



TMS24 Enhancement case: Sewage Treatment Growth

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1 Summary

Table 1 - Summary table.

Reference	PR24 Wastewater Treatment Growth
Description	<p>This Enhancement Case addresses the cost of providing additional capacity at our sewage treatment works in AMP8, to meet the forecast growth in population across our wastewater supply area.</p> <p>This enhancement investment is vital for us to remain compliant with our treated effluent discharge permits. Continued compliance with our discharge permits in the face of a growing population will ensure that we achieve our 2050 vision and outcome of cleaner rivers.</p> <p>We are submitting this Enhancement Case on the basis that sewage treatment growth is removed from the Botex+ modelling for the wastewater network plus price control, as indicated by Ofwat in the PR24 final methodology and cost assessment consultation.</p> <p>The majority of our sewage treatment works can accommodate growth in AMP8 within their respective existing design headroom and treatment capacities. This Enhancement Case focuses on only those works where enhancement investment is forecast to be needed.</p>
Outputs	<p>In AMP8, we will invest at 15 specific sewage treatment works, providing treatment capacity for known growth up to 2036. This equates to a population equivalent of 96,700 people or 40,292 new homes.</p> <p>To protect customers, we propose to implement a time incentive PCD related to late delivery of PE capacity delivered. Customers are also protected by our common Performance Commitment 'Discharge Permit Compliance', as well as preventing deterioration to storm overflows and pollution performance.</p>
Cost	<p>Totex - £355.15m</p> <p>Capex - £354.82m</p> <p>Opex - £0.33m</p>
Spend apportionment	100% wastewater network +
Delivery year	2025-2030
DPC	Not suitable for DPC. The programme does not pass the scalability assessment as each project within the programme fails to reach the minimum threshold. For more detail, please refer to TMS38 Direct Procurement for Customers.

2 Description of the proposed enhancement

This section presents the narrative for our case. It describes the need for the Enhancement Case, and the mechanisms that impact our service if we cannot invest to address growth at our sewage treatment works.

This Enhancement Case also aims to assist Ofwat in its modelling approach for sewage treatment growth expenditure allowance by explaining how some of the recent wastewater permitting changes by the Environment Agency will impact on our costs.

Our sewage treatment growth Enhancement Case is based upon upgrades to 15 of our STWs, as detailed in Table 2. This Enhancement Case will upgrade less than 5% of our 354 STWs.

Table 2 - Enhancement Case investment plan.

Sewage Treatment Works	2023 PE	% Growth in AMP8	Totex (£m) (22/23)
Culham	3,987	46%	4.37
Chalgrove	3,248	74%	4.27
Chipping Norton	9,363	23%	9.56
Andoversford	732	21%	6.27
Arborfield	20,208	33%	48.39
Didcot	45,269	36%	99.36
Cassington	19,091	24%	5.22
Wheatley	6,065	8%	4.12
Bicester	54,868	28%	50.28
Wantage	30,846	22%	41.13
Highworth	8,688	20%	12.16
Thame	13,284	21%	37.94
Stansted Mountfitchet	12,550	61%	35.27
Moreton in Marsh	5,952	7%	8.20
Blunsdon	2,222	37%	11.78

Note: a timing adjustment of £23.16m has been applied to the enhancement total but has not been applied to the bottom-up Totex in the table above

As the population in our area increases, we need to provide additional treatment capacity to meet population growth where and when it is needed. We must forecast where the increased demand will occur and provide sufficient additional treatment capacity to meet that demand in time. We look at the capacity of our sewage treatment works using four metrics to determine whether an upgrade is required or not:

1. Is there capacity to treat the incoming sewage and meet our existing **effluent quality** permit conditions?

2. Is the predicted additional demand likely to mean the **volume of treated effluent** returned to the environment exceeds our existing DWF (Dry Weather Flow) permit condