the proposed improved treatment solution for West Huntspill we had several discussions with the EA and agreed with them that a treatment solution, rather than land management was a better, more appropriate and more reliable option. This was based on the results of investigations that we had previously been carried out in catchments of the River Brue and Parrett as well as previous work carried out by EA. In a recent letter the EA have re-stated that:

> *"Both catchments had been identified as priority target areas for a Catchment Sensitive Farming (CSF) schemes to reduce agricultural pollution. This was launched in 2006. Since then over 2000 farm visits have resulted in over £8M of capital grants being awarded to farmers in the Levels and Moors target area. Whilst CSF officers continue to build relationships, raise awareness and gain improvements <u>further catchment work alone will not in our opinion improve bathing water quality at Burnham Jetty sufficiently to achieve compliance</u>."*

On the basis of our earlier discussions and exchanges with the EA we were expecting the reference to land management to be removed from the WINEP. Following receipt of Ofwat's IAP we asked the EA to confirm their position regarding the reference to a land management option. They have since stated:

> "*The West Huntspill improvement driver is intended to improve the bathing water from Poor to Sufficient. The land management alternative for West Huntspill STW was added to the WINEP with the intention of giving flexibility to the options of delivering water company improvements in bathing water quality. Prior to [Ofwat's] challenge <u>the Environment Agency had already agreed to the removal of the land management alternative from the WINEP</u> because insufficient rigour was taken in*

considering the extent of land management measures already implemented. This will happen by the end of March this year."

We therefore expect the EA to remove the land management option from the final WINEP.

West Huntspill link with poor bathing water quality?

We also asked the EA to provide a response to Ofwat's challenge that they were not convinced West Huntspill STW is necessarily the reason for the poor water quality. Their reply includes the following:-

> "*Tracer studies conducted under a previous AMP investigation in April 1998 concluded a minimum dilution/dispersion of 60 between West Huntspill STW outfall and Burnham Jetty bathing water. These studies informed the design criteria and UV consent conditions which came into force in 2000. The works is no longer achieving the required log reduction to protect the beach.*
> *With limited dilution/dispersion to the bathing water, poor and deteriorating performance for FIO die-off at West Huntspill STW is currently contributing to the non-compliance of Burnham Jetty bathing water."*

Annex G1 includes a copy of an email from the EA to Ofwat on 28th February 2019 and a letter from the EA to Wessex Water on 22nd February 2019 with their comments on the challenges in Ofwat's IAP.

5.1.3 Need for adjustment

Ofwat have stated that:

> *"…..It is not clear whether West Huntspill is a contributor to the poor water quality and whether undertaking WSX's proposed solution will generate the improvements required. If the works is currently compliant, we question what evidence is available to confirm that the proposed solution is appropriate to improve the bathing water"*

We address the query about West Huntspill's contribution to the poor water quality in Section 5.1.2 above.

In 2018 we engaged Stantec (consultants) to review the performance of West Huntspill STW, the cause for the poor bacteriological removal and the actions required to improve the performance. Their summary of the bacterial reduction performance explained that:-

- Bacterial reduction performance has deteriorated, particularly since 2013.
- The observed log reduction achieved over the UV irradiation system has deteriorated more dramatically than that over secondary treatment.
- It is likely that the deterioration in UV irradiation performance is related to the deterioration in quality of the effluent from the upstream treatment process rather than particular issues with the UV irradiation system.
- Effluent quality parameters that would affect performance of UV irradiation system are:
    - suspended solids concentration, particle size (pin floc)

- UV transmittance (soluble BOD / organic content / chemical used for septicity dosing.

The extract from their report show these findings graphically:-

Figure 5-1: Faecal coliforms reduction through treatment stages at West Huntspill STW

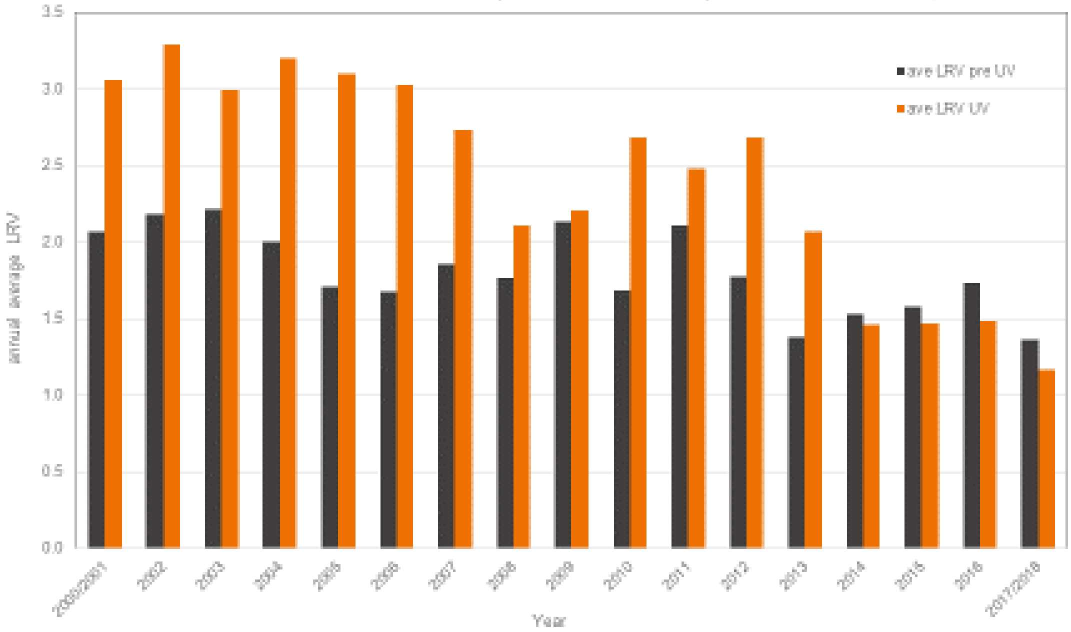


Figure 5-1 shows how the removal of faecal coliforms has reduced over time. This shows the reduction has occurred through both the treatment process upstream of the UV plant, and also through the UV plant itself. The deterioration in performance of the UV plant is considered to be due to the poorer quality treated effluent from the secondary treatment process.

Figure 5-2: Final effluent faecal coliform samples above trigger point at West Huntspill STW

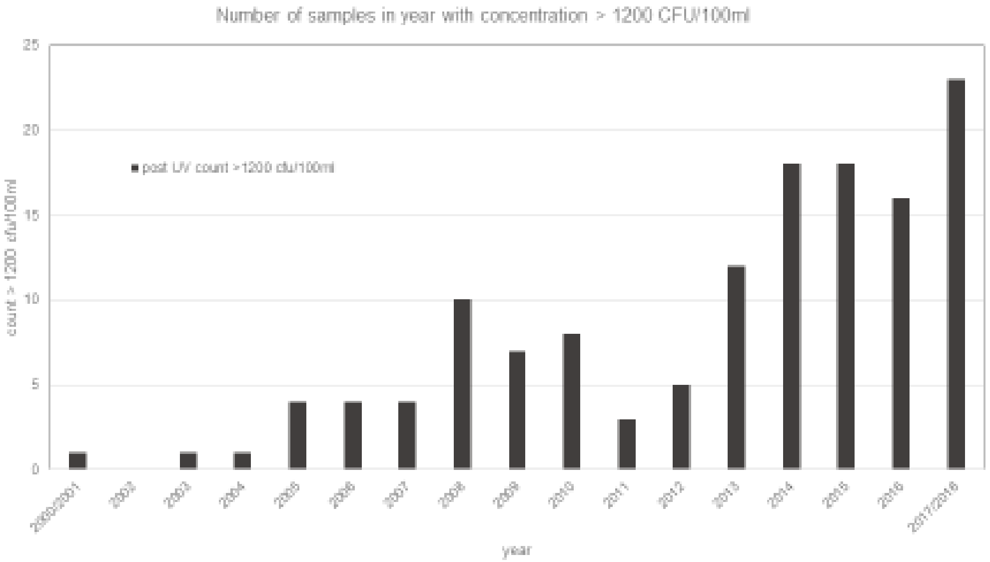


Figure 5-2 shows how the deterioration in faecal coliform removal at West Huntspill STW has resulted in an increased number of samples with faecal coliforms levels greater than

1,200cfu/100ml.

Stantec's report gave the following main reasons for the deterioration in the UV disinfection performance:-

- Final effluent quality, particularly suspended solids concentration has deteriorated, and become more variable since 2013, which has had a subsequent impact on variability in COD and BOD.
- Spikes in turbidity experienced due to higher variable suspended solids and pin floc. Poor suspended solids and turbidity would be expected to adversely affect the performance of the UV irradiation system
- Spikes in Turbidity correspond to periods of low UVT. Colloidal material and soluble organics will also contribute to poorer UVT.
- There does not appear to be any strong interference from any trade load that might affect UVT.

Figure 5-3: Changes in final effluent suspended solids quality at West Huntspill STW

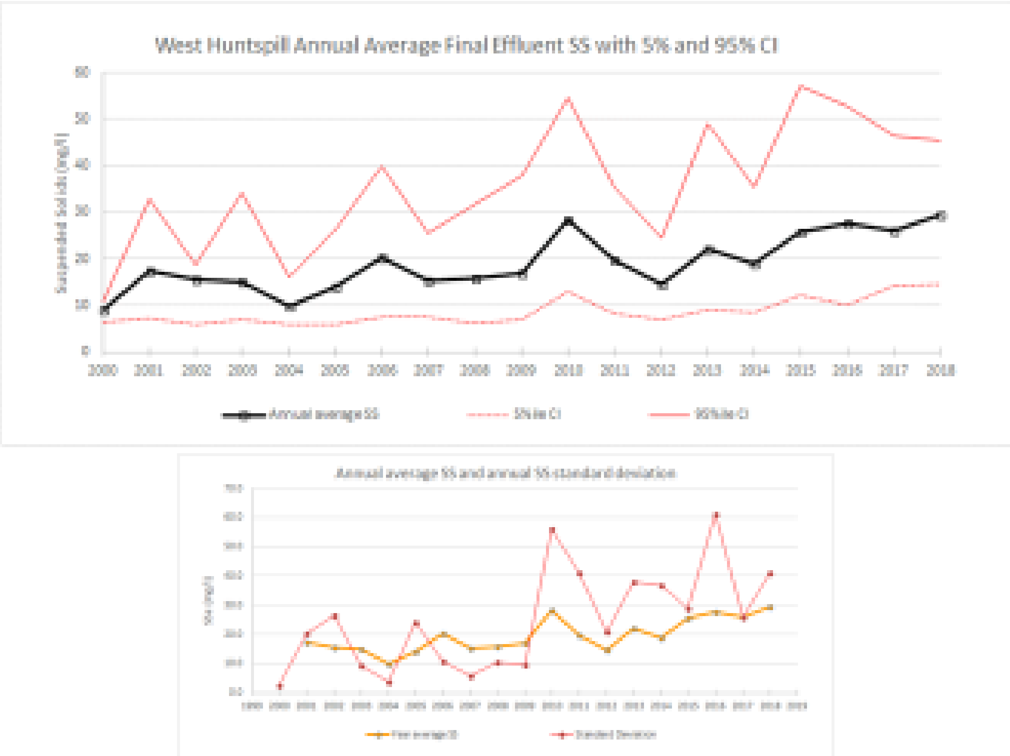


Figure 5-3 shows how the average effluent quality has deteriorated over time. Although remaining compliant with the water quality consent standard, it is considered that the increase in suspended and colloidal solids in the final effluent will have adversely affected the UV disinfection performance.

Stantec's report concluded that the deterioration in performance was linked to the activated sludge plant having an excessively short sludge age resulting in formation of pin-floc and turbid supernatant. They advised that the long-term solution would be to reduce BOD loading on the activated sludge plant to one which allows more normal range of operational headroom.

Following receipt of Ofwat's IAP in January 2019 we asked Stantec to produce a supplementary report providing an independent response to the technical queries raised by Ofwat. Their report, which confirms the finding of their original study, is included in Annex G2.

5.1.4 Best option for customers

Ofwat's deep dive into the planned works at West Huntspill concluded that the proposals fail the "best option for customers" test. They stated that:

> *" ..We would want further reassurance that the preferred ASP plant solution is the only option and will 'protect' the ageing UV plant sufficiently going forward. Information is not provided to understand if this solution is cheaper than a new or upgraded UV plant to achieve the reduction in bacteria. Is this proposed solution actually supporting the growth driver more?*
> *It is also unclear why this solution is preferable to a possible land management solution, as indicated by the EA in the WINEP3. In promoting this particular solution before investigations are complete, are WSX (and the EA) making assumptions? There appears to be limited evidence that this scheme is required or whether the issue with poor water quality is a wider catchment issue. We are also unsure why customers should be funding this solution which we are not convinced yet is necessary or most cost-beneficial."*

<u>ASP Preferred Option</u>

In Appendix G of our Supporting document 5.1 we explained that we had selected the ASP solution to meet the twin objectives of improved bacterial removal and also to provide capacity for growth. We explained that two options had been considered, Options 1 and 2 as shown below. Following receipt of Ofwat's IAP we have further considered two more options (3 and 4) as described below.

Table 5-6: Treatment options at West Huntspill STW for bathing water improvements

No.	Title	Detail	Capex £m	Opex £k/yr
1	New Pumped-fed ASP	• A new (fourth) Primary Settlement Tank (PST) similar to existing PSTs. • A new conventional activated sludge plant, run in parallel with the existing ASP plant, equipped with a Fine Bubble Diffused Aeration system. • ASP feed pumping station. • MCC for new process • New ASP effluent pipework to connect to the existing ASP outlet pipework to final settlement.	14.44	304
2	Hybrid activated sludge process (HYBACS) units	• A new (fourth) Primary Settlement Tank (PST) similar to existing PSTs.	10.20	304

No.	Title	Detail	Capex £m	Opex £k/yr
	upstream of the existing ASP	• Permanent installation of twelve HYBACS units • HYBACS feed pumping station. • MCC for new process.		
3	New UV Plant and increased biological treatment capacity	• A new UV plant designed to treat a relatively poorly treated effluent. • A smaller new carbonaceous only activated sludge plant, designed to achieve the relatively lax UWWTD and water quality standard (40:60 BOD:SS) and run in parallel with the existing ASP plant, equipped with a FBDA system. • A new (fourth) Primary Settlement Tank (PST) similar to existing PSTs • ASP feed pumping station. • MCC for new processes • New ASP effluent pipework to connect to the existing ASP outlet pipework to final settlement.	16.45	313
4	New improved UV Plant only	• This option was discounted for the technical reasons in the Stantec report in Annex G2 and summarised below.	n/a	n/a

Proposed solution

The required environmental outcome from this scheme is an improved reduction in viruses and bacteria, as described in the WINEP3 *(" West Huntspill STW to receive improved treatment to achieve 25,000-fold (4.4 log) reduction in enteroviruses and a 250,000-fold (5.4 log) reduction in E. coli* … "). In assessing the above options 1and 2 (both of which would provide some increase in treatment capacity) we concluded that, in terms of virus and bacteria removal, Option 1 is significantly superior. This is based on the performance of our Weston-super-Mare STW which was enhanced by the provision of an activated sludge process in 2013 to provide improved virus and bacteria removal. The design of the proposed upgraded ASP process for West Huntspill STW has been based on that used for Weston-super-Mare and hence provides confidence that the required environmental outcome will be achieved.

The proposed option therefore is Option 1 because:

- Installing an additional new ASP treatment stream with a 'standard' sludge loading rate and a 'standard designed' anoxic selector for improved settlement of suspended solids will:
    - improve the clarity and transmissivity of the final effluent for UV treatment
    - improve the settleability of suspended solids and reduce incidences of turbid effluent due to SS
    - improve the bacterial removal across the secondary treatment process ahead

of the UV plant.
    - enable the UV plant to achieve sufficient log removal and effluent quality for UV disinfection,
    - provide capacity to help attenuate and provide better treatment for the wide variation of flows and loads experienced at this STW.
    - and thus provide the required performance to meet the revised Bathing Water Directive bathing water standards.
- This option also provides adequate treatment capacity to meet the current load on the works and to cater for the significant increase in load by 2025 from new developments within the catchment.

Option 2 (HYBACS) has not been selected because it is an untried system ahead of UV disinfection plant, and the units are not guaranteed to offer the WINEP required log removal for bacteria and viruses. There is hence a significant risk that option would require, in addition, an upgrade to the UV disinfection plant. This makes it an unattractive option due to the additional costs associated with a new UV plant, making it more costly than option 1. Additionally, the time taken to install a new UV plant, would mean that it could not be installed in time to meet the regulatory date of March 2021.

The combined Option 3 (new UV + smaller ASP treatment stream) has not been selected because:

- it has the highest capital and whole-life cost
- the smaller aeration basin with a sludge loading rate of 0.45 and a sludge age of 3 days provides a less stable treatment performance, with a higher risk of a cloudy effluent not amenable to UV treatment,
- the smaller aeration basin provides capacity to a shorter design horizon.

Option 4 (new UV plant only) has not been selected because it fails to address the root cause of the current poor removal of bacteria and viruses by the treatment processes at West Huntspill STW. As described in the Stantec report in Annex G2, the main problem is considered to be the nature of the treated effluent from the existing highly loaded secondary treatment process. This variable, cloudy and turbid effluent is not amenable to disinfection by UV treatment, and upgrading the UV plant would not, by itself, result in an improvement that would ensure the required bacterial and virus removal would be achieved. Installation of a UV plant alone would also provide no additional treatment capacity for the significant increase in load from new developments within the catchment.

5.1.5 Robust and efficient costs

Ofwat's deep dive into the planned works at West Huntspill concluded that the proposals fail the "Robust and efficient costs" test. We acknowledge that Ofwat's position on our costs may have been reached on the basis of the wrong PE data which we had reported for this scheme. Having now corrected that data Ofwat may take a different view.

Ofwat have also stated that:

> *"…We have little confidence that the chosen solution is the best or most efficient option, or whether the alternative (replacement UV plant) would have been more suitable. It appears that the scheme could be being used as a means to improve primary settlement tanks and an ageing ASP, which would have benefits to other current / future consent compliance (P-removal / sanitary parameters) to accommodate growth. It is debatable whether this scheme should be assessed as a P or NH3/BOD removal scheme.*
>
> *We also have reason to believe that 'incompatibility with existing treatment processes' and 'limitations of the STW site area' are not robust arguments for not pursuing a conventional UV plant upgrade / replacement. There is no apparent discussion on land / catchment management options as an alternative solution."*

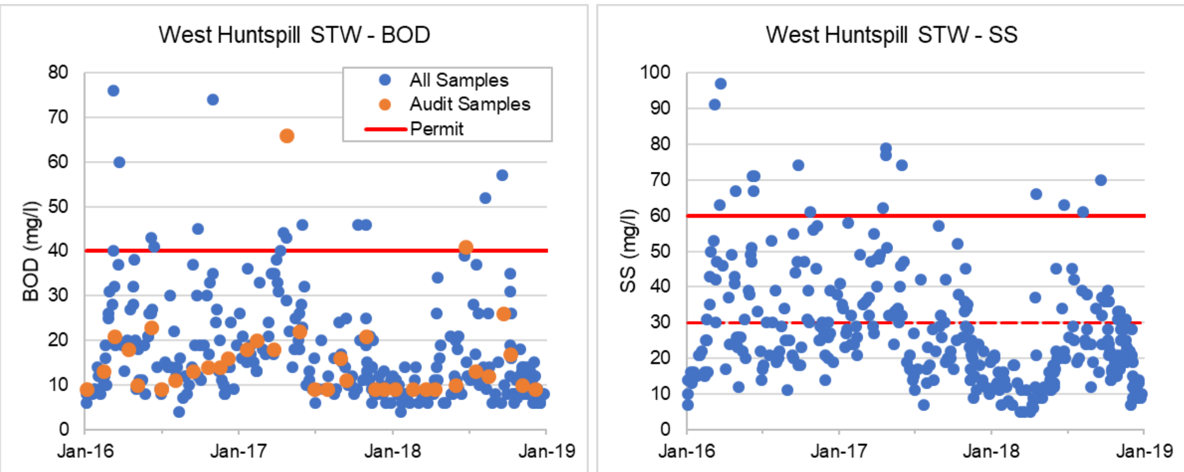
<u>Best or most efficient option?</u>

We address Ofwat's query on best option in Section 5.1.4 above.

We realise that the suggestion that this scheme could be being used to benefit other current / future consent compliance (P-removal / sanitary parameters) or that it is debatable whether this scheme should be assessed as a P or NH3/BOD removal scheme, may have been prompted as a consequence of the PE data error mentioned above. For further clarity, we explain below why those suggestions are not appropriate.

Our STW at West Huntspill discharges into the estuary of the River Parrett. Like most discharges into coastal waters the consent does not require the removal of either Phosphorus or Ammonia. The BOD permit level is 40mg/L (95%ile) plus the UWWTD requirement of 70% BOD removal. The Suspended Solids (SS) permit level is 60mg/L (95%ile). As shown in Figure 5-4 below, the STW routinely and comfortably meets the existing permit requirements (indicated by the solid red line).

Figure 5-4: Final effluent BOD and Suspended Solids performance at West Huntspill STW



The dashed red line on the SS chart marks an SS concentration of 30mg/L. This is the level that a conventionally loaded activated sludge plant would be expected to achieve, and is also the level that is amenable to UV treatment. The chart shows how the current ASP plant at West Huntspill STW regularly exceeds this level.

The main issue therefore is that despite being compliant with the existing consent conditions, the secondary treated effluent is not amenable to UV disinfection treatment. We have hence proposed an upgrade of the existing activated sludge process as the most cost effective option to remedy that situation, and to produce a better treated effluent suitable for disinfection to the level required to meet revised Bathing Water Directive standards.

Costs

The costs of the proposed ASP option have been apportioned between drivers as below:-

Table 5-7: Cost apportionment between PR19 drivers at West Huntspill STW

	Percentage	Capex (£m)	Opex (£m/yr)
STW Growth (capacity)	10%	1.44	0.032
Quality enhancement – UV disinfection	90%	13.00	0.289
	Total	14.44	0.321

5.1.6 Customer protection

Customers will be protected if the investment is cancelled, delayed or reduced in scope through the following performance commitments and their associated ODI:

- E1: Treatment works compliance
- E10: Length of river with improved water quality through WINEP delivery

The scheme has no direct river length assigned to it in the WINEP, as the site discharges to a bathing water. However, as detailed in Appendix 3.1.A, we have developed an underperformance length of 31.31km, based on the scale and cost of the project. This PC provides a mechanism to compensate customers should we fail to deliver a WINEP output.

The scheme has a ‘green’ certainty, with a regulation completion date of 30/03/21.

5.1.7 Conclusion

We have clarified the need for an enhancement scheme at West Huntspill STW. The EA have confirmed in writing that a scheme is required.

Although the capital costs for the West Huntspill STW microbiological improvement project were included in WWS2 line 21, the associated population equivalent was not included in WWn2 line 24. This has been corrected in our latest submission and brings our unit cost/PE down to below the industry median cost.

Ofwat's UV disinfection enhancement feeder model has deficiencies that make it unrepresentative of the true costs of the work to Wessex Water. We have clarified the need to install additional secondary treatment in order to meet the disinfection requirements, and have presented a number of options that we have considered to select the best option for customers, as well as demonstrating our costs to be robust and efficient. Furthermore, no specific allowance for opex has been made, despite additional opex being integral to meeting this new environmental obligation.

We would request that, on the basis of the additional evidence provided above, the UV disinfection costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

5.2 Shellfish waters

This chapter should be read in conjunction with Chapter 7.2 of *Supporting document 5.1 – Protecting and enhancing the natural environment*.

Table 5-8: Business plan table details for UV disinfection (or similar)

Table	Lines	Line Description
WWS2	21 / 68	WINEP ~ UV disinfection (or similar)

5.2.1 Ofwat's cost assessment

Ofwat's cost assessment is based on the results from their UV disinfection enhancement feeder model. In relation to Corfe Castle, this provided a capex allowance of £0.59m compared to our business plan estimated capex cost of £3.8m.

The deep dive on UV disinfection in our proposals related to improving Shellfish Waters (Corfe Castle STW) received two passes, two partial passes and a fail, as follows:

- Need for investment – pass
- Management control – pass
- Best option for customers – partial pass
- Robustness and efficiency of costs – fail
- Customer protection – partial pass.

We provide below additional evidence related to the best option for customers, robustness and efficiency of our costs, and customer protection for our investment proposal. In addition, Ofwat have disallowed the operating costs included in business plan Table WWS2 and we explain why these costs are integral to the delivery of our proposals.

Ofwat query

Ofwat have queried the stating of our p.e. for the site.

> *"We would want to verify the PE reported in WWn4 as WINEP3 provides an estimated PE of 2098 for Corfe Castle."*

We acknowledge that there is a discrepancy between the population equivalent provided in the business plan table and the WINEP:
- WWn4: 1,646 for 2017/18 (comprising resident + Ofwat methodology for non-resident)
- WINEP3: 2,098 for 2015/16 (comprising resident + full non-resident)

The value used to populate table WWn4 follows the Ofwat methodology stated in RAG 4.07 'Guideline for the table definitions in the annual performance report' that *"Companies should assume a two-thirds occupancy rate for fourth months in the year."*

The catchment has a significant non-resident population, with the site experiencing significant seasonal variations in flows and loads. Approximately 240,000 visitors go to Corfe Castle (run by the National Trust) each year, indicatively profiled as 2.5% each winter month and 20% each summer month, and there are approx. 20,000 paying visitors per annum to Corfe Castle Model Village (although the number visiting the café is an estimated

80,000). These two non-resident contributors equate to 250p.e. over the summer reduced to 50p.e. over the winter (negating any skewing from bank holiday weekends), although STW influent data supports the trend of more visitors to the area outside of the typical summer period. The new disinfection process needs to be designed for resident and full non-resident population equivalent.

As identified previously, we consider Ofwat's model costs to be biased towards implementing solely UV disinfection processes rather than considering disinfection as a whole for the treatment process, as required to meet the environmental obligations. Each STW has a different level of disinfection required, which is dependent on the receiving bathing or shellfish water. The level of enhancement required also depends on the existing treatment type and performance of the works. We do not consider Corfe Castle STW to be comparable with the 'average' scheme elsewhere, and we discuss this further in the following sections.

Furthermore, the set of econometric models that Ofwat drew on for setting base opex cost allowances do not control for UV disinfection, whether to cover the operation of the new UV plant itself or that needed for the improved secondary treatment as previously described. We accept the possibility there is some implicit allowance for the opex to meet this new obligation in the base allowance, although the choice of cost drivers in those models and Ofwat's approach to forecasting cost driver (namely on load treated at STWs with ammonia consent <3mg/l) would suggest this may be limited.

5.2.2 Best option for customers

Corfe Castle STW is a conventional biological filter works with primary tanks, secondary filters and humus settlement tanks. The site is compliant to its existing permit; however, the existing secondary biological treatment is considerably overloaded. The site has been supported by a temporary submerged aerated filter (SAF) since 2014. The existing humus tank has insufficient retention time and excessive surface loading. Solids carryover would be expected and is evident on site. This is currently not an issue because there is a tertiary lagoon prior to the outfall.

The EA's *'Water Discharge and Groundwater Activity Permits'* (EPR 7.01) additional guidance document was withdrawn in May 2018, and has been replaced with a number of more specific guidance notes. However, the replacement guidance on disinfection *('Water companies: discharge disinfection (UV and membrane), efficacy monitoring and reporting requirements and assessing compliance'*) has not yet been issued by the EA. In EPR 7.01, the EA allow the required reduction to be achieved through a combination of conventional treatment, disinfection and dilution or dispersion. With regards to disinfection processes, the EA currently accepts only UV disinfection or specific membrane filtration/disinfection processes for long-term use. Other techniques are only acceptable on a trial or interim basis.

Bacterial sampling was implemented on site in August 2018 to size the proposed UV treatment plant. Initial results show that the existing STW is removing an average of 99 % *E. Coli* (2 log reduction) between the crude influent and lagoon effluent. In comparison, an average of 97 % *E. Coli* is removed between the crude and humus tank effluent. These results are shown in the below charts and are comparable with the standard assumed reduction for conventional treatment processes detailed in EPR 7.01.

Figure 5-5: E.coli levels through treatment stages at Corfe Castle STW

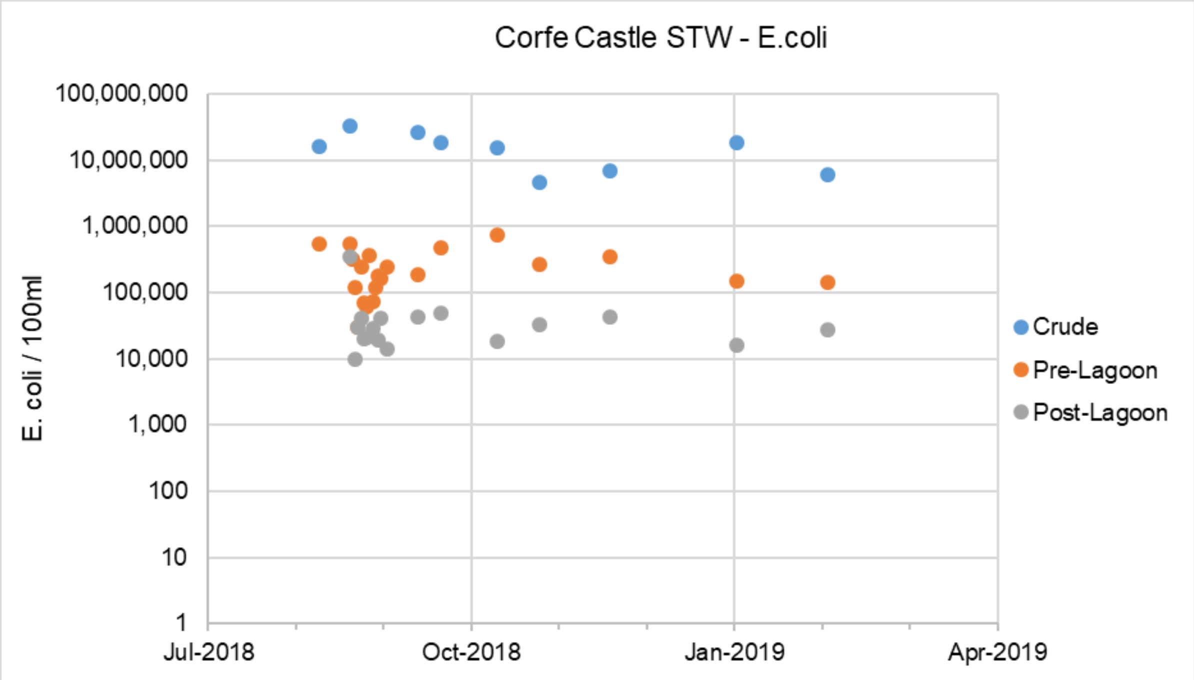
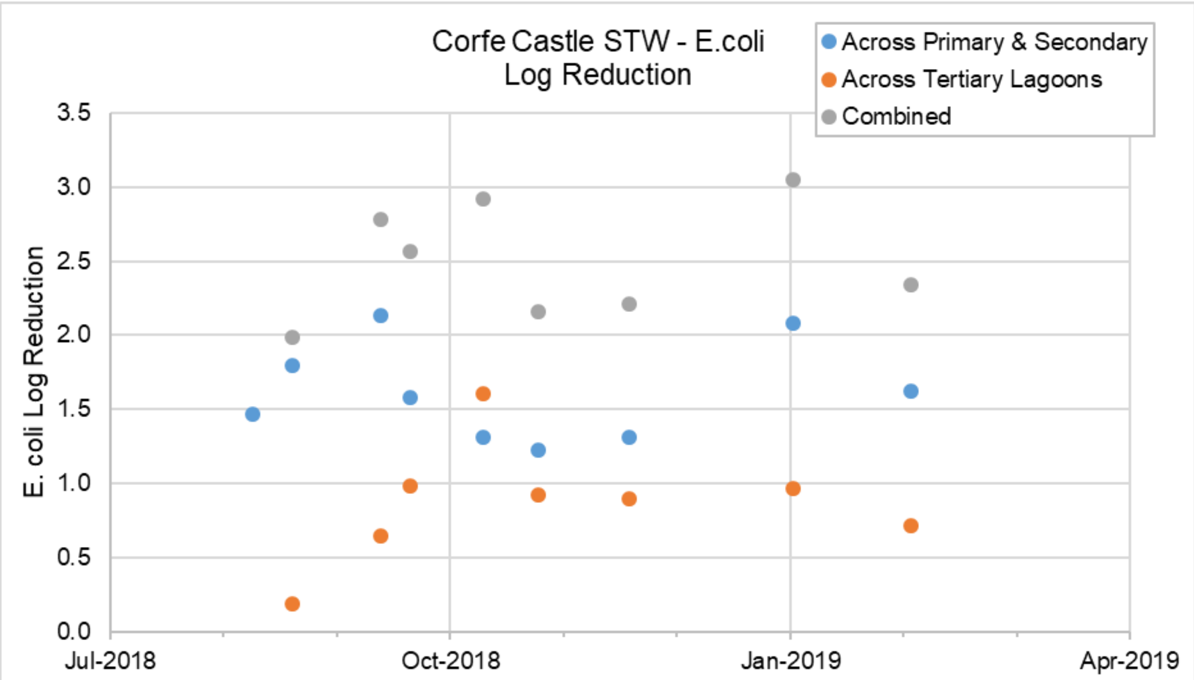


Figure 5-6: E.coli reduction through treatment stages at Corfe Castle STW

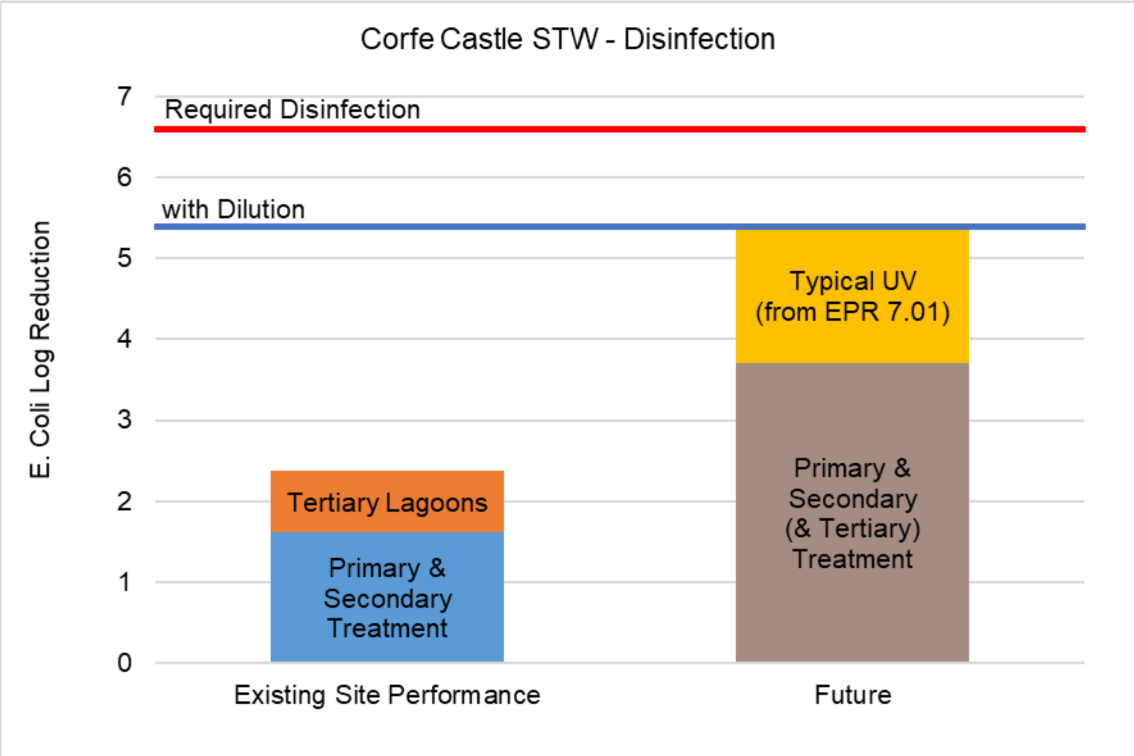


Whilst the tertiary lagoons currently offer a degree of disinfection, they are not compatible with a disinfection system (either UV or membrane) unless followed by a solids removal stage to remove any accumulated algal growth. The performance of UV disinfection depends on the quality of the incoming effluent. Algal growth can cause UV lamp fouling, and particles within the effluent can shield microbes from the UV radiation and reduce the efficacy of the process.

The WINEP requires, "*Treatment to achieve 6.6 log (4,000,000) E.coli reductions between influent and Shellfish Water boundary*". The EA subsequently advised/confirmed in July 2018:

> *"Based on a current consented DWF of 370m^3/d and a Q95 river flow of 0.069m^3/sec, the discharge is afforded 1.2 log reductions by dilution alone. As such, the new treatment process would need to deliver 5.4 log reductions across the whole works, from influent to final effluent to meet the WFD microbial standard."*

Figure 5-7: Breakdown of treatment stages at Corfe Castle STW to achieve disinfection



As can be seen from the above chart, it is not possible to achieve the required 5.4 log reduction without the addition of a dedicated disinfection process alongside improvements to the site's existing treatment processes.

The following options have been considered for improving secondary treatment:

i) 1 No. additional biological filter and 1No. additional humus settlement tank
ii) 1 No. new moving bed biological reactor (MBBR) and 1No. additional humus settlement tank

A high-level comparison of the treatment options is summarised below:-

Table 5-9: Treatment options considered to meet WINEP requirements at Corfe Castle STW

Option No.	1	2
Option Description	New UV plant With improved secondary treatment: - additional biological filter - additional humus tank	New UV plant With improved secondary treatment: - new MBBR - additional humus tank
Provides treatment capacity	✓	✓
Provides treatment capacity	✓	✓
Capex (£m)	4.263	4.883
Opex (£k/yr)	155	177
Lowest whole-life cost	✓	×

5.2.3 Robust and efficient costs

In developing the options and costs to achieve the quality (disinfection) and capacity enhancement drivers, we have sought to accurately apportion the costs between the drivers.

The construction value of the scheme was specifically benchmarked by one of our external cost consultants. Both internal and external estimates were developed from schedules of works to allow bottom-up estimates to be derived. As previously described, there is the need to provide new UV treatment as well as improve the existing secondary treatment processes in order to meet the disinfection requirement in the WINEP.

Table 5-10: Cost estimate breakdown and external benchmarking for Corfe Castle STW

	Wessex Water Internal Estimate (£k)	**External Cost Consultant** (£k)
Construction Value		
Civil work items Labour, Plant, Material & Subcontract packages	973	1,602
Mechanical and Electrical work items Labour, Plant, Material & Subcontract packages	1,273	1,324
Supervision and Prelims	556	719
Contractor Fees	196	547
Total Construction Value:	2,998	4,192
Design	449	
Project management	171	
Third party	113	
Risk (15%)	534	
Total Scheme Cost:	4,263	5,816*

* With pro-rata addition of design, project management, third party and risk.

Further details of our cost benchmarking work is described in Supporting document 8.11.

The proposed solution is therefore to provide a new UV plant with improved secondary treatment at Corfe Castle STW for:-

- new UV disinfection permit
- increased treatment capacity (to 2035)

The costs for the proposed solution have been apportioned between drivers as below:-

Table 5-11: Cost apportionment between PR19 drivers at Corfe Castle ST (excluding phosphorus)

	Percentage	Capex (£m)	Opex (£m/yr)
Quality enhancement – UV disinfection	90%	3.837	0.140
STW Growth (capacity)	10%	0.426	0.016
	Total	4.263	0.155

5.2.4 Customer protection

Customers will be protected if the investment is cancelled, delayed or reduced in scope through the following performance commitments and their associated ODI:

- E1: Treatment works compliance
- E10: Length of river with improved water quality through WINEP delivery

The disinfection improvement scheme contributes to 3.65km of river length improvement (as identified in the WINEP). The scheme has a 'green' certainty, with a regulation completion date of 30/06/21.

5.2.5 Conclusion

Ofwat's UV disinfection enhancement feeder model has deficiencies that make it unrepresentative of the true costs of the work to Wessex Water. We have clarified the need to install additional secondary treatment in order to meet the disinfection requirements, and have presented a number of options that we have considered to select the best option for customers, as well as demonstrating our costs to be robust and efficient. Furthermore, no specific allowance for opex has been made, despite additional opex being integral to meeting this new environmental obligation.

We would request that, on the basis of the additional evidence provided above, the UV disinfection costs as submitted in our business plan in September 2018 are allowed in full (subject to a potential negative adjustment for any implicit allowance if there is evidence of this).

6. Partnership working

This chapter should be read in conjunction with Chapter 7 of *Supporting document 4.1 – Providing resilient services* and Chapter 3.2 of *Supporting document 5.1 – Protecting and enhancing the environment*

Table 6-1: Business plan table details for partnership working

Table	Lines	Line Description
WWS2	33 / 80	Partnership working

In this chapter we expand on our proposals for partnership working in PR19.

6.1.1 Ofwat's cost assessment

In our business plan we included a freeform line of 'Partnership working', which was subsequently reallocated by Ofwat to their wastewater resilience model.

Our proposals received a partial pass on best option for customers, with Ofwat making the following comment:

> *"We understand that the Partnership working programme funds activity relating to catchment partnerships, biodiversity & bathing waters. We understand that these programmes are often lead by other stakeholders and thus advance programmes may not be clearly defined but are likely to include contribution to habitat restoration to enhance environmental resilience, for example. However, Wessex Water has not provided any information relating to how its proposed investment levels have been developed and this calls into question the robustness of the cost estimate. Therefore an efficiency challenge has been applied to this expenditure*."

A challenge of 20% was applied to our proposal, with a capex allowance of £1.7m compared to our business plan estimated capex cost of £2.3m.

Our proposals for Partnership working included three areas of work:

- Bathing Waters Partners Programme
- Catchment Partnerships
- Brinkworth Brook.

In the following section we provide evidence further detailing our proposals.

6.1.2 Best option for customers

Our proposals for Partnership working include three areas of work:

Table 6-2: Partnership working schemes included in our plan

Partnership Schemes	Capex (£m)
Bathing Water Partners Programme	1.056
Catchment Partnerships	0.950
Brinkworth Brook	0.317
Total	**2.323**

Costings for our partnership working schemes have been developed from current AMP6 spend and projected activity levels in PR19. Third party scheme stakeholders have provided indicative costings for some areas to inform our overall proposals.

Bathing Waters Partners Programme

In AMP7 we are proposing to support key delivery groups (Litter Free Coast & Sea Somerset and Dorset) working collaboratively with us to maximise engagement opportunities with local communities and businesses to improve bathing water quality and wider amenity. These groups will be key to supporting and enabling the delivery of our Bathing Water amenity performance commitment, alongside additional work with our Catchment Delivery Team and Catchment Sensitive Farming (a partnership between Defra, the Environment Agency and Natural England) where the greater impact on bathing water amenity is from diffuse agricultural pollution.

These two projects engage with local business to raise awareness of issues such as: waste management practices which attract vermin; disposal of fats, oils and greases and customer behavioural practices, all of which can lead very local impacts on bathing water quality and detract from the local amenity. The projects have strong links with communities raising awareness of issues such as dog fouling and littering, to provide educational resources for schools and establishing sustainable beach clean groups. The emphasis is on raising awareness and encouraging behaviour change in order that interventions are sustained by the local business and residential communities over the longer term. We have also included the provision to work with other groups such as Surfers Against Sewage, Marine Conservation Society and Local Authorities to develop and support specific campaigns and projects which may arise during the AMP.

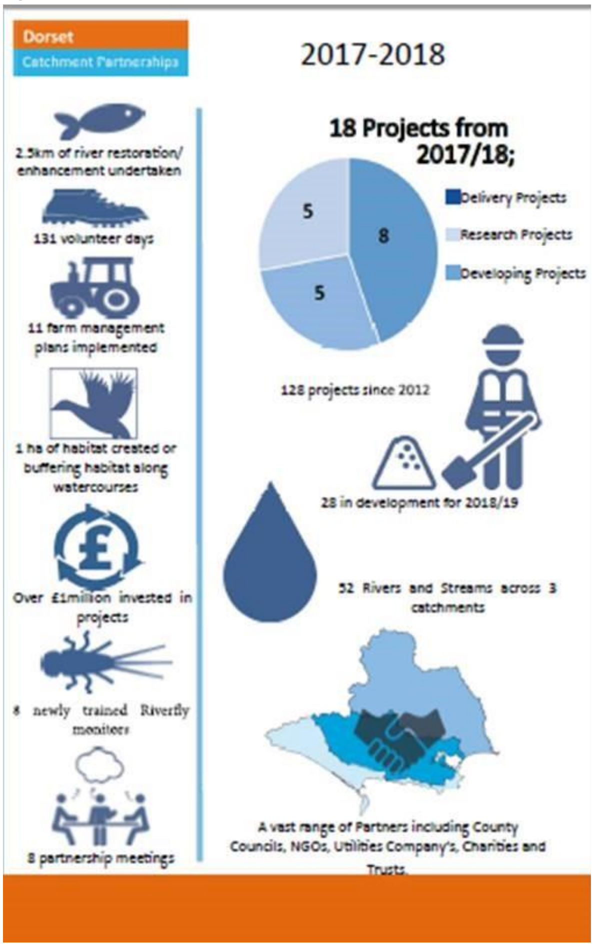
Initial conversations with the Litter Free Coast and Sea Projects have suggested that c.£80-100k per project, per year would be required to deliver the level of activity identified for PR19.

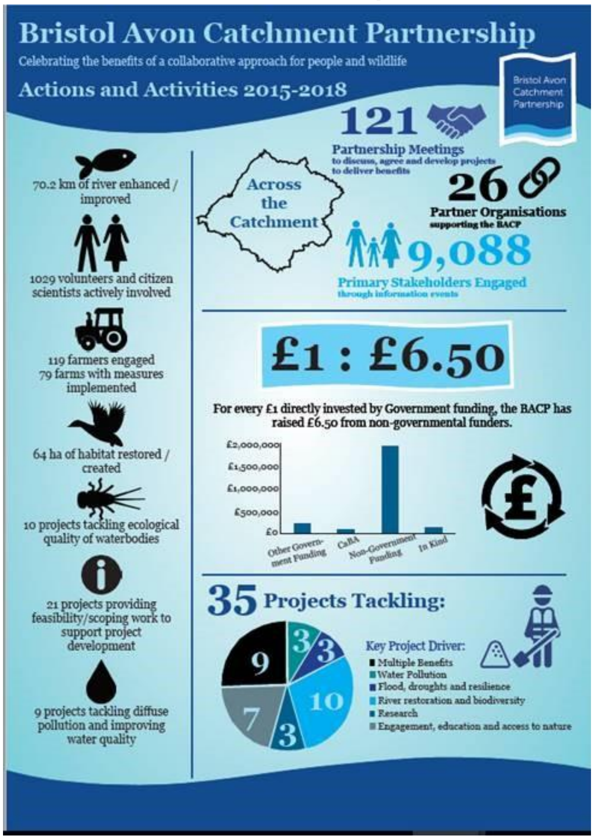
<u>Catchment Partnerships</u>

Wessex Water hosts two catchment partnerships in the Bristol Avon and Dorset. This entails financial support for two Catchment Co-ordinators (one per catchment), a Technician and an Apprentice, to develop partnership working and enable the delivery of projects to assist with the delivery of WFD and biodiversity outcomes. We intend to continue to support these partnerships during AMP7 as we recognise the huge value which is derived from enabling partners to work more efficiently and effectively together. These partnerships enable the delivery of the outcomes of the 25 Year Environment Plan in collaboration by offering a high level of river restoration and habitat creation to delivered, for example. Whilst we host the Catchment Partnerships in the Bristol Avon and Dorset, we also provide a financial contribution to the other organisations hosting the partnerships in Somerset and the Hampshire Avon.

The below infographics show the deliverables for the Dorset and Bristol Avon Catchment Partnerships during 2017-18 and 2015-18 respectively.

Figure 6-1: Deliverables for the Dorset and Bristol Avon Catchment Partnerships





In addition to the Catchment Partnerships, we also support the delivery of wider biodiversity improvements across our region through our Biodiversity Action Plan Partners Programme. This Programme comprises two grants (major and minor) to support projects within our region which contribute towards the delivery of the catchment-based approach, align with payments for ecosystems services approaches and further science and research. All projects supported are aligned with our business functions and enable the opportunity to learn and share new techniques with partners, develop best practice and deliver natural capital gain within our region but outside our landholding.

Supporting these Partnerships during AMP7 will enable the company to develop metrics and monitor the delivery of natural capital gain across our region. The intention is that the outcomes of these partnerships are used within a Wessex Water Natural Capital assessment to describe how we deliver natural gain on our landholding and within our region. This will inform a PR24 natural capital performance commitment.

The current (AMP6) 5-year costs to support the Bristol Avon CP, Dorset CP and the Partners Programme is £1.13m. This excludes the Hampshire Avon and Somerset Catchment partnerships. AMP7 budgets are based on current AMP6 spend and projected activity levels in PR19.

Brinkworth Brook

As described in Section 3.2.4 of Supporting document 5.1, we set up a 5-year pilot to investigate the potential of catchment nutrient balancing, based in Brinkworth Brook waterbody catchment in the Bristol Avon wider catchment. This pilot will investigate a number of issues, including types of measures, modes of engagement, delivery options and assessment of the impacts of measures. The pilot is being undertaken in close collaboration with the EA and local partners.

The trial commenced in June 2017 and will run through into AMP7. The budget for the full 5-year trial is £630k, with £317k identified to complete in AMP7. These costs are separate to those attributed to our phosphorus removal and catchment nutrient balancing freeform lines in WWS2

6.1.3 Conclusion

In response to Ofwat’s uncertainty about what schemes contribute to our partnership working proposals in PR19, we have supplied further information on the schemes.

We would request that, on the basis of the additional evidence provided above, the partnership working costs as submitted in our business plan in September 2018 are allowed in full.

Annexes

The following annexes are new or updated versions of annexes in *Supporting document 5.1 – Protecting and enhancing the natural environment*. Unlisted annexes have not changed from those in the supporting document submitted in September 2018.

Annex B. Avonmouth STW

This annex is an update of Annex B from
Supporting document 5.1 – Protecting and enhancing the natural environment.

1. Need

Quality Enhancement

The following lines are included in the WINEP for Avonmouth STW:

Table B-1: Quality enhancement drivers identified in the WINEP for Avonmouth STW

Driver Code	Driver code Information	Relevant section within Supporting document 5.1
Investigations / Monitoring		
U_INV	Frequently spilling overflow investigation	4.1
U_MON3	Storm tank EDM	3.5
U_MON4	Flow measurement	3.5
WFD_MON_CHEM	Chemical Investigations	3.4
WFD_INV_CHEM2		3.4
WFD_INV_CHEM14		3.4
Improvements		
U_IMP5	FFT increase	3.5

This annex relates to works associated with the improvement quality driver.

In December 2017 we were advised that the WINEP for PR19 would require an increase in flow to full treatment (FFT) at Avonmouth STW by 35.4%. This was confirmed in the WINEP3 in March 2018, which included the increase in FFT described below:

Table B-2: PR19 permit identified in the WINEP for Avonmouth STW

Driver Code	Driver code Information	Completion Date	Level of certainty?	Old Permit	New Permit
U_IMP5	FFT	31/03/2025	Green	3,472 l/s	4,700 l/s

The 4,700l/s figure represents the “3PG+I_{max}+ 3E” at year 2025.

The EA have stated, in relation to the U_IMP5 projects that “Future risk due to growth should be picked up by the Water Companies under growth or maintenance in their Capital Programme, not WINEP” and also that **“**U_IMP5 *(and U_IMP6*) drivers only apply to increases required to FFT *(and storm tank capacity)* over and above those required and funded under growth.” [2]

[2] Environment Agency (November 2017). PR19 further guidance for completing WINEP3 for flow drivers U_MON3, U_MON4, U_IMP5 and U_IMP6 DRAFT v0.10.
Environment Agency (December 2017). PR19 Driver Guidance: Increasing Flow to Full Treatment (FFT)- FINAL v3.

This means that investment to meet the new FFT at year 2025 will be costed under the quality enhancement driver, while the provision of capacity to a reasonable design horizon (i.e. 2040) will be allocated to capacity enhancement.

Growth Enhancement

Historical and future planned growth in both residential and trade flows and loads requires additional treatment capacity to ensure that the site continues to maintain environmental permit compliance. Some increase in biological treatment capacity will be required during 2020-2024, with further treatment capacity likely to be required during 2025-2030 based on population growth projections.

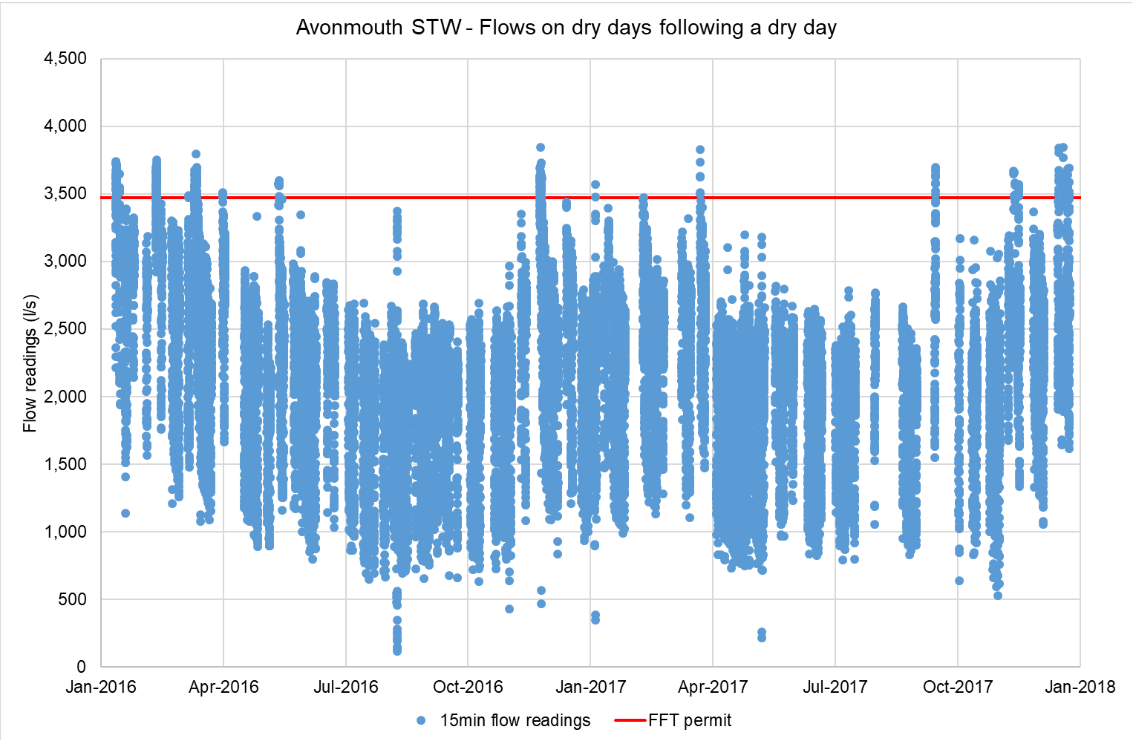
2. Background

Avonmouth STW is our largest STW, serving a population equivalent of 799,129. It treats sewage from most of the Bristol city area and also receives a high trade load, particularly from nearby industries in the Severn Estuary. The site is co-located with a Sludge Treatment Centre, which also receives sludge imports from other STWs. Additional loads are also received from the onsite Organic Waste facility and the Food Waste facility.

There are two treatment streams at Avonmouth STW, the largest treating approximately 91% of the inflow comprises 11 Sequencing Batch Reactor (SBR) basins. The last investment in capacity occurred in 2003, with the addition of three SBR basins.

The existing permit FFT is a low multiplier of DWF (<3). As can be seen in the figure below, the site routinely treats flows in excess of the permit FFT on dry days.

Figure B-1: Flows through Avonmouth STW on dry days (and following a dry day)



3. Options

The existing treatment streams are at the limit of their hydraulic capacity, and thus for the site to pass the required FFT to meet the WINEP requirements, an additional process stream is required. This has been sized as follows:

Table B-3: Design flow parameters for increased FFT at Avonmouth STW

	Current	By 2025
DWF	179,867 m^3/d = 2,082 l/s	2,082 l/s
FFT	3,472 l/s	4,700 l/s
FFT:DWF Multiplier	1.67	2.26
Flow splits to process streams		
Existing SBRs (11no. tanks as twin stream)	90% = DWF: 1,874 l/s FFT: 3,125 l/s	66% = DWF: 1,384 l/s FFT: 3,125 l/s
Existing ASP (twin lane)	10% = DWF: 208 l/s FFT: 347 l/s	7% = DWF: 154 l/s FFT: 347 l/s
New Process Stream	-	26% = DWF: 544 l/s FFT: 1,228 l/s

Two options were considered to provide the required hydraulic capacity enhancement. In brief, these two options included the following:

- Option 1 – 4 additional SBRs
  - Four new PSTs
  - Four new SBR basins and associated ancillaries, as per design of existing
- Option 2 – Additional ASP stream
  - Four new PSTs
  - New aeration lanes
  - Eight new final settlement tanks FSTs

Both of these options would be located on our land to the south of existing site operational boundary.

Table B-4: Treatment options at Avonmouth STW for the increased FFT WINEP3 driver

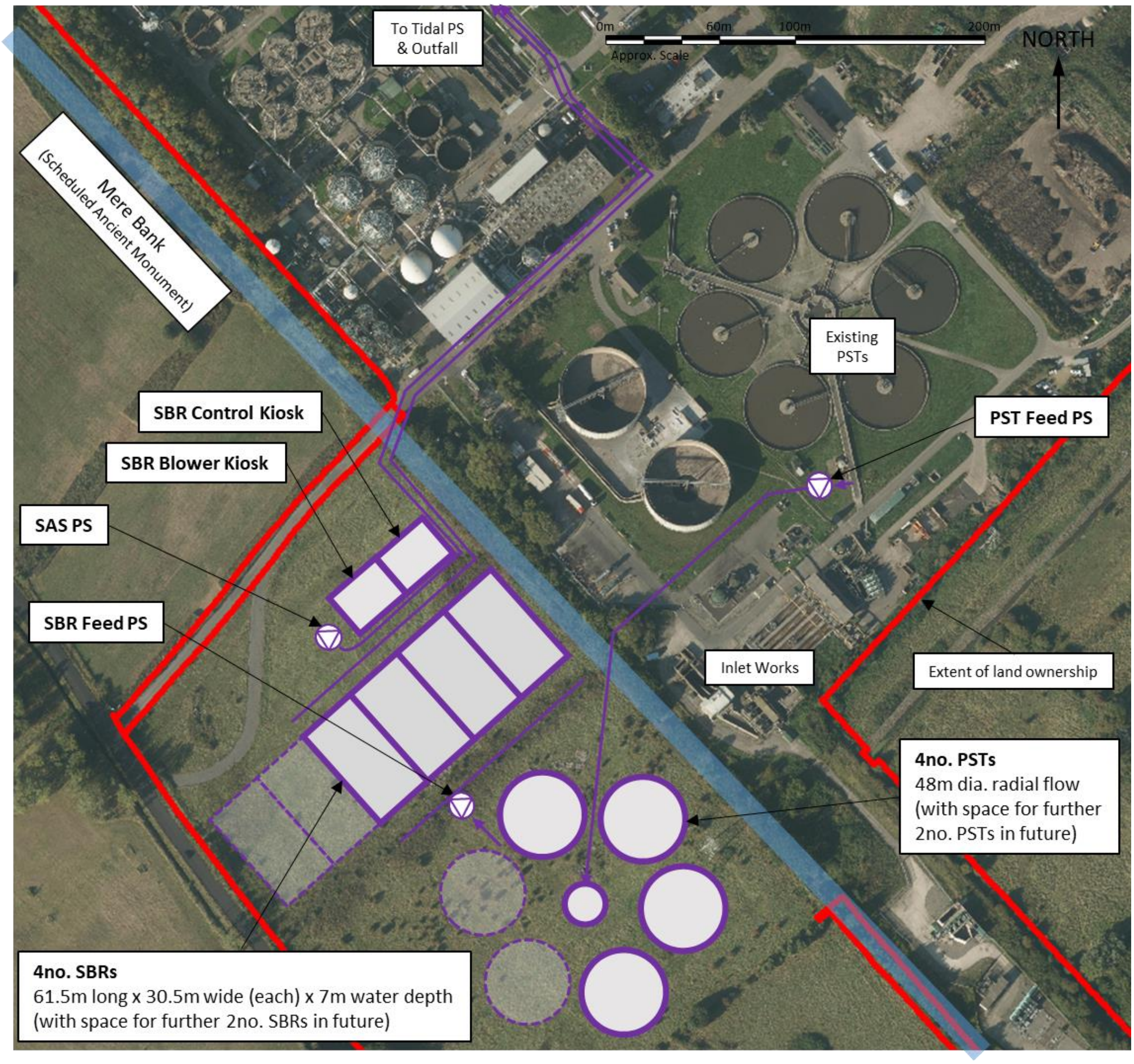
Option	Option 1 4no. SBRs	Option 2 ASP
Provides hydraulic capacity to meet new FFT	✓	✓
Provides treatment capacity to 2025	✓	✓
Permits future expansion on site for future growth	✓	×
Scheme Capex (£m)	46.02	80.84
Opex (£k/yr)	778	850
Lowest whole-life cost	✓	×

4. Proposed solution

As can be seen above, Option 1 (4no. SBRs) has the lowest whole life cost. This option also provides synergies with future treatment capacity and is thus included in our PR19 proposal.

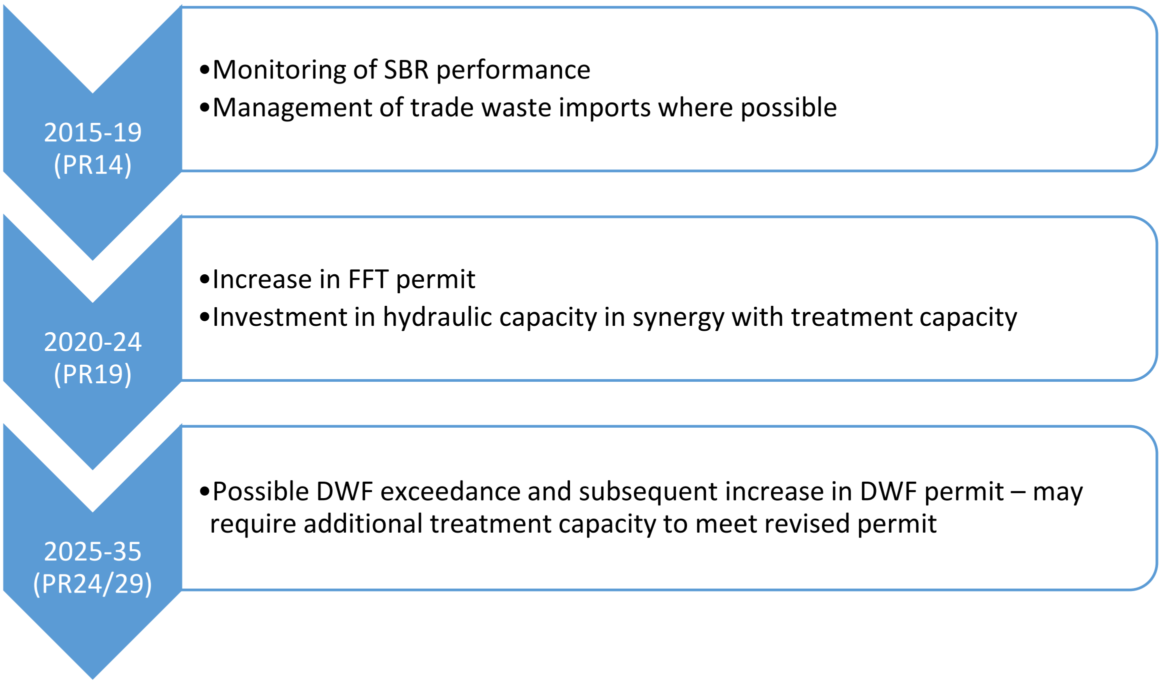
An indicative layout for this proposed option is show below.

Figure B-2: Proposed site plan of Avonmouth STW to pass an increased FFT



Due to the requirement under the WINEP, a significant increase in hydraulic capacity is required at the works. The hydraulic capacity enhancement will additionally provide treatment capacity enhancement up until 2025. Following this it is expected the permitted DWF will be exceeded around 2030, triggering a permit change. We are thus anticipating the need for further investment in treatment capacity enhancement in PR24, as shown in the following figure.

Figure B-3: Recent historical and mid/long-term plan for Avonmouth STW



Annex D. Saltford (Bath) STW

This annex is an update of Annex D from *Supporting document 5.1 – Protecting and enhancing the natural environment*.

1. Need

Quality Enhancement

The following lines are included in the WINEP for Bath (Saltford) STW:

Table D-1: Quality enhancement drivers identified in the WINEP for Saltford STW

Driver Code	Driver code Information	Relevant section in Supporting document 5.1
Investigations / Monitoring		
U_MON3	Storm tank EDM	3.5
U_MON4	Flow measurement	3.5
WFD_MON_CHEM	Chemical Investigations	3.4
WFD_INV_CHEM4		3.4
WFD_INV_CHEM14		3.4
Improvement		
U_IMP5	FFT increase	3.5

This annex relates to the works associated to meet the improvement quality driver.

In December 2017 we were advised that the WINEP for PR19 would require an increase in flow to full treatment (FFT) at Saltford STW by about 27%. This was confirmed in the WINEP3 in March 2018, which included the increase in FFT described below:

Table D-2: PR19 permit identified in the WINEP for Saltford STW

Driver Code	Driver code Information	Completion Date	Level of certainty?	Old Permit	New Permit
U_IMP5	FFT	31/03/2025	Green	580 l/s	734 l/s

The 734l/s figure represents the "3PG+I_{max}+ 3E" at year 2025.

The EA have stated, in relation to the U_IMP5 projects that "Future risk due to growth should be picked up by the Water Companies under growth or maintenance in their Capital Programme, not WINEP" and also that **"**U_IMP5 *(and U_IMP6*) drivers only apply to increases required to FFT *(and storm tank capacity)* over and above those required and funded under growth." [3]

[3] Environment Agency (November 2017). PR19 further guidance for completing WINEP3 for flow drivers U_MON3, U_MON4, U_IMP5 and U_IMP6 DRAFT v0.10.
Environment Agency (December 2017). PR19 Driver Guidance: Increasing Flow to Full Treatment (FFT)- FINAL v3.

This means that investment to meet the new FFT at year 2025 will be costed under the quality enhancement driver, while the provision of capacity to a reasonable design horizon (i.e. 2040) will be allocated to capacity enhancement.

Growth Enhancement

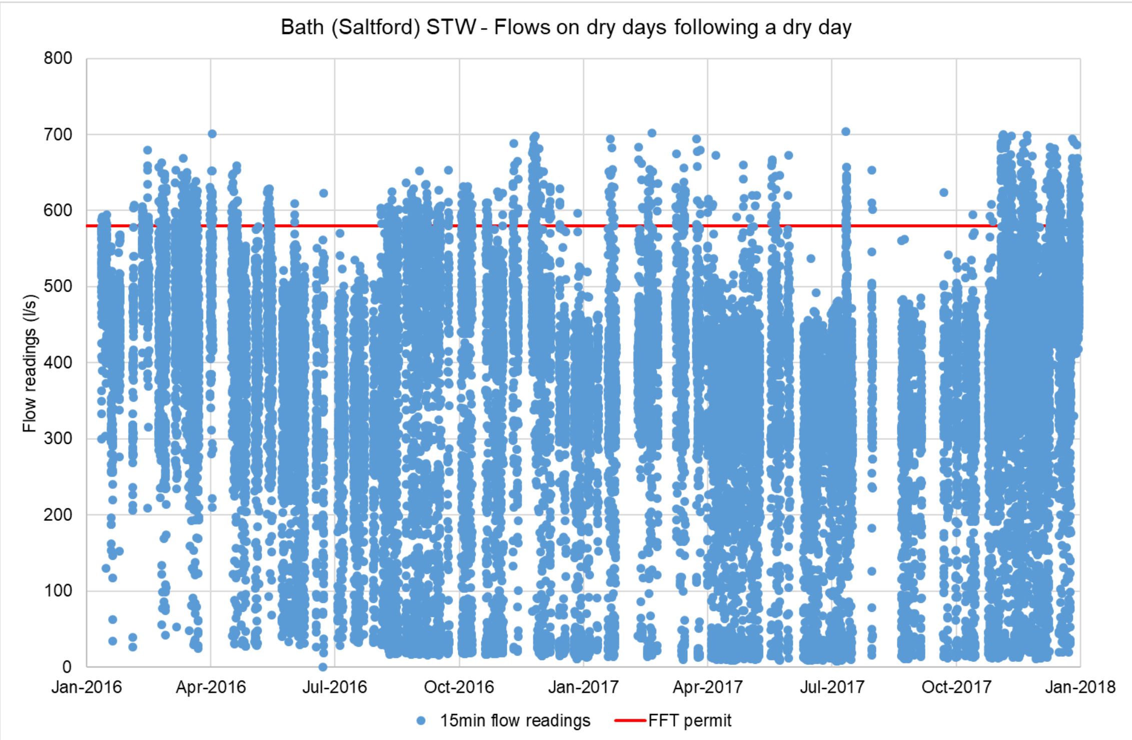
Saltford STW was listed as a defined growth scheme in our PR14 business plan. Ahead of the UWWTD FFT increase driver being added to the WINEP, we were already developing plans for a growth scheme in AMP6. The most cost beneficial option was to provide a tertiary nitrification stage on the back-end of the existing treatment processes. However, on receipt of the WINEP it became clear that this proposal would not provide the necessary hydraulic capacity required to meet the FF increase driver. To avoid significant abortive work, this AMP6 growth has thus been put on hold, and until this PR19 scheme is delivered we are maintaining the site through temporary treatment measures.

2. Background

Saltford STW is located in the Bristol Avon catchment. The STW serves a population equivalent of 118,271, comprising the city of Bath and part of Saltford, along with other surrounding villages. The STW is a conventional biological filter works with primary tanks, secondary filters and humus settlement tanks. There is also chemical dosing for P removal. Sludge is pumped into the Bristol sewerage network, for treatment at Avonmouth STW

The existing permit FFT is a low multiplier of DWF (<3). As can be seen in the below figure, the site routinely treats flows in excess of the permit FFT on dry days.

Figure D-1: Flows through Saltford STW on dry days (and following a dry day)



3. Options

The existing filter treatment works is at the limit of its hydraulic capacity. All options for increasing the hydraulic throughput through Saltford STW by 27% therefore require the provision of an additional new treatment stream, in parallel with the existing, to pass the increased flow. Our standard treatment solutions for this size of STW with conventional secondary treatment standards (25:40:10 mg/L BOD:SS:AmmN (95%ile) and <1.0mg/L P (annual average)) include:

- a new activated sludge plant (ASP) treatment stream
- a new moving bed biological reactor (MBBR) treatment stream
- a new biological filter treatment stream

Access to the STW is very poor, via a narrow road through Saltford village (although see below about potential access improvements). A design horizon to 2040 has therefore been selected for this scheme to avoid returning in the near future. The equivalent "3PG+I_{max}+ 3E" figure at year 2040 is 795 l/s, which represents an increase in FFT of 37% over the existing.

A combined project has been developed, taking account of these multiple drivers and synergies, to provide an efficient solution for the capacity and quality enhancements.

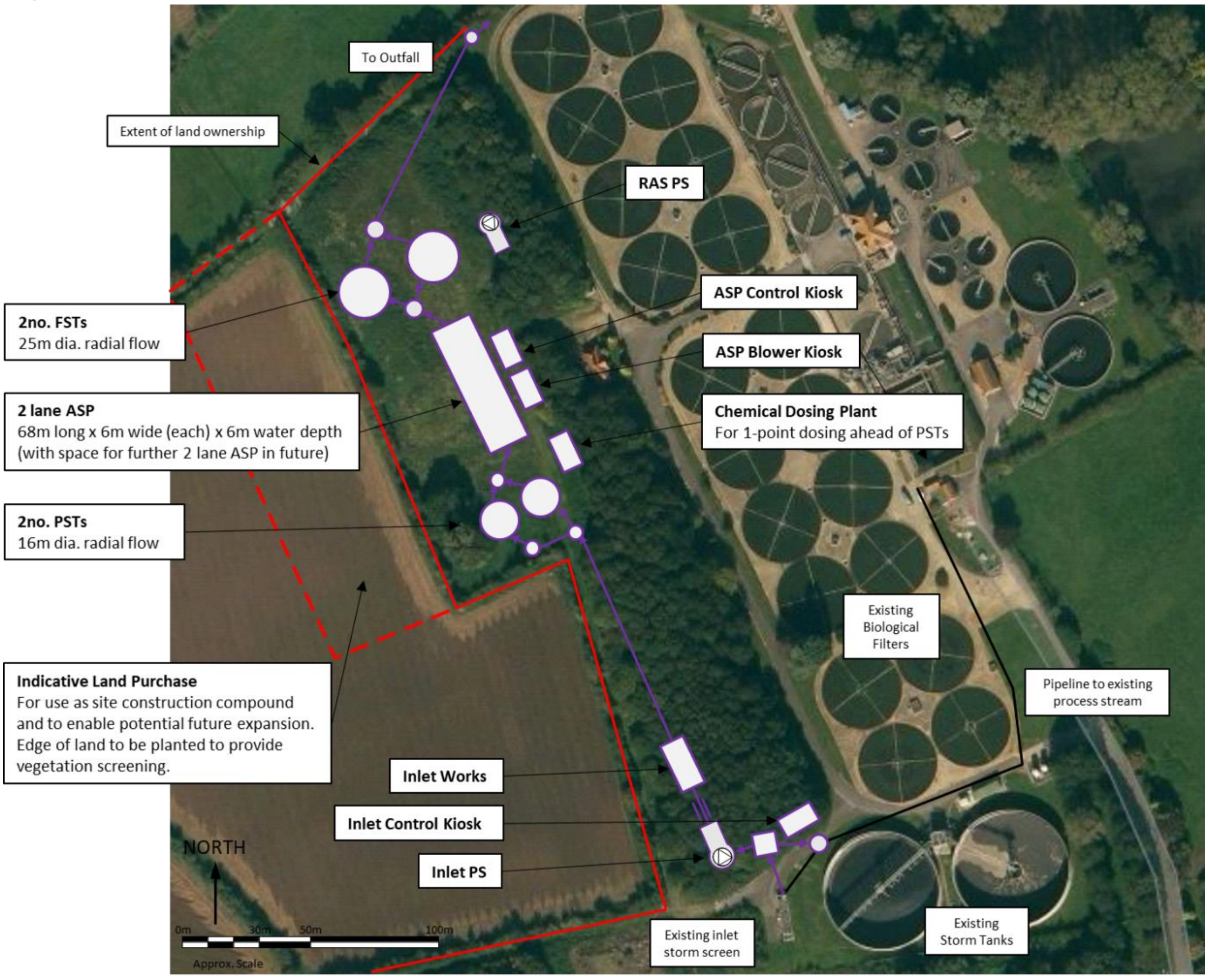
The option of providing additional treatment by extending the existing conventional biological filter treatment process was discounted due to the limited land area available at the STW site (although is included in the table below for information). A high-level comparison of the treatment options is summarised below:

Table D-3: Treatment options at Saltford STW for the increased FFT WINEP3 driver

Option	New Activated Sludge treatment stream	New Secondary MBBR treatment stream	New Secondary biological filters treatment stream	New nitrifying MBBR tertiary treatment stage.
Provides treatment capacity	✓	✓	✓	✓
Meets new FFT permit	✓	✓	✓	×
Fits on existing site	✓	✓	×	✓
Utilises existing assets	✓	✓	✓	✓
Capex (£m)	22.20	23.51	Not feasible	Fails to provide hydraulic capacity
Opex (£k/yr)	600	668		
Lowest whole-life cost	✓	×	×	×

The proposed layout for the ASP option is shown in the following figure.

Figure D-2: Proposed layout at Saltford STW to meet the WINEP requirements



<u>Required New Access</u>

Access to the STW is poor and via a narrow road through the village of Saltford. An access appraisal by our Engineering and Construction team has concluded that a new access will be needed for the construction of the proposed works, which will also involve a new access bridge over the Bristol Avon river.

The 2018 report from our Engineering & Construction team concluded that it was not practical to plan construction of the proposed major new treatment stream on the basis of using the existing access. This was due to the nature of the existing access along a narrow street and under a low bridge, as well as the disruption to village community life that construction traffic would cause. This was the same conclusion that was reached in 2002 when the last major scheme (Bath CSO project) was constructed at the site. In the previous case a temporary access and temporary river crossing were constructed to provide access for the heavy vehicles and materials required for the construction project. In the current case we have taken a longer term and more strategic view and are planning to provide a permanent new access, including a permanent new bridge across the river. This will help to secure access for potential further schemes in AMPs 8,9 and beyond.

Figure D-3 shows the three short-listed options (along with the existing access for reference) that were considered to identify an acceptable and cost-effective new access route. The cost of this new access has been estimated at £4.0 million, with this cost shared between our Flow to full treatment (£1.1million), STW Growth and Capital Maintenance business plans. The cost attributed to the FFT driver is equivalent to the cost of providing a temporary access only. Figures D-4 and D-5 show the many constraints that need to be reviewed in selecting the most appropriate new access route.

Figure D-3: Appraisal of new access routes to Saltford STW

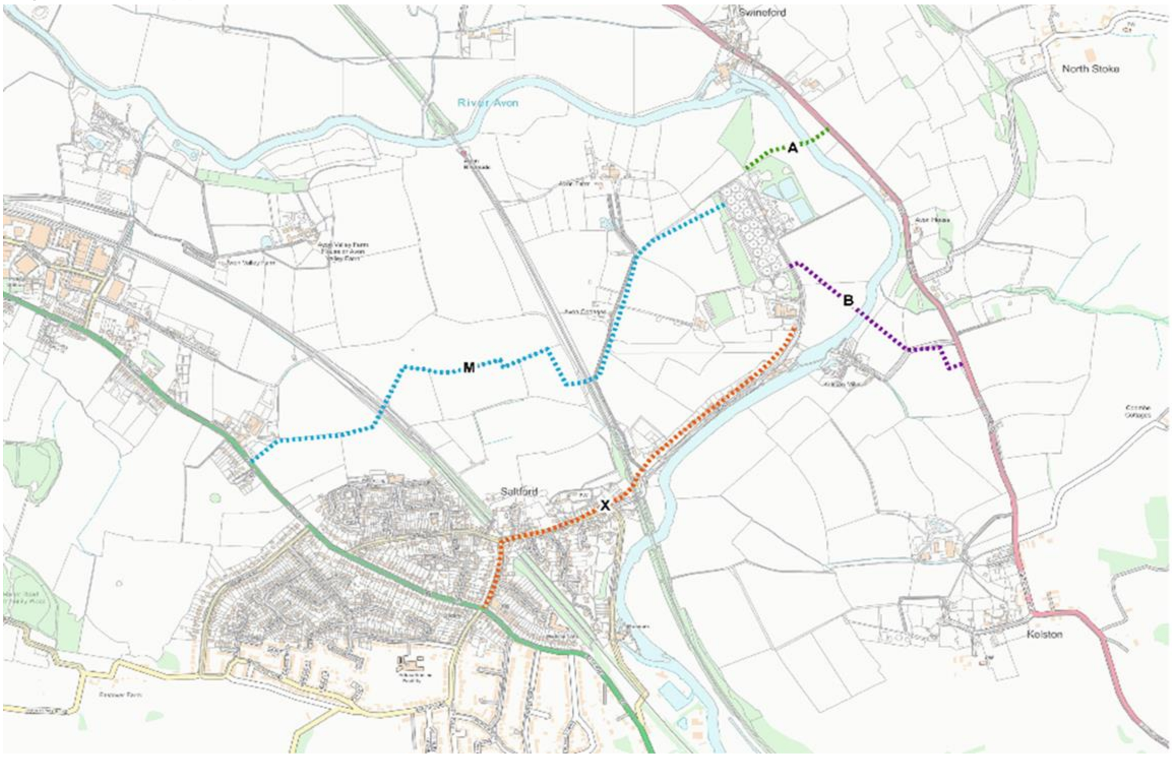
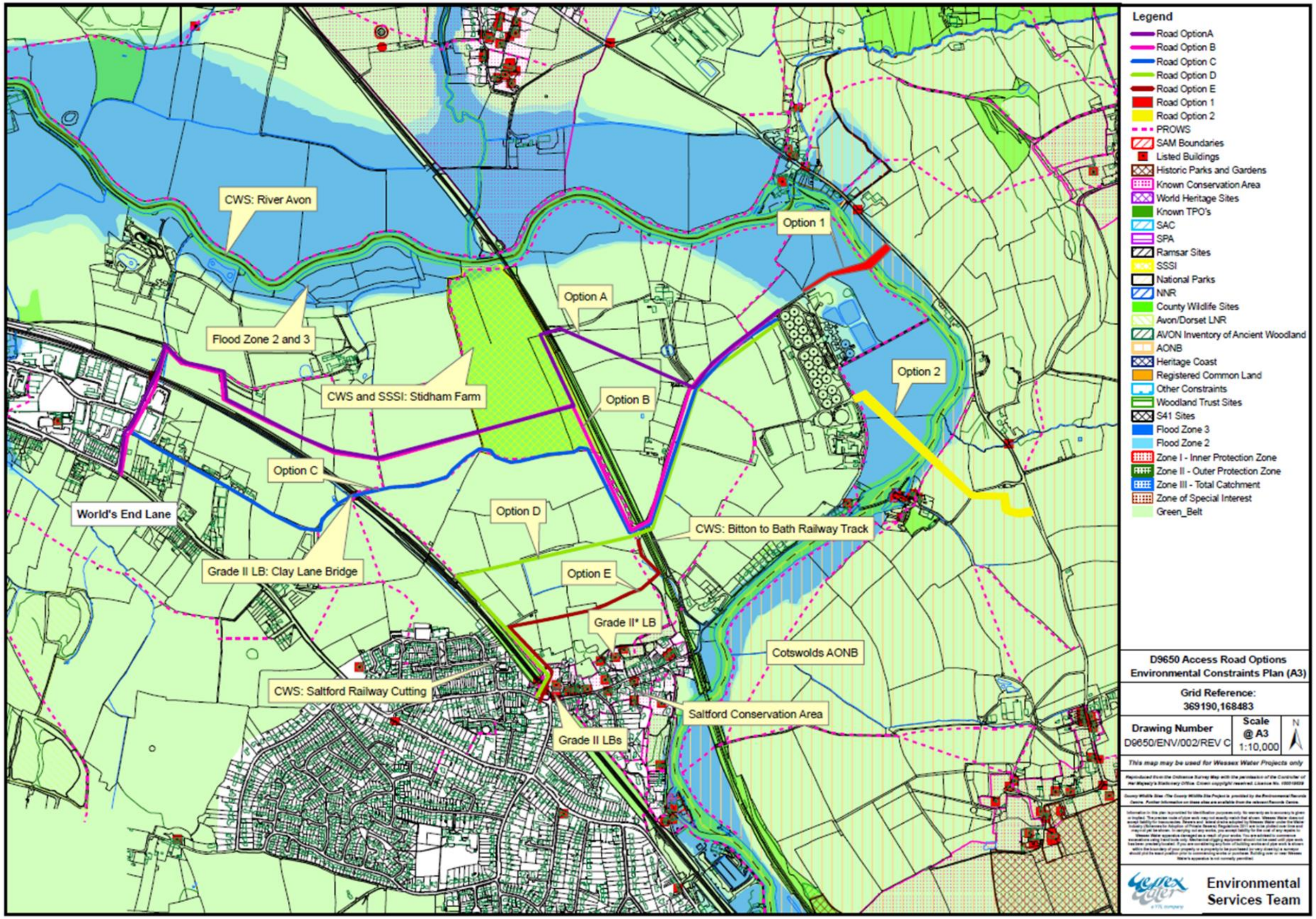


Figure D-4: Listed buildings adjacent to existing access routes to Saltford STW (route X)

Figure D-5: Environmental Designations and initial access route options



The medium to long-term plan for Bath and improvements to its CSOs potentially requires investment in additional storm storage capacity at Saltford STW in PR24 or PR29. This would also involve a significant construction project. We are therefore planning to provide a new access to the STW which can be used for construction traffic in PR19, and then as a new permanent access to the STW serving day-to-day operational needs as well as all future major engineering schemes.

We are currently in discussion with Bath & NE Somerset council (BANES) over the need and preferred location for this new access road and river crossing. Their initial response to the options discussed is that they are supportive of the option A.

4. Proposed Solution

The proposed solution is to take advantage of the synergies from a combined scheme, providing additional primary treatment and a new activated sludge secondary treatment stream to provide treatment for:

- a 37% increase in flow to treatment (to 795 l/s)
- increased treatment capacity for historical and future population growth

A new site access road and bridge over the River Avon is also proposed.

The marginal cost of providing a 10% increase in FFT over and above the 2025 figure stated in the WINEP is relatively small. Costs have therefore been apportioned between drivers as below:

Table D-4: Cost apportionment between PR19 drivers at Saltford STW

	Percentage	Capex (£m)	Opex (£m/yr)
STW Growth (capacity)	5%	1.11	0.570
Quality enhancement – increase FFT	95%	21.09	0.030
	Total	22.20	0.600

Annex E. Shepton Mallet STW

This annex is an update of Annex E from
Supporting document 5.1 – Protecting and enhancing the natural environment.

1. Need

Quality Enhancement

The following lines are included in the WINEP for Shepton Mallet STW:

Table E-1: Quality enhancement drivers identified in the WINEP for Shepton Mallet STW

Driver Code	Driver code Information	Relevant section in Supporting document 5.1
Investigations / Monitoring		
U_MON3	Storm tank EDM	3.5
U_MON4	Flow measurement	3.5
Improvements		
WFD_IMP	Ammonia removal	3.3
HD_IMP SSSI_IMP	Phosphorus removal	3.2
WFD_IMP	Phosphorus removal	3.2
WFD_NDLS	Chemical (zinc) removal	3.4
WFD_IMP	Chemical (zinc) removal	3.4

This annex relates to the works associated to meet the improvement drivers for sanitary (ammonia), nutrient (phosphorus) and chemical (zinc) removal, as detailed below:

Table E-2: PR19 permits identified in the WINEP for Shepton Mallet STW

Driver Code	Driver code Information	Completion Date	Level of certainty?	Old Permit	New Permit
WFD_IMP	Ammonia	22/12/2024	Amber	6 mg/l	3 mg/l
HD_IMP SSSI_IMP	Phosphorus	31/03/2025	Green	2 mg/l	1 mg/l
WFD_IMP	Phosphorus	22/12/2024	Amber	2 mg/l	0.35 mg/l
WFD_NDLS	Chemical (zinc)	22/12/2022	Green	-	48 µg/l
WFD_IMP	Chemical (zinc)	31/12/2024	Amber	-	42 µg/l

Growth Enhancement

There is nominal growth within the Shepton Mallet catchment, and the works is treating within capacity to achieve its current permits.

2. Background

Shepton Mallet STW is in the Brue and Axe catchment, serving a population equivalent of 30,718. It treats sewage from the nearby town of Shepton Mallet, and also receives trade loads, particularly from the cider-making industries synonymous with the west country.

Quality enhancements were last made at the site in 2013 to achieve a phosphorus permit of 2mg/l (as an annual average) for UWWTD compliance.

3. Options

Given the multiple drivers and the nature of the amber schemes being subject to ministerial approval, individual processes have been considered to target the different parameters:

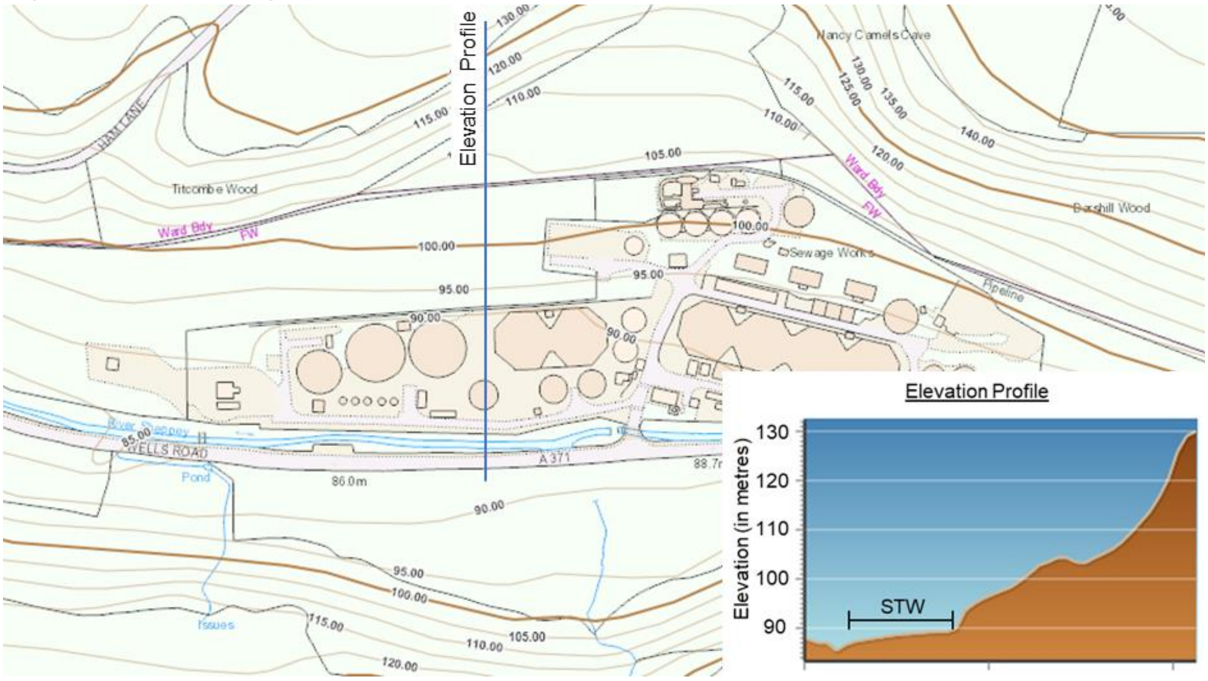
- TCF – Tertiary filtration using plastic discs covered in pile cloth filter media.
- TASF – Tertiary nitrification and solids removal using aerated sand filters.
- TNTF – Tertiary nitrification using plastic media trickling filters.
- AOP – Advanced oxidation process using both ozone (O_3) and hydrogen peroxide (H_2O_2).
- COUF – Enhanced continuously operating up-flow filter with specialised internals and hydrous ferric oxide sand to which ozone generated from air is applied.
- ASP – Activated sludge plant with carbonaceous and nitrifying microorganisms suspended in the sludge (as opposed to the other fixed film technologies).

Table E-3: Treatment options at Shepton Mallet STW to achieve the different WINEP3 drivers

Option	TCF	TASF	TNTF	AOP	COUF	ASP
Treatment Provision:						
Meets new P permit (1mg/l)	✓	✓	×	×	✓	✓
Meets new P permit (0.35mg/l)	✓	✓	×	×	✓	✓
Meets new AmmN permit (3mg/l)	×	✓	✓	×	×	✓
Meets new Zn permit (48µg/l)	×	×	×	✓	✓	✓
Meets new Zn permit (42µg/l)	×	×	×	✓	✓	✓
Capex (£m)	7.14	7.27	5.02	4.38	13.83	21.09

The site is adjacent to the River Sheppey, located on the valley slopes. As can be seen from the following figure, any site expansion will require extensive earth works.

Figure E-1: Site topography of Shepton Mallet STW



A high-level comparison of the combined treatment options to meet the WINEP3 requirements is summarised below.

Table E-4: Options comparison at Shepton Mallet STW to meet all the WINEP3 drivers

Option	TCF + TNTF + AOP	TASF + AOP	COUF + TNTF	ASP
Treatment Provision:				
Meets new P permit (1mg/l)	✓	✓	✓	✓
Meets new P permit (0.35mg/l)	✓	✓	✓	✓
Meets new AmmN permit (3mg/l)	✓	✓	✓	✓
Meets new Zn permit (42µg/l)	✓	✓	✓	✓
Meets new Zn permit (48µg/l)	✓	✓	✓	✓
Capex (£m)	16.53	11.64	18.85	21.09
Opex (£k/yr)	432	334	1,371	316

As noted earlier, there is nominal growth within the Shepton Mallet catchment and the works is treating within capacity to achieve its current permits. We do, however, anticipate the permit DWF to be exceeded by 2040, and thus would need to provide additional treatment capacity in advance of this to satisfy a pro-rata tightening of permit limits. The below table identifies the anticipated future permit values, as determined through river water quality modelling.

Table E-5: Forecast future discharge permit requirements at Shepton Mallet STW

Permit Parameter	Existing	Short Term (PR19)	Long Term (PR34)
DWF	3,750 m^3/d	3,750 m^3/d	5,285 m^3/d
BOD	18 mg/l	18 mg/l	13 mg/l
AmmN	6 mg/l	3 mg/l	2 mg/l
P	2 mg/l	0.35 mg/l	0.25 mg/l
Zinc (dissolved)	-	42 µg/l	40 µg/l

How we approach the long term will depend on what option is implemented in the short term (PR19), as described above. The table below shows the additional process units to achieve the long-term permit requirements of the site. The ability of certain processes to reliably achieve low permits and the variability of the influent load due to catchment characteristics has led to the selected options being considered.

Table E-6: Treatment options at Shepton Mallet STW to meet future permit requirements

<table>
<tr><th>Options presented in Business Plan for Short Term</th><th>Additional Process Units for Long Term</th></tr>
<tr><td>TCF +
TNTF +
AOP</td><td rowspan="3">Option 1a:
• Additional TNTFs, in a double-alternating filtration pattern to existing tertiary process stream (with associated additional interstage pumping) as there is a variable influent load
• Additional TCFs, in series to existing tertiary solids removal stream

Option 1b:
• New Moving Bed Biological Reactors (MBBR), in side-stream to existing tertiary process stream
• Additional TCFs, in series to existing tertiary solids removal stream</td></tr>
<tr><td>TASF +
AOP</td></tr>
<tr><td>COUF +
TNTF</td></tr>
<tr><td>ASP</td><td>Option 2a:
• Additional ASP lane(s), in parallel with ASP

Option 2b:
• New Hybrid Activated Sludge Plant (HYBACS), in side-stream to ASP to optimise and intensify the process performance
• Possible additional TCFs, in series to existing tertiary solids removal stream</td></tr>
</table>

The additional ASP lanes can be constructed within the existing site boundary as an extension to the proposed ASP for PR19. If the other options were implemented in PR19 then additional land would need to be purchased – this would not be adjacent to the site thus there would be associated pump away and split-site costs (such as the duplication of backwash handling facilities and standby generator provisions).

A summary of the whole-life cost analysis for the various treatment options is shown in Table E-7. This includes both the short-term (PR19) and long-term (PR34) options.

Table E-7: Whole-life cost analysis of treatment options at Shepton Mallet STW

Short-Term (PR19) Option	TCF + TNTF + AOP		TASF + AOP		COUF + TNTF		ASP	
Capex (£m)	16.53		11.64		18.85		21.09	
Opex (£k/yr)	432		334		1,371		316	
Long-Term (PR34) Option	**TNTF + TCF**	**MBBR + TCF**	**TNTF + TCF**	**MBBR + TCF**	**TNTF + TCF**	**MBBR + TCF**	**ASP**	**HYBACS + TCF**
Capex (£m)	18.30	17.48	18.30	17.48	18.30	17.48	6.84	9.58
Opex (£k/yr)	326	383	326	383	326	383	133	270
NPV Analysis								
40-year NPV[1] (£m)	42.7	42.8	34.8	34.9	65.8	65.9	34.6	37.6
60-year NPV[1] (£m)	48.3	48.5	39.8	40.0	74.9	75.1	37.0	41.2
Lowest whole-life cost	✗	✗	✗	✗	✗	✗	✓	✗

[1] All options are indexed to the date of completion of the AMP7 scheme.

4. Proposed solution

As identified previously, land availability around Shepton Mallet STW is limited. We have only a small parcel of land that can be used for additional treatment units. This restricts the options we can adopt for this site. We have undertaken a long-term strategic review of the site's needs and concluded that the option for a new activated sludge process (ASP) stream should be adopted. It is acknowledged that this is the most expensive option in the short-term, however it has the lowest whole-life cost.

The proposed solution is therefore to take advantage of the synergies provided by a new activated sludge plant to provide treatment for a more stringent Ammonia permit (3 mg/l), a more stringent Phosphorus permit (0.35 mg/l) and a new Zinc permit (42 µg/l).

This ASP option is included in our Business Plan, with the costs apportioned between drivers as shown in the table below:

Table E-8: Cost apportionment between PR19 drivers at Shepton Mallet STW

Driver Code	Driver Details	Proposed Permit	Certainty	Capex (£m)	PR19 Totex (£m)
HD_IMP SSSI_IMP	Phosphorus	1 mg/l	Green	0.14	0.14
WFD_IMP	Phosphorus	0.35 mg/l	Amber	3.49	3.56
WFD_IMP	Ammonia	3 mg/l	Amber	3.63	3.71
WFD_NDLS	Zinc (dissolved)	48 µg/l (mean)	Green	13.83	16.93
WFD_IMP	Zinc (dissolved)	42 µg/l (mean)	Amber	-[1]	-[1]
			Total:	21.09	24.35

[1] There are negligible additional capex costs to achieve the tighter 42 µg/L amber permit over-and-above that required for the 48 µg/L green permit, as it would involve the same treatment process.

Annex G. West Huntspill STW

This annex is an update of Annex G from
Supporting document 5.1 – Protecting and enhancing the natural environment.

1. Need

Quality Enhancement

The Bathing Water Directive and Regulations provide the framework for the management of the bathing waters in England. New tighter standards were introduced in 2015, with bathing waters being classified as: Excellent, Good, Sufficient, Poor. Under the directive, all bathing waters are required to meet at least Sufficient classification. Burnham Jetty North has a planning class of Poor (in 2016 and 2017), and is impacted by the discharges from West Huntspill STW.

Accordingly, the following line is included in the WINEP for West Huntspill STW:

Table G-1: Quality enhancement driver identified in the WINEP for West Huntspill STW

Driver Code	Driver code Information	Relevant section in Supporting document 5.1
Improvements		
BW_IMP1	Bathing water improvements	7.1

With a proposed permit limit:

> *West Huntspill STW to receive improved treatment to achieve 25,000-fold (4.4 log) reduction in enteroviruses and a 250,000-fold (5.4 log) reduction in E. coli between the crude influent to the treatment works and Burnham Jetty North EC designated bathing water monitoring point, based on standard influent concentrations.*

Growth Enhancement

Historical and future planned growth in both residential and trade flows and loads requires additional treatment capacity to ensure that the site continues to maintain environmental permit compliance.

2. Background

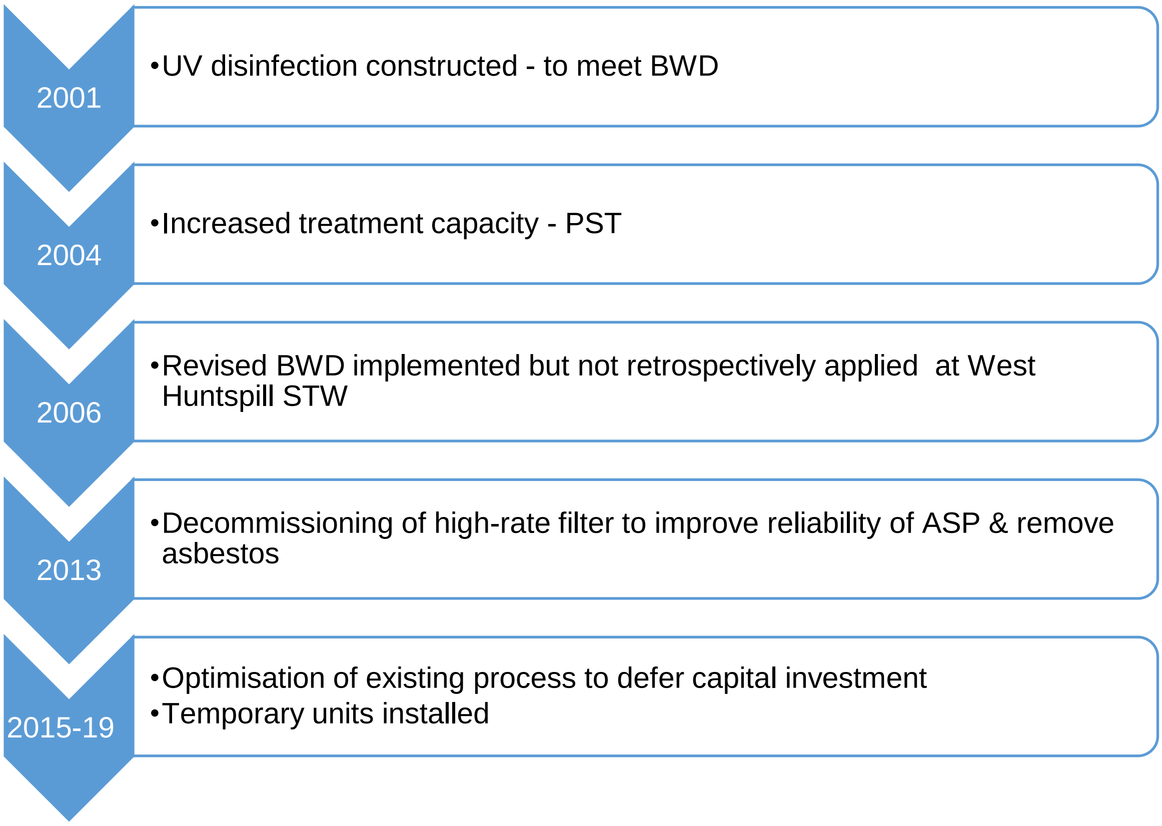
West Huntspill STW is located in the Parrett catchment, however discharges into the Burnham Jetty North designated bathing water. The STW serves a population equivalent of 47,370, comprising a number of nearby conurbations including Burnham on Sea and Highbridge, along with lots of rural villages. The works also receives a high trade load.

The STW is an activated sludge plant with primary tanks, two aeration lanes and humus settlement tanks, and was extended in 1997. Ultraviolet (UV) disinfection was installed at West Huntspill STW in 2001 to meet the requirements under the Bathing Water Directive (as per the updated conditions, 1991). The UV system was installed prior to the implementation of the revised Bathing Water Directive (rBWD, 2006) and thus a reduction in log-removal across the secondary treatment process was not considered in the permit by the EA.

The site also has a co-located Sludge Treatment Centre.

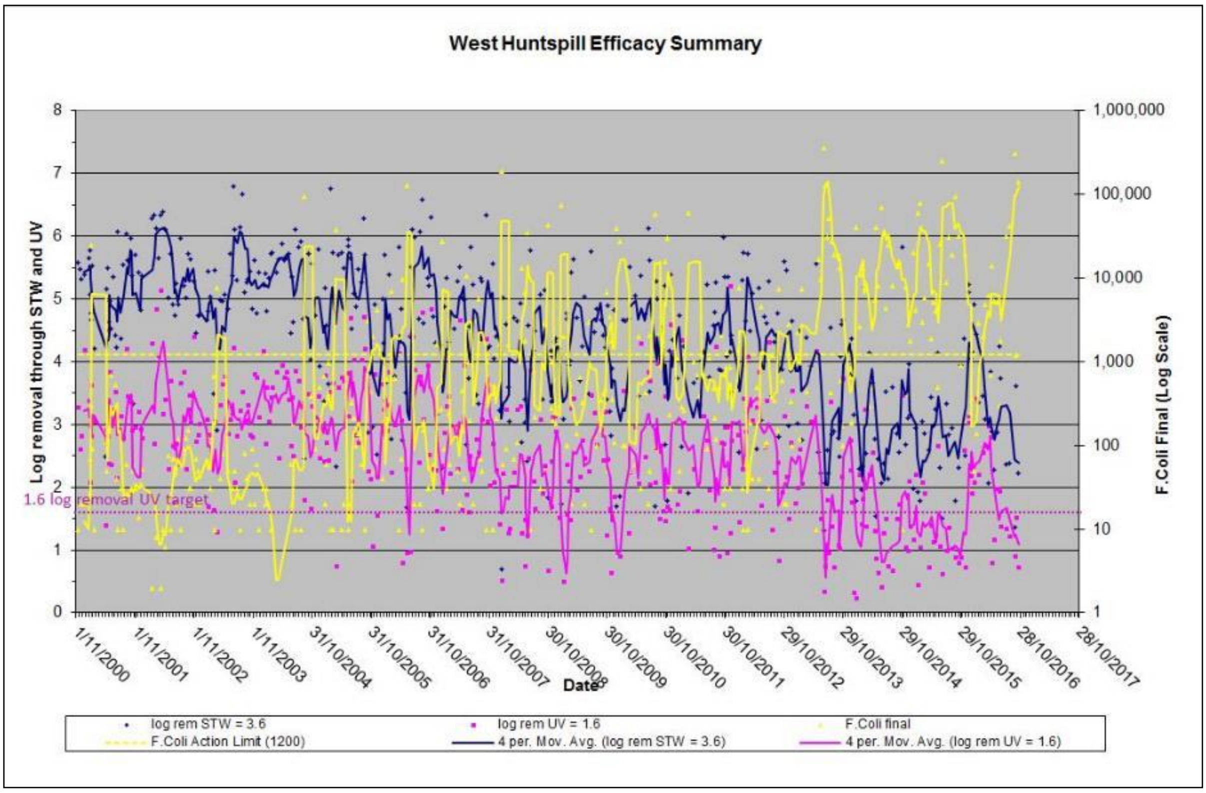
Significant investment has been deferred in the past with the existing process optimised as far as is reasonable, with temporary treatment installed. The last significant investment with respect to growth was during 2000-2005, where an additional PST was constructed. Past investment at West Huntspill STW is summarised below in the below flowchart.

Figure G-1: Historical capital investment at West Huntspill STW



West Huntspill remains compliant according to existing requirements previously set by the Environment Agency (BWD, 1991). However, as shown below, UV treatment efficacy has deteriorated gradually since the summer of 2013 despite the received UV dose being greater than 100. Current faecal coliform log kill performance is considered inadequate with reference to the rBWD and requires improvement.

Figure G-2: Efficacy summary at West Huntspill STW, with log removal rates through the STW and UV plant



3. Options

A review of the UV plant was conducted in October 2016 by Blackwell Water Consultancy. They concluded that poor transmissivity was directly related to a high concentration of suspended solids in the final effluent, due to upstream processes performing inadequately. Operational staff have also indicated that occasional drops in transmissivity might be the result of increases in trade discharge loads.

In 2018 we engaged Stantec (consultants) to review the performance of West Huntspill STW, the cause for the poor bacteriological removal and the actions required to improve the performance. Their summary of the bacterial reduction performance explained that:-

- Bacterial reduction performance has deteriorated, particularly since 2013.
- The observed log reduction achieved over the UV irradiation system has deteriorated more dramatically than that over secondary treatment.
- It is likely that the deterioration in UV irradiation performance is related to the deterioration in quality of the effluent from the upstream treatment process rather than particular issues with the UV irradiation system.
- Effluent quality parameters that would affect performance of UV irradiation system are:
    - suspended solids concentration, particle size (pin floc)
    - UV transmittance (soluble BOD / organic content / chemical used for septicity dosing

The extract from their report show these findings graphically:-

Figure G-3: Faecal coliforms reduction through treatment stages at West Huntspill STW

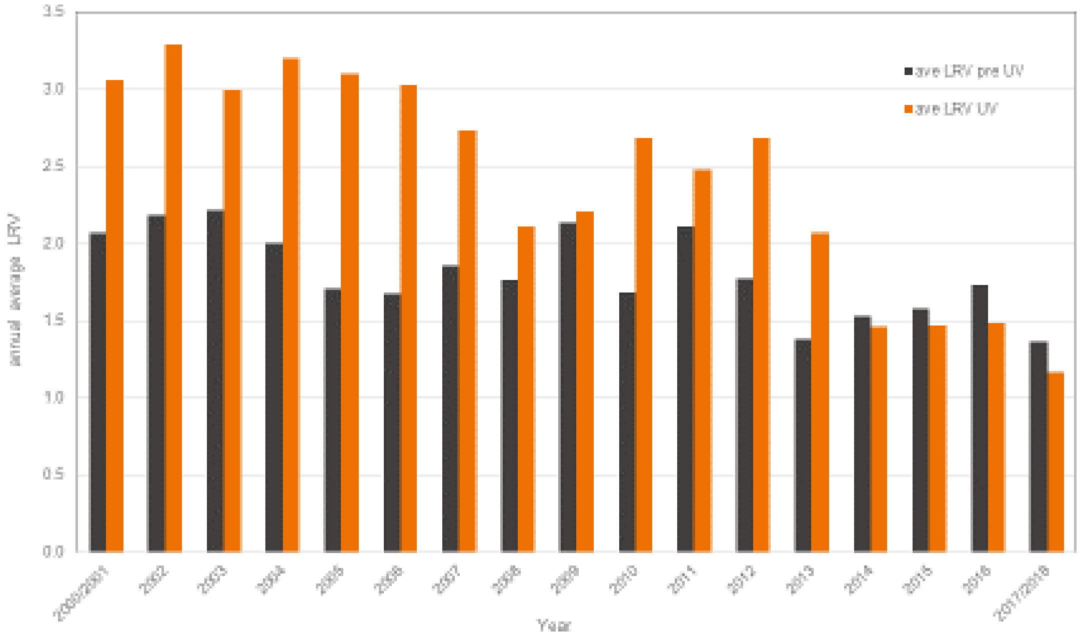


Figure G-3 shows how the removal of faecal coliforms has reduced over time. This shows the reduction has occurred through both the treatment process upstream of the UV plant, and also through the UV plant itself. The deterioration in performance of the UV plant is considered to be due to the poorer quality treated effluent from the secondary treatment process.

Figure G-4: Final effluent faecal coliform samples above trigger point at West Huntspill STW

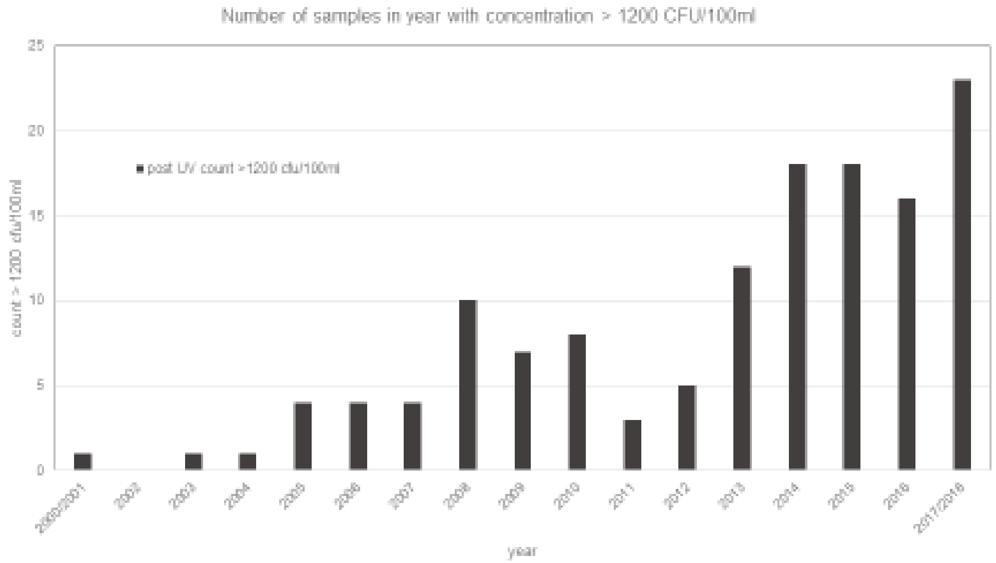


Figure G-4 shows how the deterioration in faecal coliform removal at West Huntspill STW has resulted in an increased number of samples with faecal coliforms levels greater than 1,200cfu/100ml.

Stantec’s report gave the following main reasons for the deterioration in the UV disinfection performance:-

- Final effluent quality, particularly suspended solids concentration has deteriorated, and become more variable since 2013, which has had a subsequent impact on variability in COD and BOD.
- Spikes in turbidity experienced due to higher variable suspended solids and pin floc. Poor suspended solids and turbidity would be expected to adversely affect the performance of the UV irradiation system
- Spikes in Turbidity correspond to periods of low UVT. Colloidal material and soluble organics will also contribute to poorer UVT.
- There does not appear to be any strong interference from any trade load that might affect UVT.

Figure G-5: Changes in final effluent suspended solids quality at West Huntspill STW

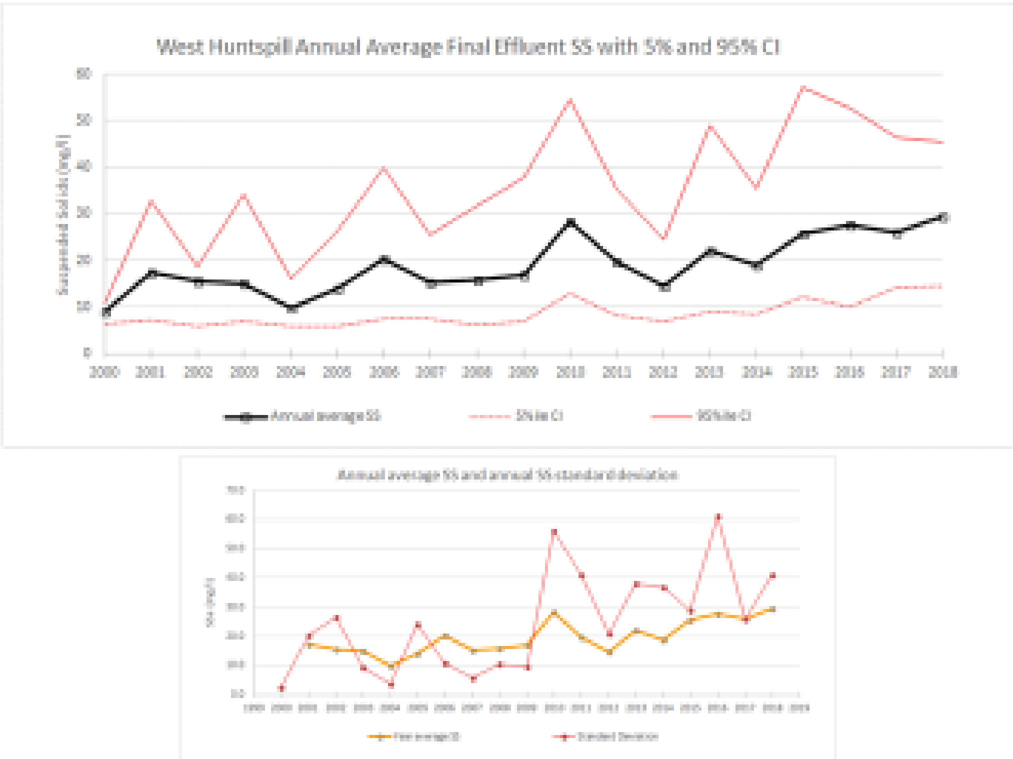


Figure G-5 shows how the average effluent quality has deteriorated over time. Although remaining compliant with the water quality consent standard, it is considered that the increase in suspended and colloidal solids in the final effluent will have adversely affected the UV disinfection performance.

Stantec’s report concluded that the deterioration in performance was linked to the activated sludge plant having an excessively short sludge age resulting in formation of pin-floc and turbid supernatant. They advised that the long-term solution would be to reduce BOD loading on the activated sludge plant to one which allows more normal range of operational headroom.

We commissioned Stantec in 2019 to undertake a further review of West Huntspill STW’s disinfection performance and overall bacterial reduction achieved at the site. Their report is included in Annex G2. This provides a high-level summary of the evaluation that has been carried out, with the aim of highlighting the key issues that drive the performance of the works, both for bacterial reduction over conventional secondary treatment and also through the dedicated final effluent UV irradiation system.

Accordingly, a high-level comparison of the options to meet the WINEP requirements is summarised below:

Table G-2: Treatment options at West Huntspill STW for bathing water improvements

No.	Title	Detail	Capex £m	Opex £k/yr
1	New Pumped-fed ASP	• A new (fourth) Primary Settlement Tank (PST) similar to existing PSTs. • A new conventional activated sludge plant, run in parallel with the existing ASP plant, equipped with a Fine Bubble Diffused Aeration system. • ASP feed pumping station. • MCC for new process • New ASP effluent pipework to connect to the existing ASP outlet pipework to final settlement.	14.44	304
2	Hybrid activated sludge process (HYBACS) units upstream of the existing ASP	• A new (fourth) Primary Settlement Tank (PST) similar to existing PSTs. • Permanent installation of twelve HYBACS units • HYBACS feed pumping station. • MCC for new process.	10.20	304
3	New UV Plant and increased biological treatment capacity	• A new UV plant designed to treat a relatively poorly treated effluent. • A smaller new carbonaceous only activated sludge plant, designed to achieve the relatively lax UWWTD and water quality standard (40:60 BOD:SS) and run in parallel with the existing ASP plant, equipped with a FBDA system. • A new (fourth) Primary Settlement Tank (PST) similar to existing PSTs • ASP feed pumping station. • MCC for new processes • New ASP effluent pipework to connect to the existing ASP outlet pipework to final settlement.	16.45	313
4	New improved UV Plant only	• This option was discounted for the technical reasons in the Stantec report in Annex G2 and summarised below.	n/a	n/a

4. Proposed solution

The required environmental outcome from this scheme is an improved reduction in viruses and bacteria, as described in the WINEP3 *(" West Huntspill STW to receive improved treatment to achieve 25,000-fold (4.4 log) reduction in enteroviruses and a 250,000-fold (5.4 log) reduction in E. coli* … "). In assessing the above options 1and 2 (both of which would provide some increase in treatment capacity) we concluded that, in terms of virus and bacteria removal, Option 1 is significantly superior. This is based on the performance of our Weston-super-Mare STW which was enhanced by the provision of an activated sludge process in 2013 to provide improved virus and bacteria removal. The design of the proposed upgraded ASP process for West Huntspill STW has been based on that used for Weston-super-Mare and hence provides confidence that the required environmental outcome will be achieved.

The proposed option therefore is Option 1 because:

- Installing an additional new ASP treatment stream with a 'standard' sludge loading rate and a 'standard designed' anoxic selector for improved settlement of suspended solids will:
    - improve the clarity and transmissivity of the final effluent for UV treatment
    - improve the settleability of suspended solids and reduce incidences of turbid effluent due to SS
    - improve the bacterial removal across the secondary treatment process ahead of the UV plant.
    - enable the UV plant to achieve sufficient log removal and effluent quality for UV disinfection,
    - provide capacity to help attenuate and provide better treatment for the wide variation of flows and loads experienced at this STW.
    - and thus provide the required performance to meet the revised Bathing Water Directive bathing water standards.
- This option also provides adequate treatment capacity to meet the current load on the works and to cater for the significant increase in load by 2025 from new developments within the catchment.

Option 2 (HYBACS) has not been selected because it is an untried system ahead of UV disinfection plant, and the units are not guaranteed to offer the WINEP required log removal for bacteria and viruses. There is hence a significant risk that option would require, in addition, an upgrade to the UV disinfection plant. This makes it an unattractive option due to the additional costs associated with a new UV plant, making it more costly than option 1. Additionally, the time taken to install a new UV plant, would mean that it could not be installed in time to meet the regulatory date of March 2021.

The combined Option 3 (new UV + smaller ASP treatment stream) has not been selected because:

- it has the highest capital and whole-life cost
- the smaller aeration basin with a sludge loading rate of 0.45 and a sludge age of 3 days provides a less stable treatment performance, with a higher risk of a cloudy effluent not amenable to UV treatment,

- the smaller aeration basin provides capacity to a shorter design horizon.

Option 4 (new UV plant only) has not been selected because it fails to address the root cause of the current poor removal of bacteria and viruses by the treatment processes at West Huntspill STW. As described in the Stantec report in Annex G2, the main problem is considered to be the nature of the treated effluent from the existing highly loaded secondary treatment process. This variable, cloudy and turbid effluent is not amenable to disinfection by UV treatment, and upgrading the UV plant would not, by itself, result in an improvement that would ensure the required bacterial and virus removal would be achieved. Installation of a UV plant alone would also provide no additional treatment capacity for the significant increase in load from new developments within the catchment.

The costs of the proposed ASP option have been apportioned between drivers as below:-

Table G-3: Cost apportionment between PR19 drivers at West Huntspill STW

	Percentage	Capex (£m)	Opex (£m/yr)
STW Growth (capacity)	10%	1.44	0.032
Quality enhancement – UV disinfection	90%	13.00	0.289
	Total	14.44	0.321

Annex G1. West Huntspill STW – EA Support for Scheme

Email from the EA to Ofwat
supporting the need for improvements at West Huntspill STW

From: Thompson, Richard <richard.thompson@environment-agency.gov.uk>
Sent: 28 February 2019 16:13
To: Hannah Stewart; Bart Schoonbaert
Cc: Ward, Kevin; Burton, Lucy; Davis, Keith
Subject: PR19 West Huntspill Improvement Scheme

Hannah / Bart

I write to you to provide clarification on a WINEP scheme for Wessex Water. I understand that the solution in proposed by Wessex Water has been challenged by Ofwat.

West Huntspill BW_IMP1 (7WW200965) is a measure to improve Burnham Jetty Bathing Water. It is a certain (green) measure with a delivery date of 2021. This bathing water is currently poor status and has been for 4 years. The measure is required to enable Burnham Jetty bathing water to achieve sufficient status under the Bathing Water Directive. The category "sufficient" is the minimum quality threshold that all Member States should attain by the end of the 2015 season at the latest.

Our WINEP released in March 2018 indicated that a land management alternative could be possible. However, after further assessment, land management is not considered to be a viable solution to provide adequate protection to the bathing water and ensure an improvement to meet sufficient status.

Without improvements to the final effluent we believe that the bathing water is at risk of being de-designated as a bathing water and permanent signage erected advising against bathing.

In our next release of the WINEP will remove the reference to land management being a viable alternative.

I hope that this provides sufficient reassurance that the scheme is required and can be funded within your draft determination.

We can provide more details if required.

Kind regards

Richard

Richard Thompson CEnv MCIWEM | Environment and Business Manager | Water, Land and Biodiversity | Environment Agency | Kings Meadow House| Reading | RG1 8DQ
Tel: 07798 830 078

Letter from the EA to Wessex Water
supporting the need for improvements at West Huntspill STW

creating a better place

Environment Agency

Mr P Wickens
Director of Regulation & Reform
Wessex Water
Claverton Down Rd
Bath
BA2 7WW

Our ref: WesHun/01

Your ref:

Date: 22 February 2019

Dear Mr Wickens,

West Huntspill sewage treatment works and Burham Jetty bathing water

We refer to your recent contact following Ofwat's Initial Assessment of Plans, where their deep dive into the West Huntspill project (WINEP ID: 7WW200965) questioned the need for the scheme.

We understand that Ofwat had included a statement that "we are not convinced West Huntspill STW is necessarily the reason for the poor water quality, considering that the EA suggests land management as an alternative option." We would like to provide the following additional information in support of the need for this work:-

Ultra Violet Treatment and effluent quality at West Huntspill sewage treatment works and the impact on Burnham Jetty bathing water.
Ultra Violet (UV) efficacy does not form part of the permit compliance assessment for UV treatment at sewage treatment works (STWs). As such West Huntspill is compliant whilst at the same time Faecal Indicator Organism (FIO) die-off through the works is poor despite the UV treatment. Since 2012 there has been a significant continued decline in efficacy at the works. Current geometric mean FIO concentrations in the effluent from West Huntspill STW are similar to those reported by Kay *et al*. for secondary treated effluent without UV.

Tracer studies conducted under a previous AMP investigation in April 1998 concluded a minimum dilution/dispersion of 60 between West Huntspill STW outfall and Burnham Jetty bathing water. These studies informed the design criteria and UV consent conditions which came into force in 2000. The works is no longer achieving the required log reduction to protect the beach.

With limited dilution/dispersion to the bathing water, poor and deteriorating performance for FIO die-off at West Huntspill STW is currently contributing to the non-compliance of Burnham Jetty bathing water.

Environment Agency Wessex:
Rivers House, East Quay, Bridgwater, TA6 4YS
email: jim.flory@environment-agency.gov.uk

Jim Flory
Direct Tel: 02030 250212

Faecal contamination from the catchment
The main river catchments influencing water quality at Burnham Jetty bathing water are the Brue and the Parrett. Both catchments were identified as priority target areas for a Catchment Sensitive Farming (CSF) scheme to reduce agricultural pollution. This was launched in these catchments in 2006. Since then over 2000 farm visits have resulted in over £8M of capital grants being awarded to farmers in the Levels and Moors target area. Whilst CSF officers continue to build relationships, raise awareness and gain improvements further catchment work alone will not in our opinion improve bathing water quality at Burnham Jetty sufficiently to achieve compliance.

The West Huntspill improvement driver is intended to improve the bathing water from Poor to Sufficient. The land management alternative for West Huntspill STW was added to the WINEP with the intention of giving flexibility to the options of delivering water company improvements in bathing water quality. Prior to this challenge the Environment Agency had already agreed to the removal of the land management alternative from the WINEP because insufficient rigour was taken in considering the extent of land management measures already implemented. This will happen by the end of March this year.

Further investigations
The INV4 bathing water ambition investigation is for assessing potential classification change from Sufficient to Good at Burnham Jetty. It is separate from the required improvement at the STW. It presents an opportunity to revisit investigations already undertaken and consider scoping more. Our judgement at this point in time is that no new fieldwork will be needed, and achieving a Good classification would currently be a challenge.
Without improvement in FIO concentration in the final effluent from West Huntspill STW Burnham Jetty bathing water will almost certainly be de-designated as a bathing water and permanent signage erected advising against bathing.

References
D. Kay, J. Crowther, C.M. Stapleton, M.D. Wyer, L. Fewtrell, A. Edwards,C.A. Francis, A.T. McDonald, J. Watkins, J. Wilkinson. (2008). Faecal indicator organism concentrations in sewage and treated effluents. Water Research 42, 442-454.

I hope this information explains our current position, but if you have any further questions please let me know.

Yours sincerely

JIM FLORY
Area Environment Manager, Wessex
(Bathing water lead)

Environment Agency Wessex:
Rivers House, East Quay, Bridgwater, TA6 4YS
email: jim.flory@environment-agency.gov.uk

Jim Flory
Direct Tel: 02030 250212

Annex G2. West Huntspill STW – Disinfection performance evaluation report

In response to Ofwat's challenge of our proposal to expand the existing secondary treatment process at West Huntspill STW to meet the WINEP disinfection requirements, we commissioned Stantec to provide an independent evaluation of the disinfection performance and overall bacterial reduction achieved at the site.

This technical note provides a high level summary of the evaluation that has been carried out, with the aim of highlighting the key issues that drive the performance of the STW, both for bacterial reduction over conventional secondary treatment and also through the dedicated final effluent UV irradiation system.

West Huntspill STW disinfection performance evaluation: Technical Note

Date:

15/03/2019

Prepared for:

Wessex Water

Prepared by:

Christy White

Project Name:

West Huntspill STW Disinfection

Project No:

41525948

Sign-off Sheet

Project Name	**West Huntspill STW Disinfection – Technical Note**
Project No	41525948
Report Reference	**West Huntspill STW Disinfection – Technical Note**

Revision	Date	Description	Author	Check	Review
1	12/03/19	Draft for client review	C White	S Palmer / M Newberry	P Loughran
2	15/03/2019	Final for issue	C White	S Palmer / M Newberry	P Loughran

Stantec

Executive Summary

Ofwat's Initial assessment of plans (IAP) for the water companies' business plans for PR19 has included a challenge to Wessex Water on the need and the proposed solution for their West Huntspill STW bathing water improvement scheme. In response to their challenge to the PR19 proposals to expand the existing secondary treatment process at the site, Stantec has been asked by Wessex Water to provide an independent evaluation of the disinfection performance and overall bacterial reduction achieved at West Huntspill STW and to comment on the efficacy and appropriateness of the proposed solution to provide improved secondary treatment.

The main purpose of this project is to identify the reasons for poor bacterial reduction performance based on an evaluation of historical data, understand the key water quality characteristics that impact the performance of the works both for bacterial reduction over conventional secondary treatment and also through the dedicated final effluent UV irradiation system. This technical note provides a high level summary of the outcomes from the evaluation.

The main conclusion from this study with regard to the challenge from Ofwat is that installing a larger UV irradiation system without improving the performance of the upstream secondary treatment may not significantly improve the overall bacterial reduction performance during periods of poorer effluent quality, typical of the characteristics observed at the works over the summer periods, due to the potential level of shielding provided by the characteristics of the effluent (pin floc, high turbidity).

The addition of a second ASP lane, as proposed in the AMP7 improvement scheme for West Huntspill, would increase the sludge age and allow the plant to be operated at a higher solids inventory. The expected benefits to performance would be:

i. bacterial reduction achieved over the secondary treatment process should improve and become less variable.

ii. the quality of the final effluent for disinfection should improve and there would be a reduction in the variation in the parameters that impact UV irradiation. This would enable the level of disinfection achieved to be more consistent with that achieved in the past.

iii. Potentially a lower inactivation required through disinfection to achieve the discharge targets, based on the fact that the better quality (lower turbidity, higher UVT) samples taken on site as part of the test work showed a lower concentrations of faecal indicators.

Addition of more secondary treatment capacity would be expected to secure a better quality and more consistent effluent for disinfection by UV irradiation, thus contributing to a more robust long term solution for the works.

Further findings from this study are summarised below:

- Historically, reduction in concentrations of faecal coliforms and faecal streptococci over the treatment processes upstream of disinfection were typical or better than expected of the processes on site, achieving an annual average of between 1.5 and 2 $\log_{10}$ for both indicator organisms. The performance has deteriorated marginally since 2013, achieving annual average reduction of 1.5 $\log_{10}$ or below, for both indicator organisms.
- The annual average reduction in inactivation of faecal coliforms and faecal streptococci observed through disinfection was between 2 and 3 $\log_{10}$ which is typical of what could be expected for a well operated UV irradiation system on a high quality final effluent. There has been an observed deterioration in performance through the UV irradiation system since 2013, with observed average inactivation for both faecal indicator organisms reducing to below 1.5 $\log_{10}$.
- Although trade loads to the works have been increasing since 2000, there has been no significant change in the characteristics of trade loads to the works that would be expected to impact the disinfection performance (e.g. containing chemicals that could reduce / change the effluent UV transmittance or impact the UV dose-response).
- An assessment of the existing UV irradiation system against performance validation information demonstrates that it has sufficient capacity to achieve the expected level of disinfection for the site when the water quality is typical of a well performing activated sludge

plant. However, UV dose-response data collected based on samples of poorer quality effluent (higher turbidity / lower UVT), typical of more recent periods in the Bathing season post 2013, can be seen to have a significant impact on the disinfection achieved by the UV irradiation.

- In 2012 the high-rate filters were removed from service for health & safety and improved process stability reasons. This resulted in an increased load to the existing ASP lane. Although there hasn't been a significant change to compliance with permitted parameters, there is an observed increase in the annual average concentration of suspended solids in the final effluent starting in 2006 and becoming more variable after 2013.
- It is likely that due to these changes in load, the quality of the final effluent produced that relates to the performance of the UV irradiation system has deteriorated, particularly during certain periods of the year. Due to the impact of poor quality effluent (pin floc, high turbidity) on the UV dose response, a larger UV irradiation system (more power) would not necessarily secure a significant improvement in disinfection, due to the level of shielding from the pin floc / higher turbidity.

Table of Contents

1. Introduction

In response to the OFWAT's challenge to the AMP 7 plans for the site to expand the existing secondary treatment process, Stantec has been asked by Wessex Water to provide an independent evaluation of the disinfection performance and overall bacterial reduction achieved at West Huntspill STW.

This technical note provides a high level summary of the evaluation that has been carried out, with the aim of highlighting the key issues that drive the performance of the works, both for bacterial reduction over conventional secondary treatment and also through the dedicated final effluent UV irradiation system.

2. Purpose

The primary objectives of this project were to determine the reasons for poor bacterial reduction performance and identify if the UV irradiation system has capacity to deliver the required disinfection performance.

3. Scope

The scope of this project was as follows:

- Evaluate historical and recent bacterial reduction performance at the treatment works
- Develop site specific dose-response information
- Evaluate the capacity of the existing UV irradiation system
- Comment on the proposed solution selected by Wessex Water to enhance the secondary treatment performance rather than upgrade the UV plant.

This approach has provided an understanding of the performance of the existing treatment processes at the works and determine the main limitations to performance.

The following sections provide the details of the assessment undertaken by this project together with the results and conclusions that have been summarised above.

4. Assessment

4.1. Historical bacterial reduction data

Figures 1a) and b) present the overall variations in the concentration of faecal coliforms and faecal streptococci, respectively, observed in the crude wastewater, secondary effluent and final effluent post disinfection observed at West Hunstpill STW. Data are provided for the period from November 2000 until January 2019.

The annual geometric mean concentrations of faecal indicator organisms (FIOs) observed in the crude wastewater has remained consistent over the period varying between 4.1 x 10^6 and 7.4 x 10^6 cfu/100ml (6.6-6.9 $\log_{10}$) for faecal coliforms and between 5.4 x 10^5 and 1.5 x 10^6 cfu/100ml (5.7-6.2 $\log_{10}$) for faecal streptococci.

The data presented in Figures 1a and 1b show a small increase in the concentration of these parameters observed in the secondary treated effluent, and a more significant deterioration in the concentration of both organisms in the UV irradiated final effluent over the period from November 2000 to January 2019.

The average log reduction in concentration of faecal coliforms achieved across the treatment works prior to UV irradiation was observed to be consistently between 1.5 and 2 $\log_{10}$ for the period from 2000 / 2001 to 2012. From 2013 onwards, the average log reduction fell slightly to 1.5 $\log_{10}$ or below. Similarly for faecal streptococci, the observed annual average log reduction through secondary treatment was 1.5 $\log_{10}$ or above prior to 2013, however after this annual average values fall marginally to 1.5 $\log_{10}$ or below.

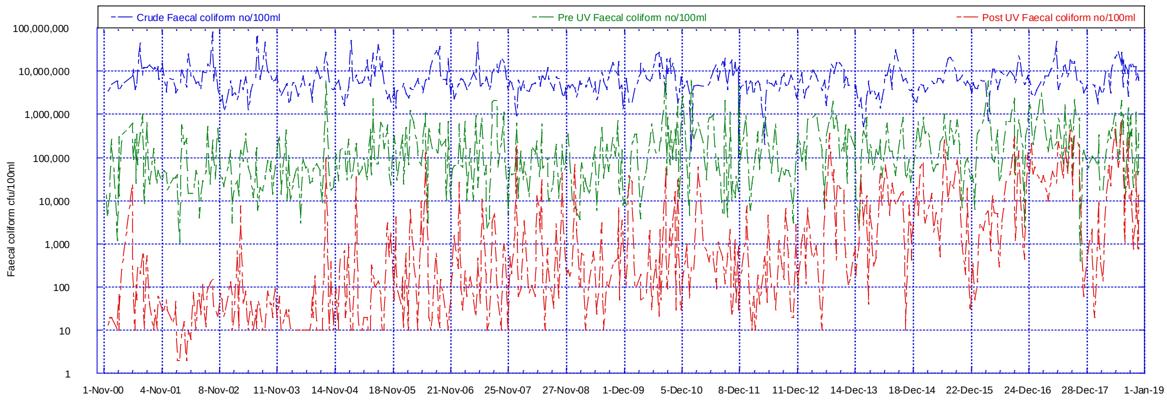


Figure 1a Observed concentrations of faecal coliforms in the crude wastewater, secondary effluent and disinfected effluent from West Huntspill STW from Nov 2000 to Jan 2019.

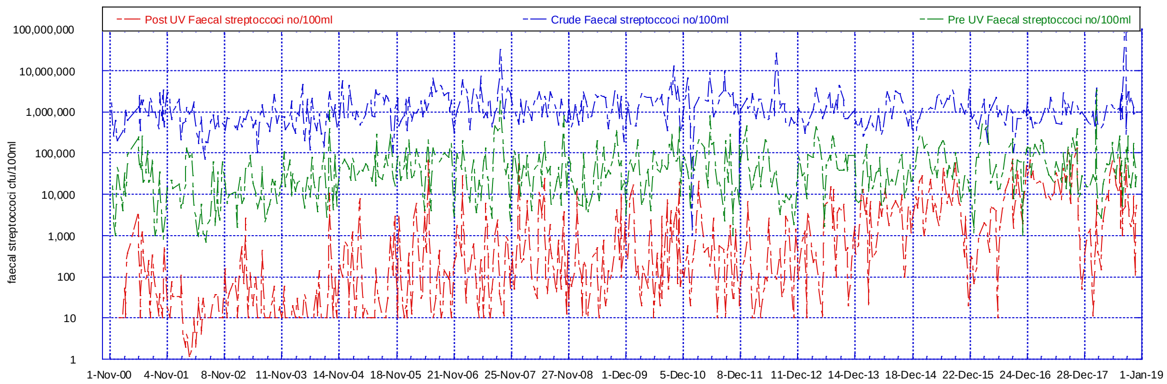


Figure 1b Observed concentrations of faecal streptococci in the crude wastewater, secondary effluent and disinfected effluent from West Huntspill STW from Nov 2000 to Jan 2019.

The average log reduction achieved in UV irradiation was observed to be consistently above 2 $\log_{10}$ for the period from 2000 to 2013 and over 2.5 $\log_{10}$ for the majority of the years assessed, consistent with the variation in the annual geometric mean concentrations of 20 to 600 cfu/100ml for faecal coliforms and 20 to 550 cfu/100ml for faecal streptococci. From 2013 onwards, the observed annual average log reduction fell to below 1.5 $\log_{10}$ and the observed annual geometric mean concentration rose above 2,000 cfu/100ml (up to 41,000 in one year) for faecal coliforms and above 1,000 cfu/100ml (up to 20,000 in one year) for faecal streptococci. It is evident that there was a more significant fall in indicator organism reduction observed through UV irradiation than through the upstream treatment process, particularly from 2013, and the observed faecal coliform concentrations were more frequently above the Wessex Water trigger point of 1,200 cfu/100ml.

Figure 2 presents a comparison of the variation in average annual reduction ($\log_{10}$) in faecal coliforms concentrations across the secondary treatment process and through the UV irradiation system, from 2000 to 2018. Similar trends were observed for faecal streptococci.

It should be noted that the number of banks in operation and the ballast power level in the UV irradiation system is controlled based on flowrate and measured UV transmittance to meet a calculated Received Dose target value. Based on the typical range of flows seen in dry weather (<200 l/s), this results in normal operation being with one bank. The second, assist bank is required for higher flowrates and is automatically initiated if the UV transmittance falls to 30% or lower.

A trial has recently been conducted to determine the performance associated with operating both banks at 100% power. The trial was conducted over the two-week period ((4th to 19th February, 2019). During this period, the UV transmittance was greater than 45% for more than 99% of the time and greater than 60% for approximately 50% of the time. Flow to disinfection varied between approximately 100 l/s and 600 l/s. Ten paired samples were taken daily (not weekends) to illustrate plant performance.

Over half of the ten samples analysed at intervals over the period recorded concentrations of *E. coli* and enterococci below the limit of detection. The other results were below 100 cfu/100ml for both organisms. The calculated average log reduction for both indicator organisms over the period was 3.3 log_{10}.

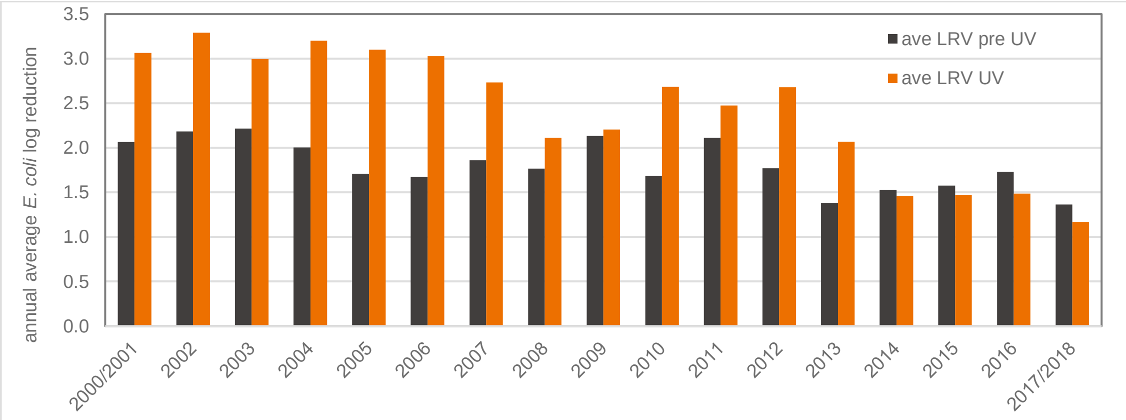


Figure 2: Observed historical annual average log reduction of faecal coliforms across secondary treatment and through UV irradiation at West Huntspill STW, 2000-2013.

Based on the observed historical data, the average reduction in concentration in upstream unit processes and the concentration of indicator organism (prior to disinfection) at West Huntspill prior to 2013 is typical or better than what could be expected, based on a comparison with published data or default assumptions, i.e.:

- EPR 7.01 (EA) gives a precautionary assumption for reduction over ASP of 2 log_{10} used in their calculation to determine disinfection requirements
- Published data from various water companies for bacterial reduction over ASPs indicates that observed average reduction through ASPs in the UK can be between 1.5 and 3 log_{10}, (UKWIR, 2012)
- Published data for bacterial concentrations post ASPs indicates expected concentrations in the effluent from carbonaceous activated sludge processes would be in the 10^4-10^5 cfu/100ml range (WERF, 2004). The study also indicates an increase in concentrations (decrease in log reduction achieved) at very low sludge age and / or low MLSS concentrations.

Potential reasons for the deterioration in inactivation achieved through the UV irradiation system after 2013 are discussed in more detail in the following section.

4.2. UV irradiation

There are a number of factors that affect the inactivation achieved through a UV irradiation system:

- process conditions (flow, UV transmittance);
- the dose-response relationship of the target organism , (which is dependent on factors including suspended solids, turbidity, nature of the floc;
- UV irradiation system capacity / dose delivery;
- UV irradiation system operational issues (fouled sleeves, significant number of lamp fails, control philosophy).

An assessment of these factors at West Huntspill STW has been made and is summarised in the following sections.

Appendix A presents the Figures used for this assessment.

4.2.1. Process conditions

West Huntspill is a treat all flows works. An assessment of the recorded flow data to the UV irradiation system over a five year period (2013-2017) indicates that, with the exception of 2014, the flowrate to the UV irradiation was below 200 l/s for 70% of the year and flow-rates exceeded 400-500 l/s for approximately 5% of the time. A maximum flow of approximately 600 l/s has been observed. The data indicates that there has been no significant increase in the annual flow profile from 2013 to 2017. A summary of the flow data is presented in Figure A1.

A comparison of the recorded flowrate and UV transmittance values for 2017 indicates that the UV transmittance is generally higher during periods of high flowrate, and appears to be lower during periods of lower flowrates. It should be noted that the recorded UV transmittance data appears to be capped at 35% as a minimum value. This lower cap is present on the site SCADA so is probably an artefact of the instrument reading.

A comparison of the online trends (as illustrated in Figure A3) from 2013 to 2017 for turbidity and UV transmittance indicates an inverse relationship between these two parameters, with spikes / periods of higher effluent turbidity corresponding to periods of lower UV transmittance. Generally the data shows that low turbidity corresponds to UV transmittance values above 45-50%. However, when the turbidity spikes sometimes between 20-40 NTU) it can be seen that the recorded UV transmittance is 30% or below. .

The assessment of the capacity of the UV irradiation system has been carried out for UV transmittance values from 30% to 50%. The historical variation is UV transmittance is is summarised in Figure A2.

4.2.2. Dose – Response relationship

The current permitted / reported "Received Dose" at West Huntspill STW is a theoretical / calculated dose that is not directly relatable to disinfection performance and cannot be directly related to the UV dose developed through collimated beam test work. Therefore this report will focus discussions on the UV dose determine through collimated beam test work which can be related to the supplier's performance validation information.

The level of inactivation achieved in UV irradiation depends on the UV Dose (validated dose) applied and the quality of the wastewater; therefore it is not possible to make a generic comparison of performance with other works. However, from the observed disinfection performance prior to 2013, it can be seen that the UV irradiation system consistently achieved approximately 2 $\log_{10}$ of faecal coliforms and 1.4 $\log_{10}$ of faecal streptococci.

The dose-response relationship describes the sensitivity of the target organism to UV irradiation and the extent of disinfection that can be achieved on a site specific basis. UV dose-response relationships for faecal coliforms and faecal streptococci have been developed using the results from collimated beam test work carried out on samples of final effluent (pre UV irradiation) obtained from the site. The data have been used to evaluate the capacity of the existing UV irradiation system, in conjunction with performance validation information from the equipment supplier (Trojan) by determining:

i. the sensitivity of the target organisms to UV irradiation under different effluent quality scenarios;

ii. the target dose required to achieve the disinfection performance for these scenarios.

Collimated beam test work was carried out on six samples collected in February / March 2019. Each sample was analysed in triplicate. The physical characteristics of the samples taken provide an envelope of values for UV transmittance, turbidity and concentration of suspended solids. Samples were collected under a variety of observed flow conditions.

The dose response data presented in Figures 5 and 6 shows the concentration of target micro-organism remaining after a UV dose was applied in the collimated beam test for each sample. This is called the collimated beam dose and can be equated to the validated dose performance of the UV irradiation system using the combined equation developed by Trojan from the validated reports (Trojan

Feb 2009, Nov 2009). It should be emphasised that the collimated beam dose is not relatable or comparable to the measured applied / received dose in the current permit for the site. The range of performance that could be delivered by the existing UV irradiation system (depending on the flowrate and water quality) is shown in the shaded area. This has been determined from the assessment and will be discussed in the next section.

For the purpose of this assessment, the target levels shown in Figure 5 for *E. coli* (faecal coliforms) has been set to <1,200 cfu/100ml (the Wessex Water trigger point on efficacy data), and an associated value for enterococci (faecal streptococci) for Figure 6 has been calculated based on 40% of the faecal coliform target, i.e. 480 cfu/100ml, as this is the expected ratio between the two organisms, based on comparison of the target geometric mean values in the Bathing water (*E. coli* / enterococci 80/32 cfu/100ml).

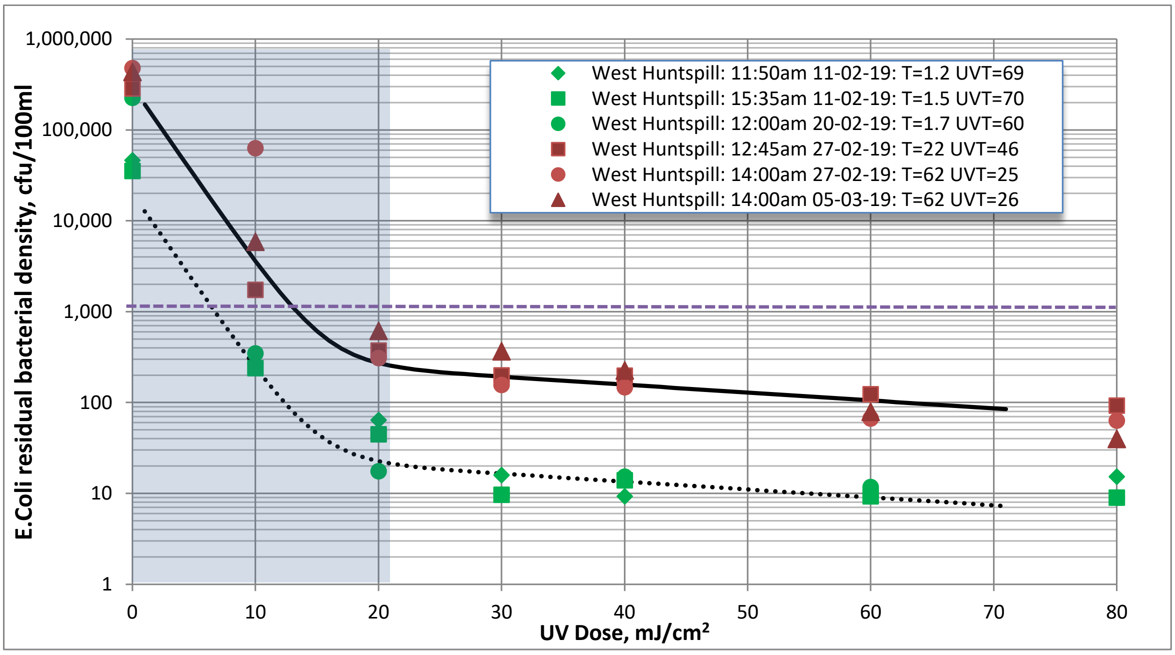


Figure 5: UV dose response data for *E.coli* (representing faecal coliforms)

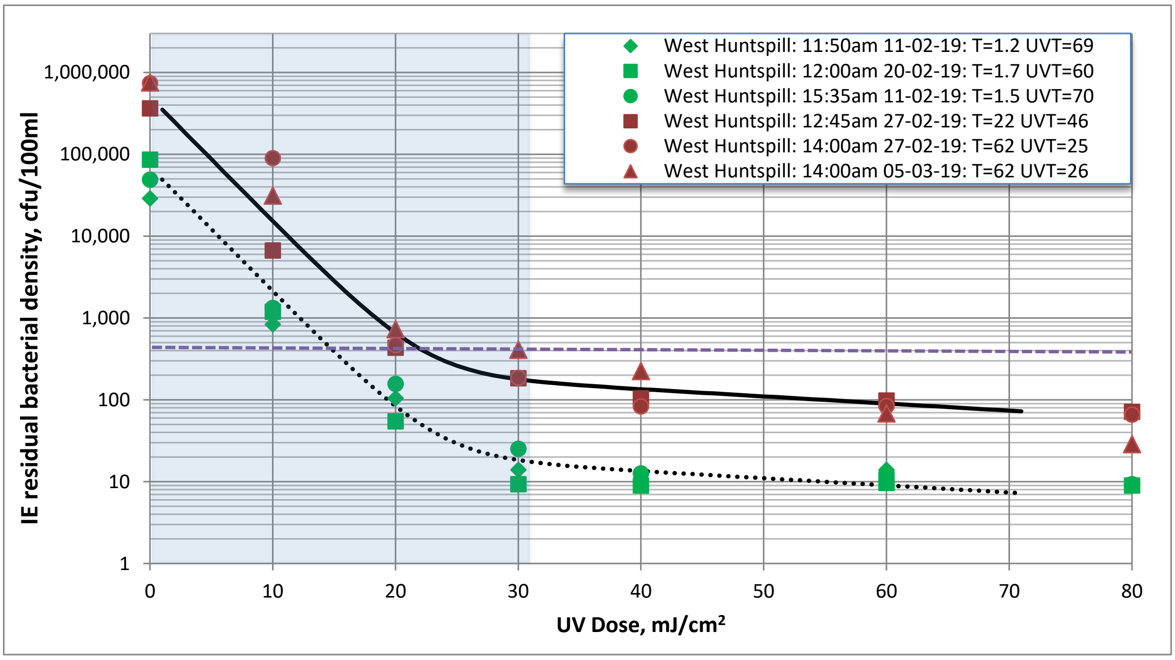


Figure 6: UV dose response data for *enterococci* (representing faecal streptococci)

The data in the curves presented illustrate the impact of turbidity and UV transmittance on the level of disinfection that is achievable.

- For the samples with lower turbidity (1-2NTU) and high UVT (>60%), shown in green points on the graph), the initial concentration of target organism in the samples were almost 1 log lower than that observed in the samples with higher turbidity (>20 NTU) and lower UVT (<30%) (shown in brown points on the graph) (with the exception of one data point for *E. coli*).
- The overall log inactivation required to meet the target concentration is greater for the samples with higher turbidity by about 0.5-1 $\log_{10}$.

The dose response curves are characterized by two distinct regions, shown by the black and red dotted lines in Figures 5 and 6.

- The initial part of the curves exhibits an approximate first order response with a similar gradient for both sets of water quality, where disperse organisms are inactivated. The second, flatter part of the curve is where the organisms more associate with the particles are inactivated and the response tails at a higher concentration for the samples with higher turbidity with only a marginal improvement in the residual concentration achieved with increases in UV dose.
- The residual (remaining) concentration at which the response transitions from the first order curve to the flatter response is lower in the samples with low turbidity (and high UVT), compared to the samples with high turbidity (and low UVT). For example, looking at the dose response for *E. coli*, the transition point is at a dose of approximately 15mJ/cm^2 and residual concentration of <100 cfu/100ml for the samples with low turbidity and residual concentrations of nearer 500 cfu/100ml for the samples with high turbidity.
- The UV dose required to achieve residual organism concentrations below the target values was less in the samples with low turbidity (approximately 9 mJ/cm^2 for *E. coli* and 13 mJ/cm^2 for intestinal enterococci). In both cases the target point is within the first order part of the dose response curve.
- Higher UV doses were required to achieve the target concentrations for the samples with poorer water quality; approximately 18 mJ/cm^2 for *E. coli* and greater than 20 mJ/cm^2 for intestinal enterococci. In these cases the dose required to achieve the target residual is on the flatter part of the curve, where there is a lower overall reduction with increased in UV dose.
- The lowest residual concentration achieved tends towards approximately 100 cfu/100ml for both organisms with poorer water quality, whereas a concentration of closer to or below 10 cfu/100ml (the limit of detection) is achieved with the samples of higher water quality, demonstrating the impact of higher turbidity and higher concentrations of suspended solids on the efficacy of UV irradiation.

In summary, for the samples with higher turbidity, the log inactivation required to meet the target residual concentration is greater than with the samples with low turbidity. The UV dose required to meet the target residual concentration is higher for these samples, and the increased effect of shielding from the higher turbidity pushes the required dose past the transition point of the first order curve, into the second region where the sensitivity to disinfection decreases, i.e. it is harder to achieve the target residual concentration in the samples with poor water quality, than it is in the samples with good water quality.

Table 1 summarises the dose related information discussed above from the collimated beam test results that will be used in the assessment of the existing UV irradiation system in the following section.

Table 1: Comparison of sensitivity to UV irradiation and dose required to meet target residual and log inactivation

Target organism	Turbidity NTU	Initial concentration (geometric mean U75%CI), cfu/100ml	Target log in-activation	Sensitivity mJ/cm²/ log	Target dose mJ/cm²
E. coli (faecal coliforms)	<2	7.2×10^4	1.9	4.5	9
	>20	3.9×10^5	2.6	4.5	13
Enterococci (faecal streptococci)	<2	1.6×10^4	1.3	10	13
	>20	2.9×10^5	2.6	10	26

4.2.3. Assessment of existing UV irradiation system

The details of the UV irradiation system installed at West Huntspill are summarised below:

Table 2: Summary of West Hunstpill STW UV irradiation system (details provided by Trojan UK)

System	Trojan UV 3000+ (Automatic Mech/Chem Quartz cleaning)
Number of channels	1
Lamp type	794447-OG (LPHO Amalgam lamps, approx. 250W)
Number of banks	2 (Configured as D/A)
Lamps per bank	136
Lamp orientation	Horizontal
Lamp spacing	3"
Headloss at 440 l/s	70mm
Maximum validated flowrate	600 l/s
Maximum headloss tested during validation	102mm at 600 l/s over 2 banks
Theoretical target UV Dose	50mJ/cm² PSS
Installation date	2001

It is noted that the maximum head loss associated with the operation of two banks that were tested during the validation process was limited to 102mm, which equates to a maximum flow rate through the system of 600 l/s, therefore, the UV irradiation system is capable of treating flows up to 600 l/s without causing any loss of performance due to high head loss.

Unlike more recently developed UV irradiation systems where multi-organism validations have been developed, this system has a number of more limited single organism (MS2, T1) validations. However, Trojan has combined these separate validations and Stantec has used that information in combination with the dose response data from the previous section to provide an indication of the likely performance of the system for a range of flow and UV transmittance values.

Tables 3 and 4 summarise the estimated performance of the existing UV irradiation system based on the criteria defined in Table 1 for *E. coli* and intestinal enterococci and the performance prediction equations provided by Trojan in their validation reports.

The shaded cells in Tables 3 and 4 indicate the trend of expected performance with 1 and 2 banks in operation at different combinations of flowrate and UV transmittance. The cells shaded in blue would be expected to meet the required log inactivation for both high and low turbidity effluent. The cells shaded in green would meet the log inactivation requirements for the low turbidity (high quality) effluent. The cells shaded in orange do not provide a sufficient log inactivation to meet the target concentration or log inactivation. The cells with “>” indicate that the maximum log inactivation is limited to the maximum achieved from the dose response relationship.

Table 3: Estimated log inactivation of *E. coli* based on number of operational banks for the range of flow and UV transmittance observed at the site

Banks	1					2				
UVT	30	40	45	50	60	30	40	45	50	60
100 l/s	2.6	3.5	3.5	3.5	>3.5	>3.5	>3.5	>3.5	>3.5	>3.5
200 l/s	1.7	2.7	3.4	3.5	>3.5	>3.5	>3.5	>3.5	>3.5	>3.5
400 l/s	1.1	1.7	2.1	2.6	>3.5	2.9	>3.5	>3.5	>3.5	>3.5
600 l/s	0.9	1.3	1.5	1.9	>3.5	2.1	3.1	>3.5	>3.5	>3.5

Table 4: Estimated log inactivation of intestinal enterococci based on number of operational banks for the range of flow and UV transmittance observed at the site

Banks	1					2				
UVT	30	40	45	50	60	30	40	45	50	60
100 l/s	1.6	2.5	3.2	3.5	>3.5	3.4	>3.5	>3.5	>3.5	>3.5
200 l/s	1	1.6	1.9	2.4	>3.5	2.3	3.3	>3.5	>3.5	>3.5
400 l/s	0.7	1	1.2	1.5	2.4	1.5	2.1	2.5	3.1	>3.5
600 l/s	0.5	0.7	0.9	1.1	1.7	1.2	1.6	1.9	2.3	>3.5

The data in tables 3 and 4 indicate that (assuming all lamps in operation):

For *E. coli*:

- The target performance would be expected to be achieved under all flow and UV transmittance when operating both banks, with the exception of flowrates above 400 l/s at UV transmittance of 30% or lower (i.e. high flows and poor quality effluent). Above 400 l/s, at UV transmittance of 30% or lower, the target performance would not be expected to be achieved.
- When operating a single bank, the target performance would be expected to be met for all flowrates and UV transmittance above 50%, assuming good effluent quality. For UV transmittance of 45%, the expected performance would not be achieved above 400 l/s and for UV transmittance of 40%, the maximum flowrate that the target performance could be expected is 200 l/s. For 30% UV transmittance the system is limited to delivering target performance at a maximum flowrate of 100 l/s.

For intestinal enterococci:

- When operating both banks, the target performance would be expected to be achieved for all flowrates for UV transmittance values above 45%. At UV transmittance of 40%, the performance would be expected for flowrates up to 200 l/s. At 30% UV transmittance the target performance would be expected for flowrates up to 100 l/s.
- When operating a single bank, the target performance would be expected to be met for all flowrates and UV transmittance above 60%, assuming good effluent quality. For UV transmittance of 50%, the target performance would not be achieved above 400 l/s and for UV transmittance of 45%, the maximum flowrate that the target performance could be expected is approximately 200 l/s. For 40% UV transmittance the system is limited to delivering target performance at a maximum flowrate of 100 l/s. if the UV transmittance is 30%, the expected performance for intestinal enterococci would be below the target.

In summary, as the water quality deteriorates and the inlet concentration increases, the operation of the second bank is required. Based on achieving inactivation of enterococci (the more onerous condition), for UV transmittance of 45% or below, and poorer turbidity (>20 NTU), the second bank is expected to be required at flows above approximately 200 l/s and for effluent quality of 30% UV transmittance two banks would not be expected to achieve the target concentration of enterococci for flowrates above 100-200 l/s.

This assessment demonstrates how critical the quality of the effluent is, both in terms of UV transmittance and also suspended solids / turbidity for achieving the desired disinfection performance and the possible impact on the performance that can be achieved if the effluent quality has deteriorated.

Other factors that may contribute to under performance

a) Lamp failures:

The expected performance discussed in the previous section is based on the assumption that all lamps in a bank are in service. The validation work is carried out with all lamps in service and there is no potential in the performance prediction equations to calculate a reduce performance based on number of failed lamps.

Particularly during operation of a single bank, the impact of lamp fails can be significant. For example. If the concentration of E. coli into disinfection is 1×10^5 cfu/100ml, and the expected inactivation is 2 log, if 10% of the lamps are missing, then 10% of the flow will not be disinfected to the required level. A very simplified calculation to demonstrate the effect on the concentration of organisms in the effluent post disinfection is: $90\% \times 10^3 + 10\% \times 10^5 = 1 \times 10^4$ *E. coli*, i.e. the overall reduction is limited to 1 $\log_{10}$.

On the recent site visit there were a total of 23 failed lamps in a single bank of 136, or 16.9%, with only one bank in operation. This is likely to have had a significant impact on the performance that could be achieved.

It is recommended that if a lamp fails in a bank, there is immediate automatic changeover to the second bank. If there are lamp fails in both banks then it is recommended that both banks are operated at full power.

Operating two banks in series to achieve the required dose provides more efficient performance than a single bank, particularly if there are failed lamps in the first bank, as the second ban can provide some disinfection to the portion of water that was effectively bypass in the first bank.

b) Fouling

Algal growth was observed at the entrance to the UV irradiation channel and on the lamp cables indicating accumulation of organic matter that could pass into the channel and impact disinfection performance. It is recommended that the channel and cables are cleaned as well as the lamps at regular intervals.

c) Measured flowrate

There appears to be a recirculation system in place located downstream of the UV irradiation channel, to transfer flows to the inlet. However, this flow does not go through the MCERTS flowmeter, and thus the flowrate used to calculate the lamp power required to achieve the dose set-point will be lower than the actual flowrate through the channel, due to the addition of the recirculated flow. This would result in lower performance than expected at low flows when this recirculation system is in operation.

4.3. <u>Impact of upstream process performance</u>

It is likely that the reduction in UV irradiation performance is related to the deterioration in quality of the effluent from the upstream treatment processes (primary and secondary) rather than any particular issues with the UV irradiation system. As discussed in the previous section, effluent quality parameters that would be expected to affect performance of UV irradiation system are:

- suspended solids concentration, particle size (pin floc)
- UV transmittance (soluble BOD / organic content / chemical used for septicity dosing

Discussions and observations from a site visit in December 2018 was in conjunction with analysis of historical performance data was used as the basis for a high level evaluation of the treatment works. Table 4 summarises the issues identified with the performance of the upstream processes that are likely to have an impact on the performance of the existing UV irradiation system.

Table 4: Summary of upstream process issues

Process	Performance impact
Inlet works	Septicity due to long, flat sewer network. Potential impact on UVT and UV performance as septicity undermines primary tank BOD removal efficiency, increasing load to ASP
Trade input	Trade load includes bakery: possible source of oleic acid (margarine) which can stimulate Microthrix parvicella growth at longer sludge ages. BOD load from food manufacturers significant (23% of total) which contributes to high BOD load onto activated sludge plant
Centrate return load	BOD is high (4,400 mg/l) which contributes to elevated BOD concentrations and load onto activated sludge plant
PST	High crude sewage BOD/ high BOD sludge liquors create high BOD concentrations
Secondary treatment (ASP)	Plant stressed by high BOD load from PSTs, creating tendency to operate at short sludge age.
Final tanks	In 2016 Microthrix parvicella causes filamentous bulking and SSVI increases which lead to increased final effluent SS, in turn increasing BOD and COD. Sludge age reduced to successfully control Microthrix parvicella. However, increases in BOD load now reduce sludge age too much and pin floc results, which includes small hard to settled solids and an increase in colloidal material – which decrease final effluent turbidity even with coagulant dosing.

A summary of the key points from the evaluation of the upstream treatment process at West Hunstpill STW are as follows:

- There does not appear to be any strong interference from any trade load that might affect the UV transmittance.
- Final effluent annual average SS concentration increases after 2006 but then also becomes more variable after 2013 which has had a subsequent impact on variability in COD and BOD (and turbidity and UV transmittance).
- Spikes in turbidity experienced due to higher variable suspended solids and pin floc. Poor suspended solids and turbidity would be expected to adversely affect the performance of the UV irradiation system.
- Spikes in turbidity correspond to periods of low UV transmittance. Colloidal material and soluble organics will also contribute to poorer UVT.
- The existing ASP operates at low sludge age and maintains a low solids inventory. This can result in development of a pin floc, causing a deterioration in turbidity.
- The proposed AMP7 solution to add a second ASP lane would enable this reduction in overall BOD loading rate to secondary treatment. This solution would be expected to securing a better quality effluent, and reducing the variability of the effluent quality for disinfection, thus lessening the risk of reduced inactivation performance from the UV irradiation system due to poor UV transmittance / high turbidity.
- Additionally, a longer sludge age would be expected to increase bacteriological reduction further contributing to securing the required levels of bacteriological reduction.

5. Summary and conclusions

The main conclusion from this study with regard to the challenge from Ofwat is that installing a larger UV irradiation system without improving the performance of the upstream secondary treatment may not significantly improve the overall bacterial reduction performance during periods of poorer effluent quality, typical of the characteristics observed at the works over the summer periods, due to the potential level of shielding provided by the characteristics of the effluent (pin floc, high turbidity).

The addition of a second ASP lane, as proposed in the AMP7 improvement scheme for West Huntspill, would increase the sludge age and allow the plant to be operated at a higher solids inventory. The expected benefits to performance would be:

i. bacterial reduction achieved over the secondary treatment process should improve and become less variable.

ii. the quality of the final effluent for disinfection should improve and there would be a reduction in the variation in the parameters that impact UV irradiation. This would enable the level of disinfection achieved to be more consistent with that achieved in the past.

iii. Potentially a lower inactivation required through disinfection to achieve the discharge targets, based on the fact that the better quality (lower turbidity, higher UVT) samples taken on site as part of the test work showed a lower concentrations of faecal indicators.

Addition of more secondary treatment capacity would be expected to secure a better quality and more consistent effluent for disinfection by UV irradiation, thus contributing to a more robust long term solution for the works.

Further findings from this study are summarised below:

- Historically, reduction in concentrations of faecal coliforms and faecal streptococci over the treatment processes upstream of disinfection were typical or better than expected of the processes on site, achieving an annual average of between 1.5 and 2 $\log_{10}$ for both indicator organisms. The performance has deteriorated marginally since 2013, achieving annual average reduction of 1.5 $\log_{10}$ or below, for both indicator organisms.
- The annual average inactivation of faecal coliforms and faecal streptococci observed through disinfection was between 2 and 3 $\log_{10}$ which is typical of what could be expected for a well operated UV irradiation system on a high quality final effluent. There has been an observed deterioration in performance through the UV irradiation system since 2013, with observed average inactivation for both faecal indicator organisms reducing to below 1.5 $\log_{10}$.
- Although trade loads to the works have been increasing since 2000, there has been no significant change in the characteristics of trade loads to the works that would be expected to impact the disinfection performance (e.g. containing chemicals that could reduce / change the effluent UV transmittance or impact the UV dose-response).
- An assessment of the existing UV irradiation system against performance validation information demonstrates that it has sufficient capacity to achieve the expected level of disinfection for the site when the water quality is typical of a well performing activated sludge plant. However, UV dose-response data collected based on samples of poorer quality effluent (higher turbidity / lower UVT), typical of more recent periods in the Bathing season post 2013, can be seen to have a significant impact on the disinfection achieved by the UV irradiation.
- In 2012 the high-rate filters were removed from service for health & safety and improved process stability reasons. This resulted in an increased load to the existing ASP lane. Although there hasn't been a significant change to compliance with permitted parameters, there is an observed increase in the annual average concentration of suspended solids in the final effluent starting in 2006 and becoming more variable after 2013.
- It is likely that due to these changes in load, the quality of the final effluent produced that relates to the performance of the UV irradiation system has deteriorated, particularly during certain periods of the year.

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Trojan validation report: Trojan UV3000Plus 3" lamps spacing (MS2) Report February 2009

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Appendix A

Figures presenting summary of assessment of Historical flow and effluent quality data

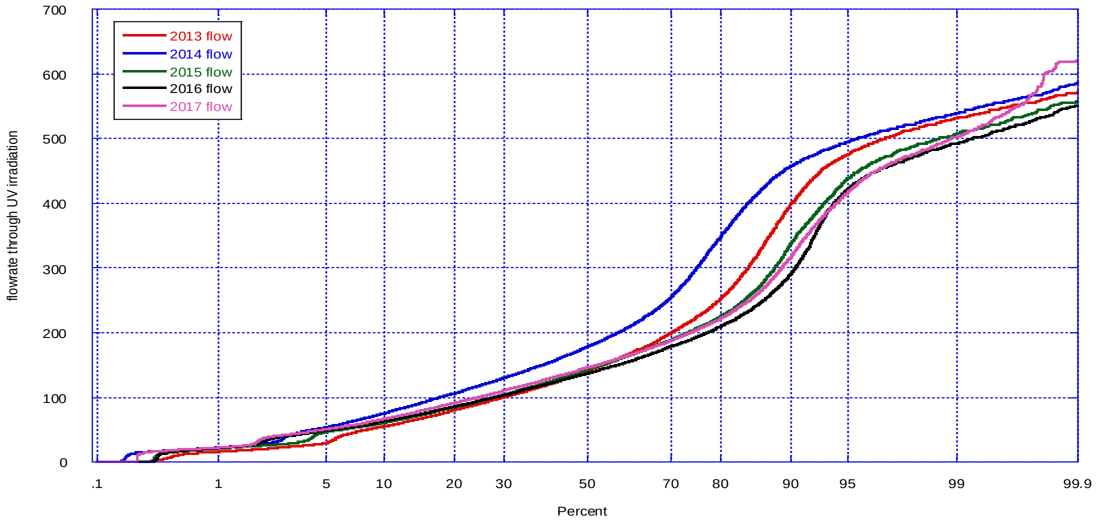


Figure A1: Summary of the variation in flowrate to the UV irradiation system, 2013- 2017.

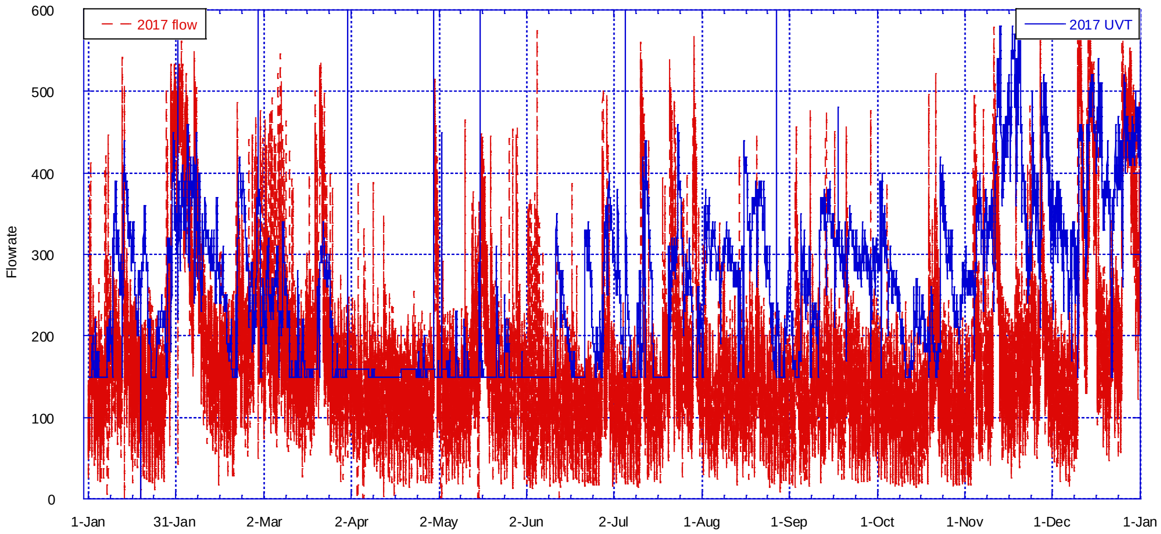


Figure A2: Comparison of flowrate and UV transmittance for 2017

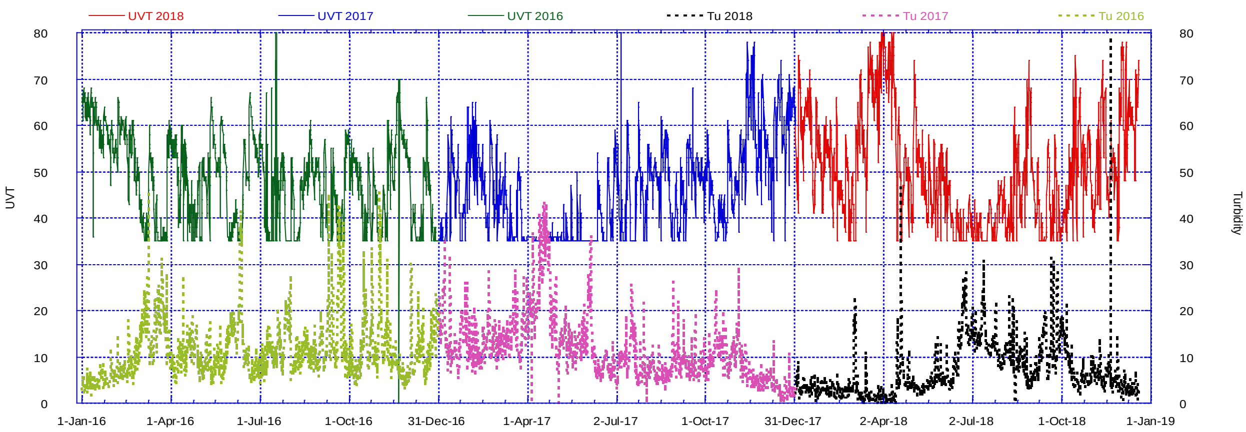


Figure A3: Comparison of the online UV transmittance and turbidity data from 2013 to 2017.

Appendix B

Photographs from site visits (Dec 2018 and Feb 2019)

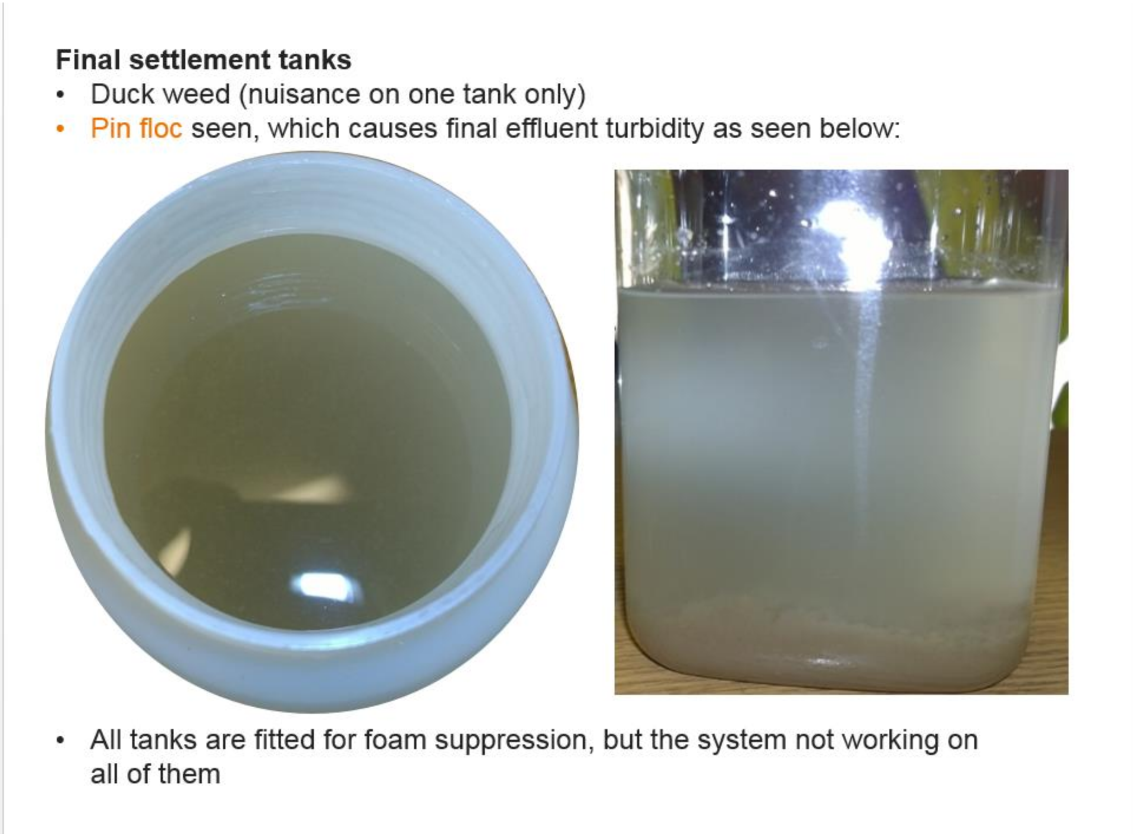


Figure B1: photograph from site visit December 2019 showing pin floc / high turbidity in final effluent

Figure B2: photograph showing pin floc in the final settlement tanks

Annex H. Yeovil (Pen Mill) STW

This annex is an update of Annex H from
Supporting document 5.1 – Protecting and enhancing the natural environment.

1. Need

Quality Enhancement

The following lines are included in the WINEP for Yeovil (Pen Mill) STW:

Table H-1: Quality enhancement drivers identified in the WINEP for Yeovil (Pen Mill) STW

Driver Code	Driver code Information	Relevant section in Supporting document 5.1
Investigations / Monitoring		
U_MON3	Storm tank EDM	3.5
U_MON4	Flow measurement	3.5
Improvements		
U_IMP6	Storm storage capacity increase	3.5
WFD_ND	Ammonia removal	3.3
WFD_IMP	Ammonia removal	3.3
WFD_ND	Biochemical Oxygen Demand (BOD) removal	3.3
WFD_IMP	Biochemical Oxygen Demand (BOD) removal	3.3
HD_IMP SSSI_IMP WFD_IMP	Phosphorus removal	3.2

This annex relates to the works associated to meet the improvement drivers for sanitary (ammonia and BOD) and nutrient (phosphorus) removal, as detailed below:

Table H-2: PR19 permits identified in the WINEP for Yeovil (Pen Mill) STW

Driver Code	Driver code Information	Completion Date	Level of certainty?	Old Permit	New Permit
WFD_ND	Ammonia	31/03/2025	Green	15 mg/l	12 mg/l
WFD_IMPg	Ammonia	22/12/2024	Amber	15 mg/l	4 mg/l
WFD_ND	BOD	31/03/2025	Green	30 mg/l	12 mg/l
WFD_IMPg	BOD	22/12/2024	Amber	30 mg/l	14 mg/l
HD_IMP WFD_IMP SSSI_IMP	Phosphorus	22/12/2024	Green	2 mg/l	0.65 mg/l

As the requirement to provide increase storm storage at this STW is a specific requirement for improved assets not related to the above quality drivers or for treatment enhancement for growth we have considered this separately in Section 3.5 of Supporting document 5.1.

Growth Enhancement

Yeovil STW was listed as a defined-contingent growth scheme in our PR14 business plan. We have been able to defer investment by managing the load and optimising the performance of the existing secondary treatment processes and the high-rate filter that was built in 2013. However future planned growth in both residential and trade flows and loads requires additional treatment capacity to ensure that the site continues to maintain environmental permit compliance.

2. Background

Yeovil (Pen Mill) STW is located in the Parrett catchment, serving a population equivalent of 53,852. Trade loads are dominated by a leather/tanning industry, along with significant contributions from local aerospace industries.

Sludge is pumped to Yeovil (Vale Road) Sludge Treatment Centre for processing, which also receives sludge imports from other STWs. Sludge liquors are returned by pipeline for treatment at the STW.

The STW is a two-stage biological filter works with first stage primary tanks, a high rate filter process with associated settlement followed by secondary filters and humus settlement tanks. There is also chemical dosing for phosphorus removal.

The original works was constructed in the 1950s, with additional secondary biological filters provided in the mid 1960's. Between 1976 and 1980 further secondary filters were installed and the high rate filter stage introduced for part of the flow. In the early 2000's it was recognised that expansion was required as loads to the site exceeded the treatment capacity provided and measures were planned, however, the requirement for these was obviated by the closure of a major trader. The headroom released by this has now been lost. Limited additional capacity was provided in 2013 when a second high-rate filter was installed along with chemical dosing to achieve a phosphorus permit of 2mg/l (as an annual average) for UWWTD compliance.

The STW regularly approaches its limit for ammonia discharge. Compliance with the discharge permit has, on occasions, been met by tankering sludge liquors from Vale Road STC, requiring significant Opex. The ammonia loading on the second stage filters (where most of the ammonia removal occurs) is already 20% greater than design standards and by 2025 will be 30% greater.

3. Options

In our PR14 capacity enhancement proposals we considered options for additional secondary treatment (such as by additional stone media filters or a new plastic media filters) or adding a tertiary treatment stage (such as tertiary nitrifying filters).

Given the multiple drivers and the nature of the amber schemes being subject to ministerial approval, individual processes have been considered to target the different parameters.

Our standard design solutions for achieving the WFD no deterioration (ND) limits would be similar to our options for capacity enhancement, however these options would not be wholly suitable to achieve the tighter WFD improvement (good ecological status) limit for ammonia (4mg/l). The following options have thus been considered:

- An additional activated sludge process stream
- Additional secondary treatment and tertiary aerated sand filters

A further combined Habitats Directive, Water Framework Directive and SSSI driver requires a tightening of our permit standard for phosphorus to 0.65mg/l (as an annual average). Phosphorus tightening will require:

- Tertiary treatment (filtration) with 2-point chemical dosing, or
- Activated sludge secondary treatment with 2-point chemical dosing

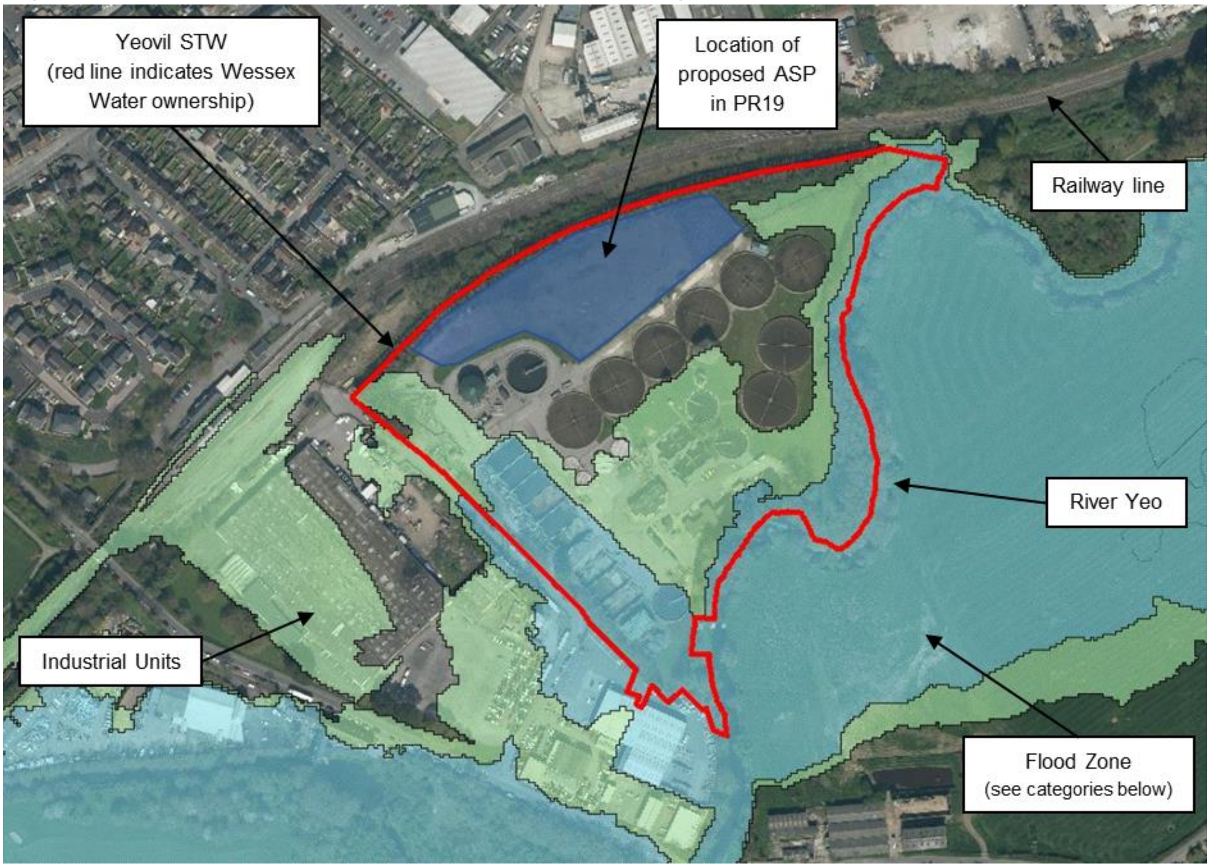
A high-level comparison of treatment options is summarised in the below table.

Table H-3: Treatment options at Yeovil (Pen Mill) STW to achieve the different PR19 drivers

Option	**Stone media filters** with dedicated P-removal stage	**Plastic media filters** with dedicated P-removal stage	**Tertiary Nitrifying filters** with dedicated P-removal stage	**Activated Sludge Plant**
Treatment Provision:				
Growth Capacity	✓	✓	✓	✓
AmmN (to 12mg/l)	✓	✓	✓	✓
P (0.65mg/l)	✓	✓	✓	✓
AmmN (4mg/l)	✗	✗	✗	✓
Capex (£m):				
AmmN (12mg/l) and Growth	4.76	3.99	3.35	
P (0.65mg/l)	4.26	4.26	4.26	18.51
AmmN (4mg/l)	5.28	5.28	5.28	
Total to achieve all drivers:	14.30	13.53	12.89	18.51

Land availability around this STW is limited, as shown in the figure below.

Figure H-1: Site plan of Yeovil (Pen Mill) STW showing constraints to future expansion



Environment Agency Flood Zones:

Zone 3 – High Probability – Land having a 1 in 100 or greater annual probability of flooding

Zone 2 – Medium Probability – Land having between a 1 in 100 and 1 in 1,000 annual probability of flooding

How we approach the long term needs of the site will depend on what option is implemented in the short term (PR19). Additional treatment capacity can be constructed within the existing site boundary as an extension to the proposed ASP for PR19. If the other options were implemented in PR19 then additional land would need to be purchased. We have identified a non-adjacent area of land to the south east of the existing site as a possible location for a new site. There would be associated pump away and split-site costs, such as the duplication of backwash handling facilities and standby generator provisions.

In consideration of this pump-away option, our proposal would be to only take partial flow (1.25 x permit DWF) to the new site – rather than full FFT – to then blend flows with the existing site effluent to meet future permit requirements. This avoids significant additional capex and opex required to treated full FFT at a new site.

A summary of the whole-life cost analysis for the various treatment options is shown in Table H-4. This includes both the short-term (PR19) and long-term (PR34) options.

Table H-4: Whole-life cost analysis of treatment options at Yeovil (Pen Mill) STW

Short-Term (PR19) Option	Stone Media Filters	Plastic Media Filters	Tertiary Nitrifying Filters	ASP
Capex (£m)	14.30	13.53	12.89	18.51
Opex (£k/yr)	279	338	354	320
Long-Term (PR34) Option	**Pump away and new partial treatment process**			**ASP Expansion**
Capex (£m)	11.28			3.42
Opex (£k/yr)	265			110
NPV Analysis				
40-year NPV[1] (£m)	32.0	32.4	32.0	29.7
60-year NPV[1] (£m)	36.0	36.6	36.2	31.9
Lowest whole-life cost	×	×	×	✓

[1] All options are indexed to the date of completion of the AMP7 scheme.

4. Proposed solution

As identified previously, land availability around Shepton Mallet STW is limited. We have only a small parcel of land that can be used for additional treatment units. This restricts the options we can adopt for this site. Whereas the requirements for growth and the more limited quality enhancements can be achieved by utilising additional secondary units with chemical dosing, the requirement to achieve a 4mg/l ammonia permit would not be feasible with this strategy. We have therefore concluded that the option for a new activated sludge process (ASP) stream should be adopted.

The costs from the proposed ASP option have been apportioned between drivers as shown in the table below:

Table H-4: Cost apportionment between PR19 drivers at Yeovil (Pen Mill) STW

	Percentage	Capex (£m)	Opex (£m/yr)
Quality enhancement			
Phosphorus removal		4.26	0.11
Ammonia& BOD removal (WFD_ND)		5.04	0.13
Ammonia & BOD removal (WFD_IMP)		7.95	0.06
Total Quality enhancement	93%	17.25	0.29
STW Growth (capacity)	7%	1.26	0.02
	Total:	18.51	0.32

Annex I. Frequent spilling overflows – further evidence

This is further evidence detailing the WINEP FSO programme.
Also see Section 3.2 above.

This Annex provides further evidence to our FSO proposals, containing an example report. This is one of the 13 FSO appraisals that we undertook in 2018 under the new Storm Overflow Assessment Framework (SOAF) process.

C9918 – PR19 Sewerage Planning Support
Part F – frequently spilling overflows

Report for site 16561 – Watleys End in Field off Factory Road CSO – Winterbourne – Avonmouth STW Catchment

Prepared	Reviewed
Kieron Bacon	James Allmand
18/5/18	21/5/18

SECTION 1 – PROJECT INFORMATION

1.1 Project Need

As part of Wessex Water's PR19 preparation, WECs have been requested to develop high-level options to reduce spill frequencies at a number of CSOs. A link to the brief for this work is included here, with further clarification in DM-#1810648. This report details options surrounding 16561 – Watleys End in Field off Factory Road CSO – Winterbourne – Avonmouth STW Catchment. NB: this overflow will be referred to as Watleys End CSO throughout this report.

1.2 Existing system and model

Figure 1 below shows the location of the 16561 Watleys End CSO in relation to the local foul sewer network, and Figure 2 shows its geographical location in relation to the wider Avonmouth STW Catchment (Catchment ID: 23013). The CSO is located just upstream of the 825mm Ø Frome Valley Trunk Sewer. The CSO discharges into the (Bristol) River Frome, and is located in pasture land and scrub.

Figure 1: Watleys End CSO Location

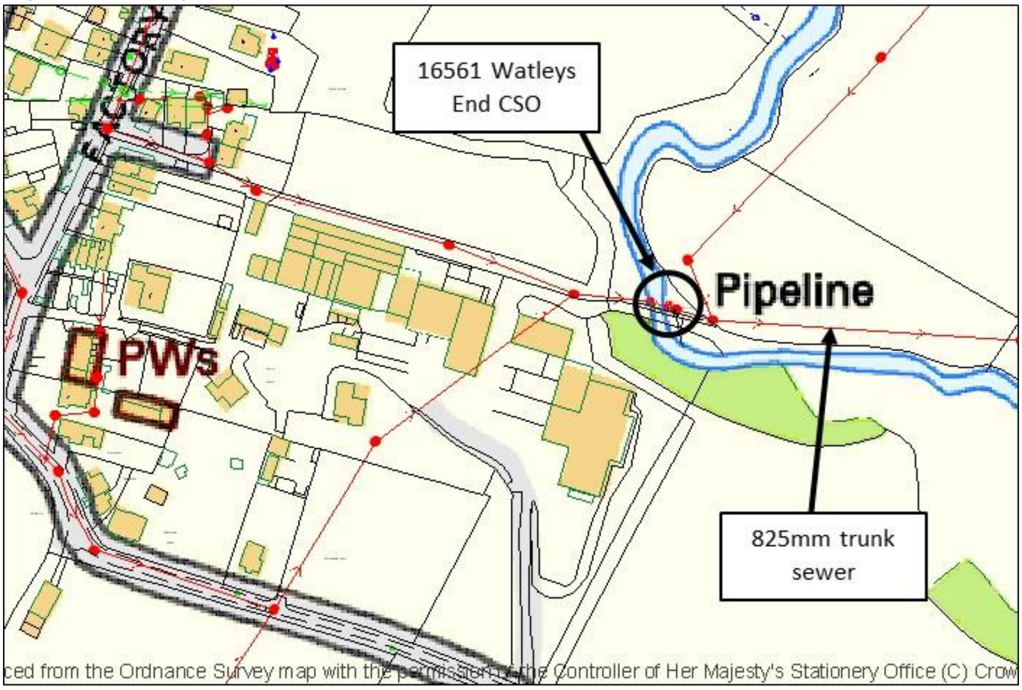
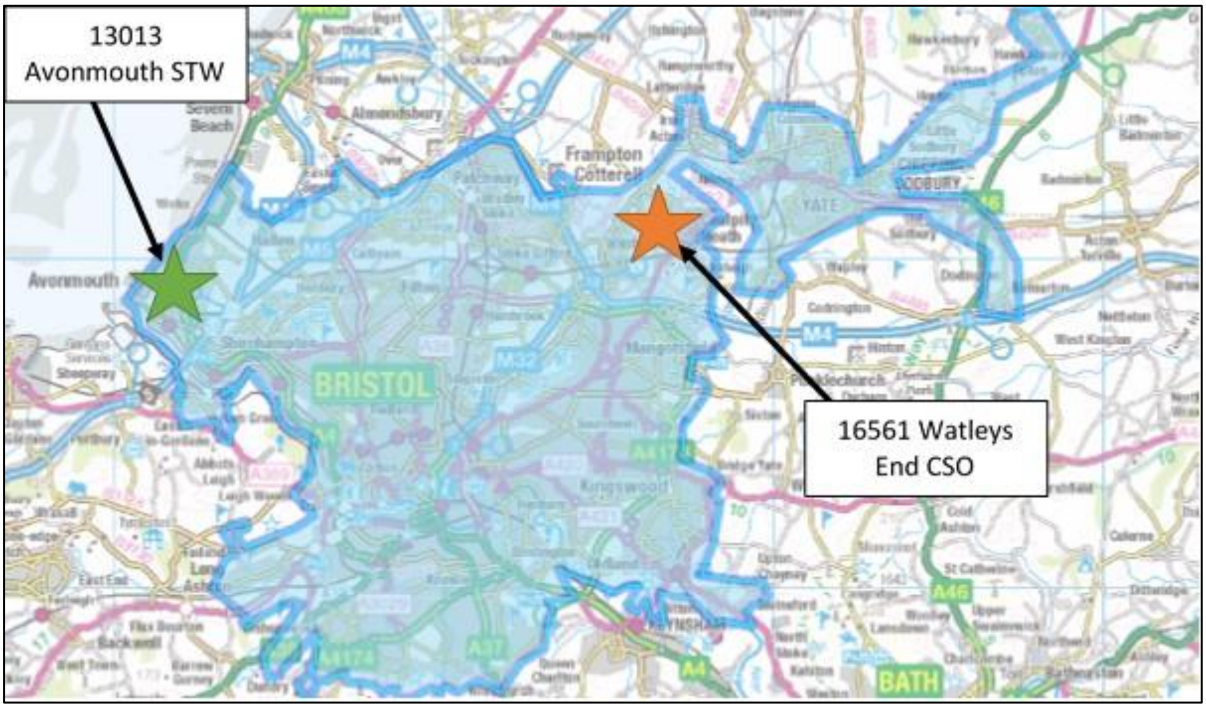


Figure 2: Location of Watleys End CSO within the Avonmouth catchment



The CSO is located on the eastern side of the River Frome, immediately downstream of a pipe bridge. The CSO chamber is above-ground. Flows enter the CSO via an incoming 225mm Ø sewer from the pipe bridge. During dry weather, flows continue through the chamber, and exit via a HydroSlide with a peak design flow of 26l/s. Flows are then conveyed by 225mm Ø sewer to an 825mm Ø trunk sewer, which ultimately drains to the Inlet Works at the Avonmouth STW (Asset ID: 13013). During storm conditions, if 26l/s is exceeded in the HydroSlide, then flows spill via two Copa Cyclone 6mm screens. Spill flows are conveyed via a pipe bridge to be discharged to the River Frome via the river bank to the west.

The current consent for the CSO (no. 103072, see Table 1) states a maximum Dry Weather Flow (DWF) of 709m³/d and a minimum Flow to Full Treatment (FFT) of 26l/s. The consent also specifies 6mm screening is required. Modelling indicates that the FFT consent value is being achieved, while modelled Dry Weather Flow is 366m³/d, so DWF is not breached. The Copa Cyclone screens have 6mm openings, therefore the screening requirement is also achieved.

The catchment local to Watleys End CSO, and the trunk sewer downstream, was last verified using a flow survey undertaken in 2016 as part of project C9855. A write up of this verification is included in the report saved in DM-#1790359.

The network used for this investigation is '134562-C9918-PR19 16561 Watleys End CSO-Pruned'. Urban Creep with a Design Horizon of 2031 has been applied for all the future scenarios. See section 5 for modelling references.

Discharge No. 1 SEWER STORM OVERFLOW			
Consent No: 103072			
Name	Consent	Unit	Limit
Dry Weather Flow	709	m³/d	Absolute
Flow To Full Treatment	26	l/s	Absolute
Screening Requirement	6	mm	Absolute

Table 1: Consent criteria for 16561 Watleys End CSO

1.3 Predicted Spill Frequency and Volume, and Predicted Flooding

1.3.1 Base and Option Spills (for both options modelled)

	StormPAC (10 yr. Average)	
	Spill Frequency	**Total Volume (m³)**
Base – *No Urban Creep*	68	40,075
Base – *including Urban Creep*	69	41,417

Table 2: Spill summary of of base network (with and without Urban Creep

	StormPAC (10 yr. Average)	
	Spill Frequency	**Total Volume (m³)**
Option 1 – Offline storage upstream of CSO (*preferred*)	13.5	24,517

Table 3: Spill summary of preferred option – Option 1 (includes Urban Creep)

Option 2 – Flow diversion with new CSO (*second option*)	StormPAC (10 yr. Average)	
	Spill Frequency	**Total Volume (m³)**
16561 Watleys End CSO	14	491
New CSO	17	24,410
Total (both CSOs)	*31*	*24,901*
Average Spill Count (both CSOs)	**15**	**N/A**

Table 4: Spill summary of second option – Option 2 (includes Urban Creep)
See Section 5 for references to StormPAC results analysis spreadsheets

1.3.2 Impact on Downstream CSOs (for Option 2 only)

Detailed notes on the impact of option 2 on the downstream CSO's can be found here: C9918-201416055-349. Included in this assessment are spills from Watleys End, and the new proposed CSO that forms part of Option 2.

Note: As Option 2 increases the pass-forward flow rate into the Frome Valley Trunk Sewer, only this option has been assessed for CSO spill changes for downstream CSOs

	StormPAC (10 yr. Average)	
	Spill Frequency	**Total Volume (m³)**
Base – *No Urban Creep*	911	11,923,531
Option – *No Urban Creep*	856	11,925,315
Change absolute	-55	1,784
Change percentage	*-6%*	*0.01%*

Table 5: Spill summary of downstream CSOs for second option – Option 2

1.3.3 Flooding Impact (for Option 2 only)

For storms of 5-year return period, five manholes are predicted to have an increase in flood volume of 10m³ or greater, with a maximum volume increase of 26m³ with option 2 in place compared to the base model. For storms of 30-year return period, fourteen manholes are predicted to have an increase in flood volume of 10m³ or greater, with a maximum volume increase of 81.3m³. These flooding increases are predicted on both the trunk sewer, and branches. Appendix 5 shows locations where 30-year flooding is expected to increase by 10m3 or greater if option 2 is built.
Detailed notes on flooding impact can be found here: C9918-201416055-349
Note: As Option 2 increases pass-forward flow rate into the Frome Valley Trunk Sewer, only this option has been assessed for flooding risk

2 Details of Proposed Schemes

There is one Preferred Option to reduce spills at 16561 Watleys End CSO, and one Second Option:

Option 1 (preferred) – Offline storage tank upstream of CSO, with pumped return

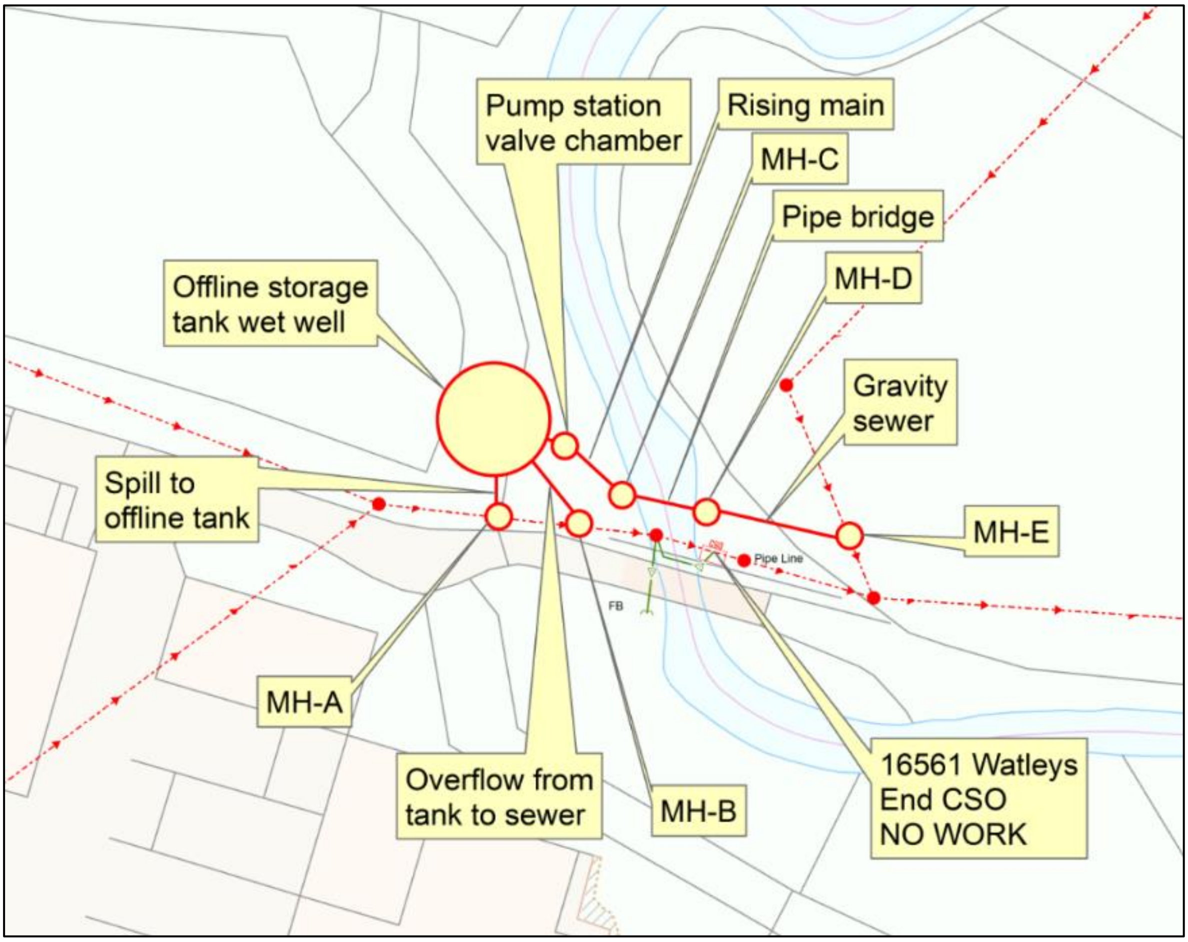
Option 2 (second option) – Flow diversion to new gravity sewer upstream of 16561 Watleys End CSO with new additional CSO

2.1 Preferred Solution: Option 1 (Scenario S3d) – Offline storage tank upstream of CSO, with pumped return

This option involves the construction of a 1,269m³ offline storage tank upstream of the existing 16561 Watleys End CSO. See Figure 3 for a plan of Option 1. This requires a new manhole upstream of 16561 Watleys End CSO with a 26l/s HydroSlide to control pass-forward flows, with spills to the offline tank. The tank will have a pumped return, and a high-level continuation overflow to prevent flooding once the tank is full.

Spill flows to be returned to the network via a duty-standby pumping station, at a rate of 58l/s. The pumped return crosses the River Frome via a pipe bridge and connects to the 825mm Ø trunk sewer via a new manhole. The high-level overflow from the tank flows to the network via a new manhole on the existing system, between the new spill-to-tank manhole, and the existing CSO chamber. The effective storage volume is 1,250m³, which is the volume below the high-level overflow from the tank. Figure 3 shows a plan overview. Tables 6, 7 and 8 show manhole, pump, and sewer schedules.

Figure 3: Arrangement of proposed Option 1



C9918 – CSOs – 16561 – Watleys End in Field off Factory Road CSO PR19

Manhole ID	Diameter (m)	Depth (m)	Ground Type	Work
MH-A	2	2	Grass	New manhole on existing 300mm Ø pipe. Pass-forward flow controlled by 26l/s HydroSlide. 300mm Ø spill pipe to offline storage tank
MH-B	2	2	Grass	New manhole on existing 300mm Ø pipe. Receives 300mm Ø overflow pipe from offline storage, with flap valve
MH-C	2	2	Grass	New manhole to receive flows from 250mm Ø rising main. Forward flows via 300mm Ø gravity sewer pipe bridge over River Frome.
MH-D	2	2	Grass	New manhole to receive flows from 300m Ø pipe bridge. Forward flows via 300mm Ø gravity sewer
MH-E	2	2	Grass	New manhole on 825mm Ø trunk sewer, to receive flows from 300mm Ø gravity sewer. Depth monitor required for real-time control of pump station
Storage Tank	12.5	12.5	Grass	Offline storage tank with 1250m^3 effective storage, and to house 2 pumps (duty-standby) with pump rate of 58l/s
Valve Chamber	2.4	1.5	Grass	Dry well to house pump valves and related apparatus

Table 6: Construction details for new manholes required for Option 1

Number of Pumps	Configuration	Flow Rate (l/s)	Head (m)
x 2	Duty-standby	58	13

Table 7: Details of required pumps for Option 1

Pipe Description	Manhole ID		Width (ID) (mm)	Depth (m)	Length (m)	Ground Type	Work
	Up stream	Down stream					
Spill pipe	MH-A	Storage Tank	300	2	10	Grass	Gravity sewer to convey spilled flows from existing 300mm Ø sewer to storage tank
Tank overflow pipe	Storage Tank	MH-B	300	2	10	Grass	Overflow pipe to convey flows from the storage tank to 300mm Ø sewer, with flap valve on downstream end (entry to MH-B)
Rising main	Valve Chamber	MH-C	250	2	10	Grass	Rising main to convey flows out of the storage tank
Gravity sewer pipe bridge	MH-C	MH-D	300	2	10	Grass	Gravity sewer downstream of rising main. Pipe bridge of River Frome
Gravity sewer	MH-D	MH-E	300	2	15	Grass	Gravity sewer to convey flows into the 825mm Ø trunk sewer

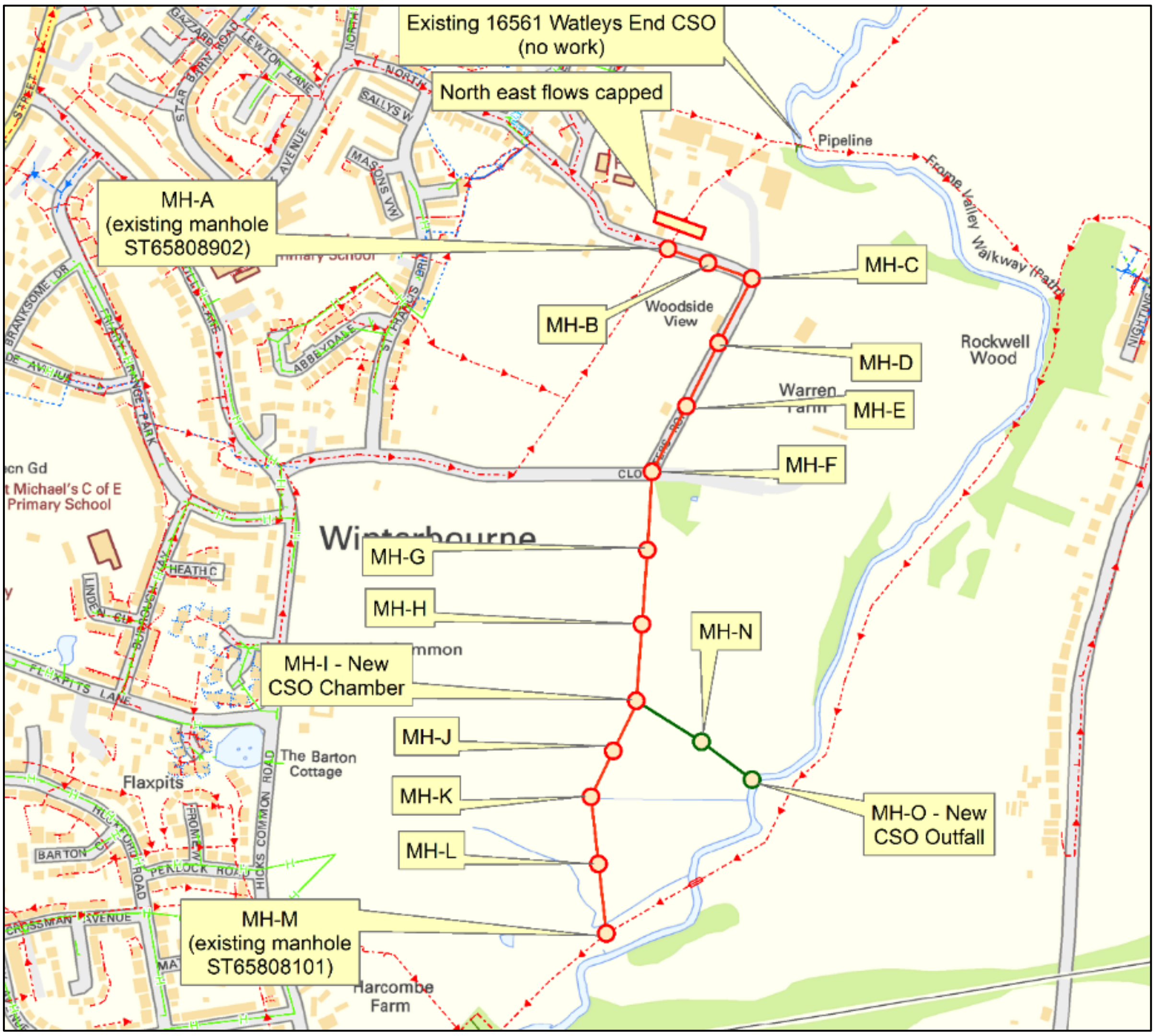
Table 8: Construction details for new conduits for Option 1

2.2 Second Solution: Option 2 (Scenario S9C) – Flow diversion to new gravity sewer upstream of 16561 Watleys End CSO with new additional CSO

This option involves capping flows from existing manhole ST65808902 and diverting flows into a new 300mm/900mm/225mm Ø gravity sewer, with a new connection point on the Frome Valley trunk sewer at existing manhole ST65808101, of length 924m. New CSO to be constructed on the new gravity sewer with fixed screen and wash-down system and 225mm Ø gravity spill pipe to the River Frome, of length 157m. The incoming sewer to the CSO chamber is 900mm Ø, with pass-forward flow controlled by a HydroSlide, limited to 26l/s. The continuation gravity sewer is 225mm Ø. Figure 4 shows a plan overview. Tables 9 and 10 show manhole and sewer schedules.

Note: during dry weather flow, maximum velocities in the proposed 900mm Ø gravity sewer are predicted to be 0.6m/s, which is lower than the advised self-cleansing velocity of 0.75m/s (see Wessex Water's Design Standard DS500). If this option is progressed, consideration must be made regarding this, such as a dry weather flow channel in the 900mm Ø pipe, by utilising steeper gradients, or by regular inspection and jetting. Consideration for velocities will also be required on the existing 300mm Ø downstream from where it is capped, as velocities here are likely to be very low, depending on number of connections.

Figure 4: Arrangement of Option 2 (second option)



C9918 – CSOs – 16561 – Watleys End in Field off Factory Road CSO PR19

Manhole ID	Diameter (m)	Depth (m)	Ground Type	Work
MH-A	2	2.5	Surfaced road	Rebuild existing manhole ST65808902 and divert all flows into new 300mm Ø gravity sewer. Existing outgoing 300mm Ø pipe capped
MH-B	2	2.5	Surfaced road	New manhole on new gravity sewer. 300mm Ø incoming sewer, and 900mm Ø outgoing gravity sewer
MH-C	2	7.5	Surfaced road	New manhole with incoming and outgoing 900mm Ø gravity sewers
MH-D	2	8	Surfaced road	New manhole with incoming and outgoing 900mm Ø gravity sewers
MH-E	2	8.5	Surfaced road	New manhole with incoming and outgoing 900mm Ø gravity sewers
MH-F	2	8.5	Surfaced road	New manhole with incoming and outgoing 900mm Ø gravity sewers
MH-G	3	8.5	Grass	New manhole with incoming and outgoing 900mm Ø gravity sewers
MH-H	2	7.5	Grass	New manhole with incoming and outgoing 900mm Ø gravity sewers
MH-I – new CSO chamber	4	6.5	Hedgerow & grass	CSO chamber: • 2m weir with Hydrok Peak Screen, 2m x 1m (i.e. 2m^2 area) horizontal screen. Screen washing system • Pass-forward flow controlled with Hydrok HydroSlide with maximum flow rate of 26l/s. • Incoming 900mm Ø gravity sewer • Outgoing 225mm Ø gravity sewer Spills via 225mm Ø gravity sewer
MH-J	2	4.5	Grass	New manhole with incoming and outgoing 225mm Ø gravity sewers
MH-K	2	2	Hedgerow	New manhole with incoming and outgoing 225mm Ø gravity sewers
MH-L	2	2.5	Grass	New manhole with incoming and outgoing 225mm Ø gravity sewers
MH-M	2	3	Grass	Rebuild existing manhole ST65808101 on 825mm Ø trunk sewer, to receive new 225mm Ø gravity sewer
MH-N	2	2.5	Grass	New manhole with incoming and outgoing 225mm Ø gravity spill pipes
MH-O – outfall	N/A	N/A	Riverbank	Outfall for new CSO, into the River Frome, with 225mm Ø flap valve. Incoming 225mm Ø gravity sewer

Table 9: Construction details for new manholes required for Option 2

Pipe Description	Manhole ID		Width (ID) (mm)	Depth (m)	Length (m)	Ground Type	Work
	Upstream	Downstream					
Gravity foul sewer pipe	MH-A	MH-B	300	2.5	51	Surfaced road	New foul gravity sewer
Gravity foul sewer pipe	MH-B	MH-C	900	7.5	55	Surfaced road	New foul gravity sewer
Gravity foul sewer pipe	MH-C	MH-D	900	8	86	Surfaced road	New foul gravity sewer
Gravity foul sewer pipe	MH-D	MH-E	900	8.5	85	Surfaced road	New foul gravity sewer
Gravity foul sewer pipe	MH-E	MH-F	900	8.5	88	Surfaced road	New foul gravity sewer
Gravity foul sewer pipe	MH-F	MH-G	900	8.5	94	Grass	New foul gravity sewer
Gravity foul sewer pipe	MH-G	MH-H	900	8.5	89	Grass	New foul gravity sewer
Gravity foul sewer pipe	MH-H	MH-I	900	7.5	92	Grass	New foul gravity sewer
Gravity foul sewer pipe	MH-I	MH-J	225	6.5	59	Grass	New foul gravity sewer
Gravity foul sewer pipe	MH-J	MH-K	225	4.5	61	Grass	New foul gravity sewer
Gravity foul sewer pipe	MH-K	MH-L	225	2.5	81	Grass	New foul gravity sewer
Gravity foul sewer pipe	MH-L	MH-M	225	3	83	Grass & hedgerow	New foul gravity sewer to convey flows into 825mm Ø trunk sewer
Gravity storm overflow sewer pipe	MH-I	MH-N	225	2.5	81	Grass	Overflow pipe to convey flows from new CSO chamber to the River Frome
Gravity storm overflow sewer pipe	MH-N	MH-O	225	2.5	76	Grass	Overflow pipe to convey flows from new CSO chamber to the River Frome

Table 10: Construction details for new conduits for Option 2

3 Site/Option Constraints

3.1 Option 1 – Preferred Option

16561 Watleys End CSO is located on the field edge of pasture/grazing farmland, with dense scrub and trees in its immediate surroundings. The CSO chamber is on the east bank of the River Frome, while the outfall is located on the west bank, with spill flow conveyed via a pipe bridge.

The Environmental Constraints Map as shown in Appendix 3 indicates that the River Frome is associated with Flood Zones 2 and 3, so work for this option will need to consider potential river working associated with the pipe bridge. In addition, the Frome Valley River Path footpath follows the eastern bank, so a path closure/diversion would likely be required. The River Frome is also designated a County Wildlife Site in this area. The surrounding trees and scrub would also need to be considered.

The Contaminated Land map in Appendix 4 shows there are no known contaminated land areas within the 50m buffer of this option.

The High-Level E3MP also highlights that brown trout and hedgehog have been recorded in the vicinity, and are protected species. Himalayan balsam and Canadian waterweed are invasive species which have been recorded in the vicinity. The pipe bridge will require planning permission. The CSO is located within the Bath & Bristol Greenbelt.

The High-Level E3MP can be found here: C9918-20146055-275. Note that a full E3MP will be required if this scheme is progressed.

3.2 Option 2 – Second Option

Manhole ST65808902 (head of the new gravity sewer) is located on a narrow rural/peri-urban lane, with the proposed gravity sewer following Cloister Road for 365m. The proposed sewer continues for 275m through grazing pasture to the proposed CSO chamber. The CSO spill pipe runs for 157m through grazing pasture to the bank on the west of the River Frome. The continuation pipe from the CSO runs for 284m through grazing pasture to connect into the Frome Valley Trunk Sewer at manhole ST65808101. Sewer depths vary between 2.5m and 8.5m. The proposed CSO chamber is located in grazing pasture.

The Environmental Constraints Map as shown in Appendix 6 indicates that the River Frome is associated with Flood Zones 2 and 3, so work for this option will need to consider potential river working associated with the outfall of the proposed CSO, and the connection point of the proposed gravity sewer into the Frome Valley Trunk Sewer. The River Frome is designated a County Wildlife Site, and a SSSI is located approximately 450m south of the proposed works. Trees and scrub may need to be considered. Several Grade II listed buildings have been noted approximately 350m west of the proposed works.

The Contaminated Land map in Appendix 7 shows there are no known contaminated land areas within the 50m buffer of this option.

The High-Level E3MP also highlights that multiple protected species have been recorded in the area, including hedgehog, ghost moth, and bluebell, and several different bird species. Himalayan balsam, Japanese knotweed, and Canadian waterweed are invasive and non-native species which have been recorded in the vicinity.

The High-Level E3MP can be found here: C9918-201416055-461. Note that a full E3MP will be required if this scheme is progressed.

4 Discounted Options

- Option 3 – Removal of surface water runoff from the foul/combined system
  The total impermeable area (roofs and roads) in the upstream catchment of 16561 Watleys End CSO is 21 hectares. Of this, the model indicates that 4.71ha is connected to the foul/combined system. Simulations have been undertaken to quantify how much connected area would need to be disconnected to reduce predicted spills to approximately 26/year. This has been found to be 4.66ha, or 99% of the currently connected area. *Note: a reduction in spill counts to fewer than 15/year is not achievable by removal of impermeable area alone.*
  This level of reduction would require the laying of at least 2km of new public surface water sewer, with 280 new lateral SW connections onto private property to accept runoff from roofs. The use of rainwater gardens has been considered, but is not feasible due to the shortage of space.
  Calculations for surface reduction to achieve 26spills/year, and spill summary, can be found here: C9918-201416055-457. Calculations and key assumptions made for estimating the length of new sewer required, and number of laterals, can be found here: C9918-201416055-463

- Option 4 – System Reinforcement
  The downstream system currently has insufficient capacity to accept the required increase in pass-forward flows. To accommodate the required increase, would require a minimum of 1.2 km of downstream reinforcement. Construction of this would be extremely disruptive because the existing Frome Valley Trunk Sewer would need to be upsized – this sewer is close to the banks of the River Frome, so construction would be difficult. The average gradient for this sewer is very shallow at 1:1192. Furthermore, this in turn would cause unacceptable increases in spill flows at downstream CSOs

- Option 5 – Online storage upstream of CSO
  Prohibitively large tank sewers would be required; also issues with minimum velocities; difficulty with construction

- Option 6 – Offline storage at CSO downstream of CSO screen
  Insufficient space due to proximity of river; difficulty with low ground levels as CSO chamber is above ground

- Option 7 – Construct a new sewage treatment works
  Prohibitively expensive

- Option 8 – Gravity or pumped sewer to different sewage treatment works catchment
  Nearest catchment is 4.5km away; potential capacity issues at receiving sewage treatment works; prohibitively expensive.

5 Network Modelling Files

File	Details
InfoWorks Database Location	On ICM Server
Database	074_1 Bristol (v65)
Catchment Group	C9918-PR19 16561 Watleys End CSO optioneering **[ID 134561]**
Base Model	134562-C9918-PR19 16561 Watleys End CSO-Pruned **[ID134562 V85 S0]**
Base Scenario with Urban Creep	S0b-Base+Urban Creep DH2031 **[ID134562 V85 S0b]**
Option 1 – Preferred Option Scenario	S3d-sealed tank **[ID134562 V85 S3d]**
Option 2 – Second Option Scenario	s9C-Diversion&new CSO+flow control **[ID134562 V108 S9C]**
Option 3 – Disregarded Option Scenario	S7-reduced impermeable **[ID134562 V102 S7]**
The following network and scenario were used to assess the impact of Option 2 on downstream CSOs, using the full Bristol model. Note: no Urban Creep for either Base or Option	
Base Model (no Urban Creep)	70722-Avonmouth STW-VM-DH2016-(Bristol Strategy Base) **[ID70722 V315 S0]**
Option 2 Scenario (no Urban Creep)	S20-C9918-16561 Watleys-OptFlowDiv+newCSO **[ID70722 V315 S20]**

File	Location
Base StormPAC Results	C9918-201416055-93
Base **with Urban Creep** StormPAC Results	C9918-201416055-393
Option 1 **with Urban Creep** StormPAC Results	C9918-201416055-349
Option 2 **with Urban Creep** StormPAC Results	C9918-201416055-460
North Bristol Flow Survey 2016 – Report	DM-#1790359
Option 2 flooding and downstream CSO impact summary	C9918-201416055-349
Option 3 (surface removal – disregarded) – surface calculations & spill summary	C9918-201416055-457

6 Estimated Costs

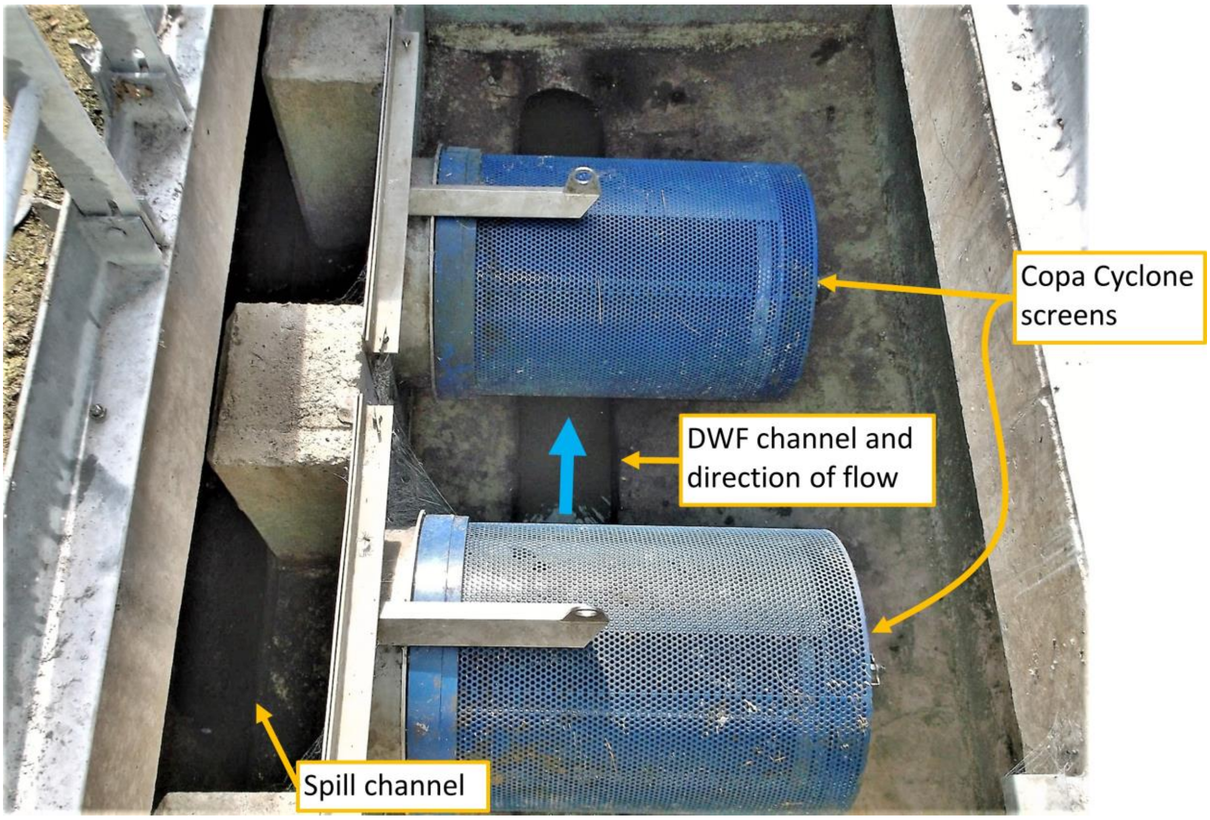
Option All in £'000s	**Proposed Project Cost**	**Change in Opex**
Option 1 – Preferred Option:	1,612	2
Option 2 – Second Option:	4,121	3

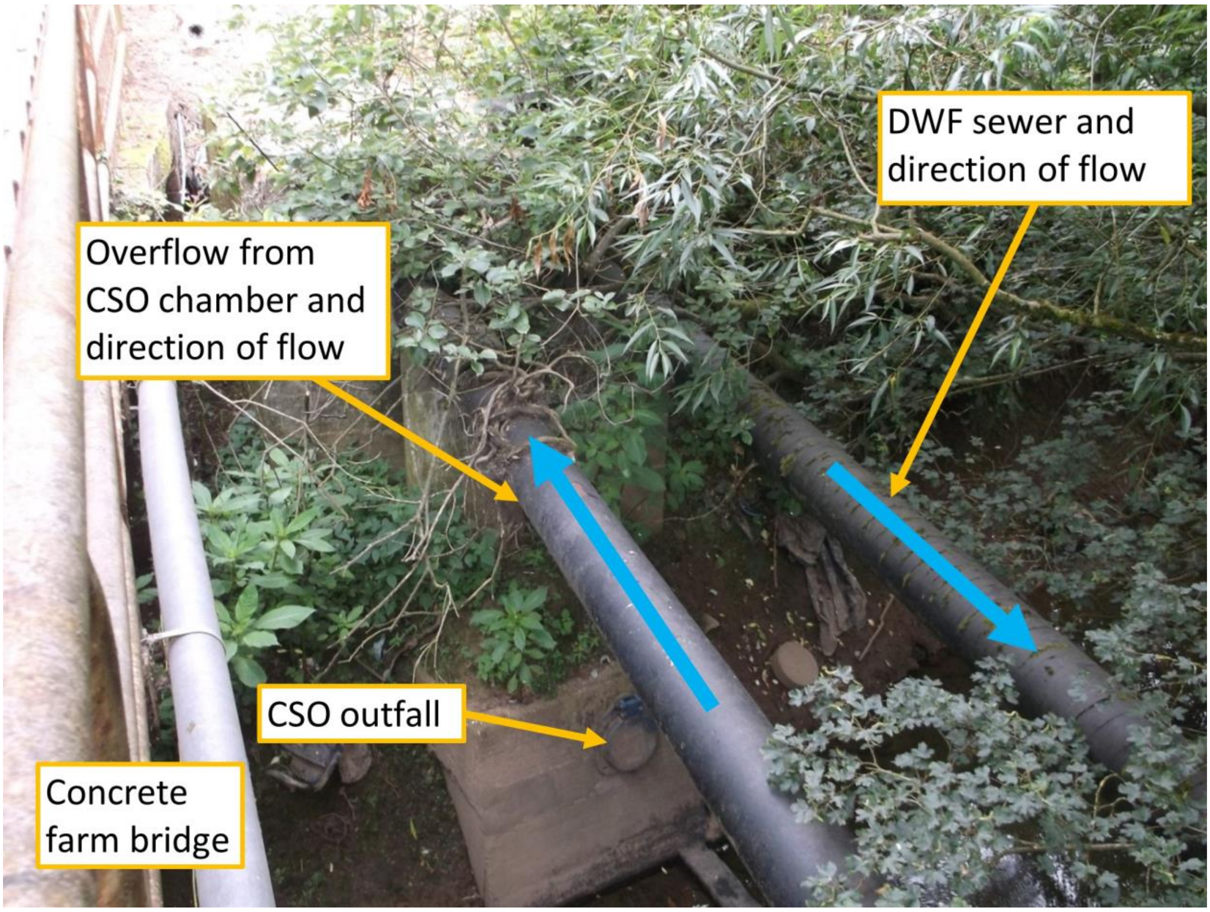
The High-Level Cost Estimates can be found here:

Option 1: C9918-201416055-364

Option 2: C9918-201416055-469

Appendix 1 – Photos of 16561 Watleys End CSO





Appendix 2- Screen grab from calculation spreadsheet for Option 1 – preferred option

Created by: JK

Calculation of storage in circular storage with conical base

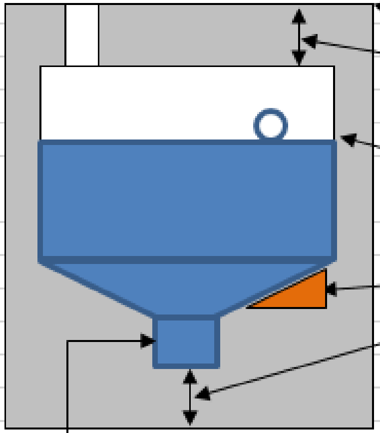
Fill in highlighted yellow fields only

Total volume required	m3	1,250
Pumped return?		yes
Tank dia equal to tank height or excavation height?		tank
Ground level	mAOD	41.750
Cover slab thickness	m	0.30
Cover opening area	m2	1.00
Effective top of storage level (generally overflow level)	mAOD	41.300
Benching slope (1 in)	(normally 1:3)	3
Overdig	m	1.00
Chamber floor level (if known)	mAOD	

Enter "excavation" for a tank with diameter as close as possible to excavation depth (from ground level to bottom of overdig, or "tank" for a tank with diameter as close as possible to the tank internal height (from"bottom of benching" to "effecitve top storage level")

If tank is open to the air with no cover slab, delete these two values.

Leave cell blank to auto-calculate depth. If a level is entered, the spreadsheet will give the smallest ring size that can give the required volume. If the combination of tank depth, required volume and benching means that the benched section extends above the top water level, the cells below will show an error message.



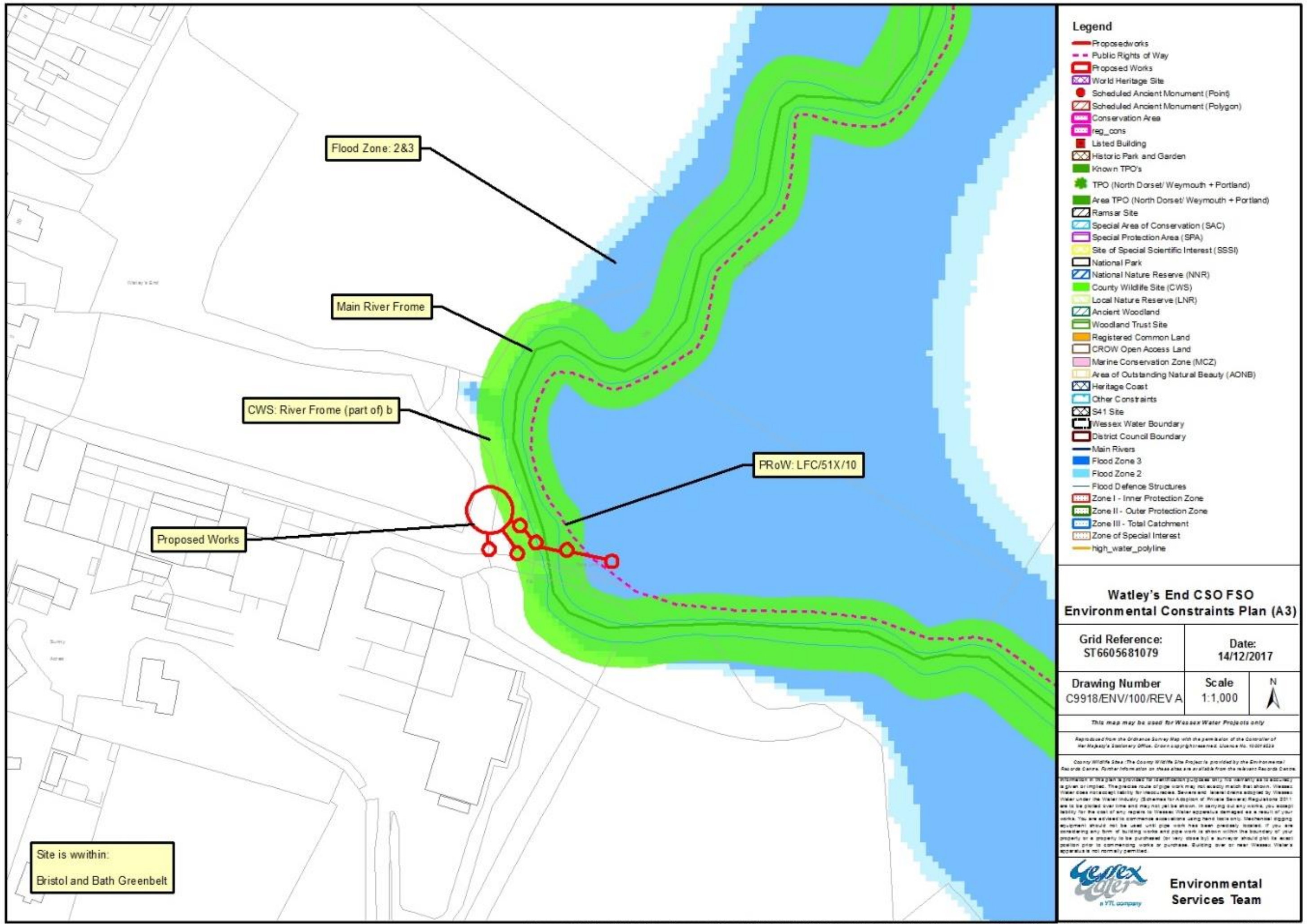
Pump sump (only present if pumped return selected)

Final calculated values

Final tank volume (-sump)	m3	1250.00	
Final shaft diameter	m	12.50	Note: This output is always a standard ring diameter
Top of benching	mAOD	31.81	
Bottom of benching	mAOD	29.91	
Bottom of tank	mAOD	29.51	
Nominal bottom of excavation	mAOD	28.51	
Depth of excavation	m	13.24	
Pump switch on level	mAOD	29.913	based on switch on level being bottom of tank + 400mm
Pump switch off level	mAOD	29.613	based on switch on level being bottom of tank + 100mm
Return pump rate (6hr)	l/s	58	pump rate required to empty tank in 6 hours
Tank roof level	mAOD	41.450	
Total constructed volume	m3	1,269	volume up to spill level + volume up to cover slab

C9918 – CSOs – 16561 – Watleys End in Field off Factory Road CSO PR19

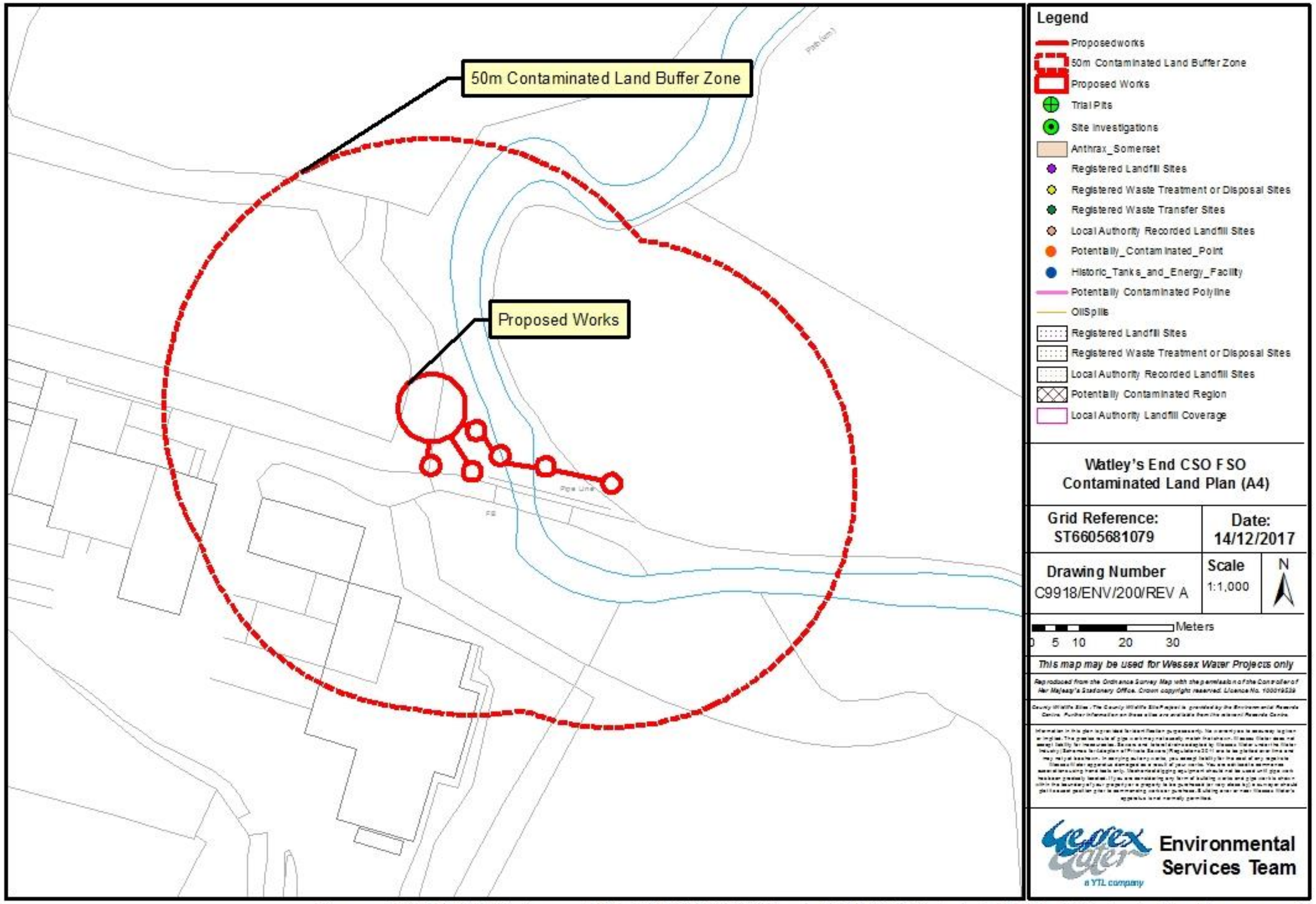
Appendix 3 – Environmental Constraints Plan for Option 1 – preferred option



Document Path: K:\E&Q\Environment Waste\PR19\C9918\Watleys's End CSO\1_EnvironmentalConstriants_01 Environmental Constraints_new[A3]_v2.mxd

C9918 – CSOs – 16561 – Watleys End in Field off Factory Road CSO PR19

Appendix 4 – Contaminated Land Buffer for Option 1 – preferred option



Document Path: K:\E&Q\Environment Waste\PR19\C9918\Watleys's End CSO\2_ContminatedLand_02 Contamination_Plan_new.mxd

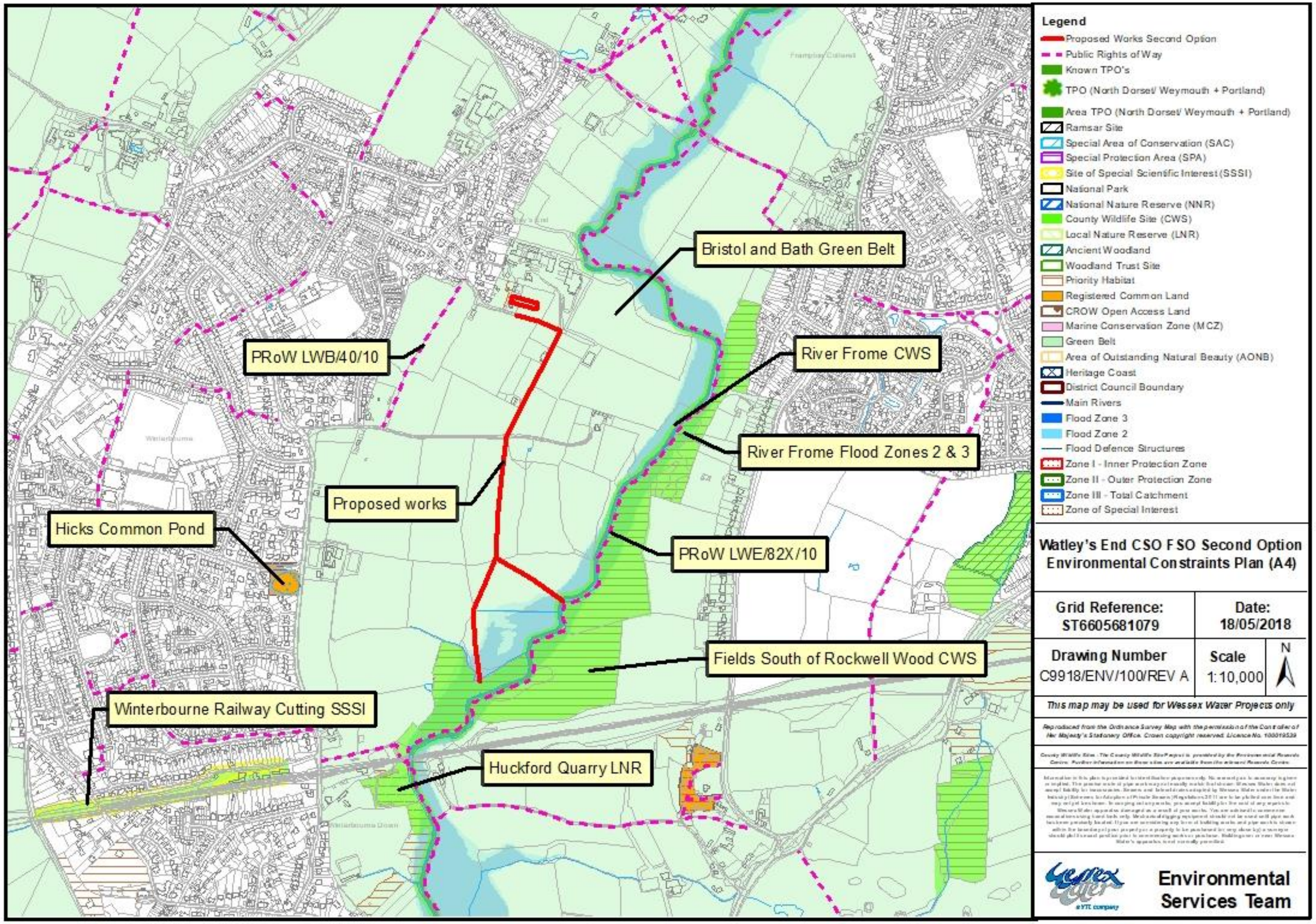
Appendix 5 – Option 2 – increased flood volume locations

Option 2 – manholes where flooding is predicted to increase >10m³ for 30-year return period

Detailed notes on flooding impact can be found here: C9918-201416055-349

C9918 – CSOs – 16561 – Watleys End in Field off Factory Road CSO PR19

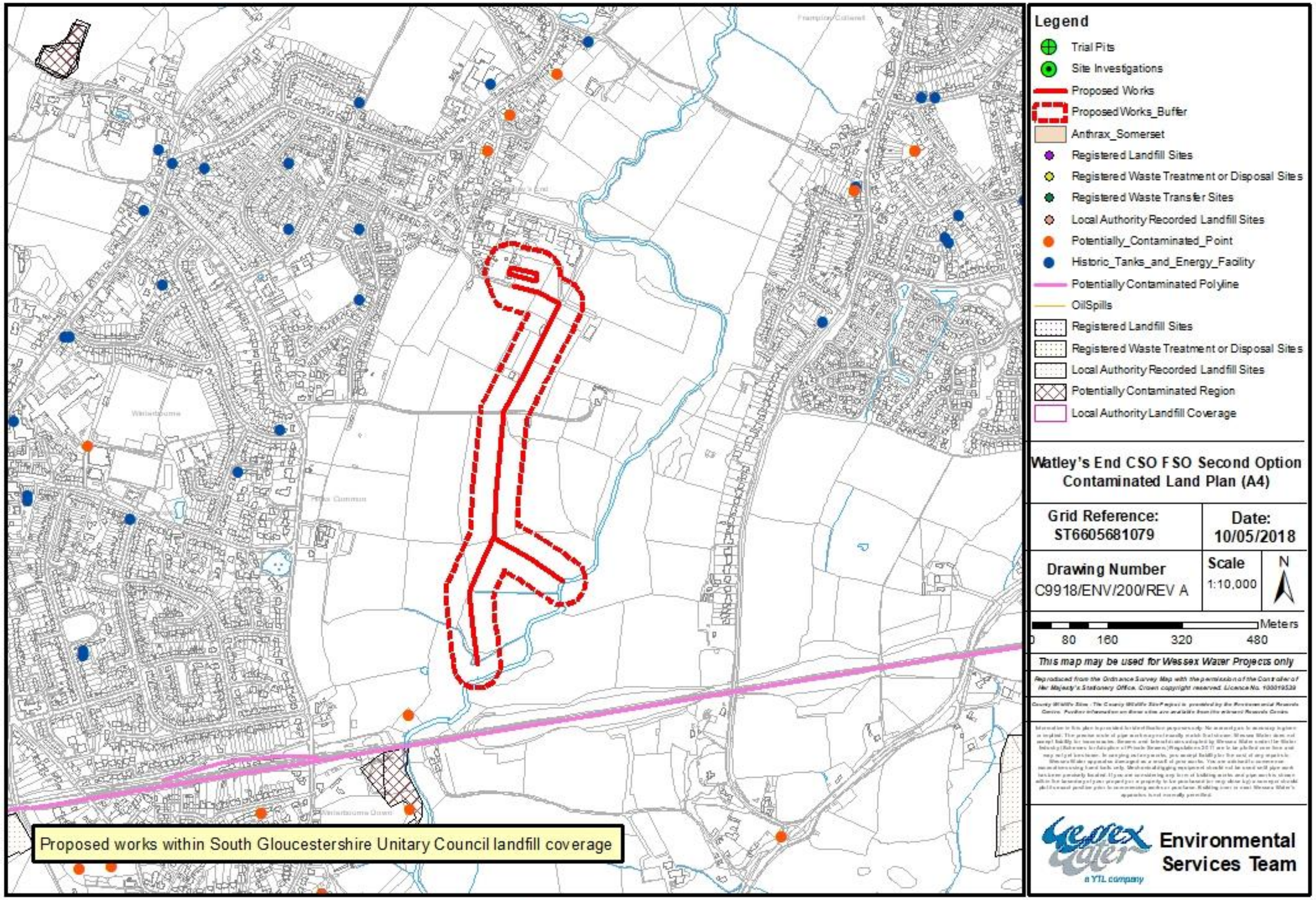
Appendix 6 – Environmental Constraints Plan for Option 2 – second option



Document Path: K:\E&Q\Environment Waste\Networks\C9918 - Watley's End\1_EnvironmentalConstraints\C9918-ENV-100-REVA.mxd

C9918 – CSOs – 16561 – Watleys End in Field off Factory Road CSO PR19

Appendix 7 – Contaminated Land Buffer for Option 2 – second option



Document Path: K:\E&Q\Environment Waste\Networks\C9918 - Watley's End\2_ContaminatedLand\C9918-ENV-200-REVA.mxd

Annex J. Integrated urban drainage – further evidence

This is further evidence detailing our WINEP IUDM programme.
Also see Section 3.3 above.

This Annex provides further evidence to our WINEP Integrated Urban Drainage (IUDM) schemes.

AMP6 National Environmental Programme

Burnham Jetty
Bridgwater Integrated Urban Drainage (IUDM)

Appendix 1 Scope

Wessex Water

September 2015

a YTL company

Appendix 1: NEP measure specification form

Water company / Environment Agency measure specification form	
EA areas(s)	SW
WaSC:	Wessex Water
Measure type:	Investigation
Measure name:	**Bridgwater IUDM**
Measure ID:	
Permit ref:	
Outfall NGR:	
Scheme objectives / permit standards	
Regulatory Date:	31 March 2020
NEP Reference	6Wx000071
NEP Driver Code	rB1
Other:	

Details of work to be carried out
a) Details of short-term actions: Integrated Urban Drainage Management (IUDM) is aimed at sustainably controlling water. In this scope it refers to removal of surface water or infiltration from the combined sewerage system to improve the performance of the CSOs or reduce flood risk. The short term actions are to identify opportunities for IUDM and evaluate the benefits and costs. Partnership working would provide extra benefits and working with other flood risk management authorities should be promoted. The extent of this IUDM review is Bridgwater, Burnham, Highbridge and Sloway Lane catchments. The proposals and prioritisation of IUDM scheme will be prepared by November 2017.
b) Details of mid to long-term actions: The mid-term action is to implement the most cost beneficial scheme(s) by 2020, capped at a budget of £2m included in the PR14 business plan.
c) Options the company has considered: Separation of surface water runoff and/or infiltration from the combined sewerage system.
d) Benefits of option: Improved CSO performance, reduced flood risk, potential energy savings.
e) Reasons for choosing the preferred option: N/A.
f) Specific supporting evidence that option will address the environmental need:

N/A.
g) Timescales for delivery, including key milestones: March 2017 – Options report March 2020- Implementation of a scheme.
h) Details of how the company intends to measure the benefits and outcomes: The AMP5 WsM IUDM scheme will be evaluated alongside the CIRIA project looking at the benefits of SUDs.
i) For investigations identify the proposed solution: Ongoing.
j) Other details:

Catchment measure water quality objectives:			
The scheme is linked to the Burnham Jetty improvements to improve the bathing water quality.			
Permit change			
Agency initiated variation		Application for variation.	

Signatures		
Natural England (for Nature Conservation measures only)	N/A	
Environment Agency NRBMS Account manager	Signed: **Sharon May**	Date: 29 September 2015
Environment Agency Area IEP representative	Signed: **Emma Townsend**	Date: 9 September 2015
Water Company	Signed: **David Martin**	Date: 1 September 2015
By giving approval the Environment Agency does not accept responsibility for the engineering design or construction of the scheme. The Environment Agency gives approval without prejudice to its statutory powers to take any necessary enforcement action.		

Annex K. Sewerage Investigation Assessments

In AMP6 we have processes to proactively inspect and clean (jet) sewers prone to blocking (e.g. flat sewers or siphons). However, to achieve the improved performances required by the WISER in terms of pollution and flooding, we need a step change.

We have held over the past year as series of workshops to identify best ways of working as well as highlighting the need to do More work (e.g. more jetting). One gap we identified was that repeat incidents, especially pollution incidents were not formally written up with recommendations to reduce the risk of future incident recurring.

We therefore immediately expanded the scope of our High Level Assessment team to examine non-hydraulic issues. Using existing datasets to focus investigations to identify appropriate proactive interventions which have the potential to reduce escape of sewage issues. The team will produce Sewerage Investigation Assessment reports (SIAs), summarising the problem and proposing interventions.

The SIA process (shown on the next page) allows for significant input and liaison with operational staff, to gain knowledge of the problem, establish what interventions have taken place and agree if additional intervention is required. Possible interventions resulting from a SIA:

- Do nothing
- Hydraulic issue identified – carryout HLA
- Non-hydraulic issues identified
    - PR intervention – from letter drops to local social media campaign
    - Local R&M repair
    - Add to routine inspection and cleaning schedule
    - In-sewer monitoring

SIAs will then be reviewed 12-18 months after inventions to establish whether interventions have been successful or need to be modified, obviously reviews will occur sooner if incidents occur in the meantime.

The SIAs provide focus for acquiring knowledge of issues at a particular location and will in future provide good evidence to the EA of how Wessex is managing particular its sewerage assets. Within the company we have existing data sources for examining the sewerage network – proactive rehabilitation CCTV, sewerage risk model, sewerage hotspots, CCTV downstream of CSOs, repeat pollutions, repeat sewerage contacts, EDM and in-sewer monitoring, hydraulic sewer models and telemetry.

The SIA process has already started based on analysis of repeat pollution incidents and serviceability issues identified from recent CCTV surveys undertaken downstream of CSOs; with 13 completed. More details and examples are detailed in *IAP response Appendix 7 – Minimising sewer flooding.*

Going forward the plan is to develop a serviceability sewer risk model to evolve from interventions based on reactive incidents to proactive intervention to reduce the risk of escape of sewage. An objective risk model can be used to highlight areas of greatest risk, giving the business a tool to help prioritise its inspection and investigation work.

As part of the Drainage and Wastewater Management Plans programme a Risk Based Catchment Screening exercise has considered likelihood and consequence factors affecting customer risk on a catchment by catchment basis. This initial scoring, and subsequent work under the BRAVA will result in a list of prioritised catchments for the investigating team to begin working on as part of a rolling programme.

The serviceability sewer risk model will then help the investigating team to focus their catchment investigation on specific high risk lengths in the first instance. Investigations should be flexible in nature and evolve based on evidence on the ground.

The factors that the model may use are shown in the table below:

Consequence Score Factors	Likelihood Score Factors
• Proximity to watercourse / waterbody • Proximity to SSSIs etc. • Proximity to other high consequence polygons – Sewer Risk Model could provide additional consequence factors • Diameter of sewer • Repeat incidents • Proximity to SW sewers	• Location of takeaways/restaurants • Nursing homes, nurseries • Tree density data • Structural Grade • Condition Grade • CCTV results • Incidents • EDM data • Recently moved house • SPS telemetry

The efficacy of the model will be assessed from feedback from both the HLA team and operations, also by keeping track of whether CCTV or site surveys confirm the risk predictions made by the model.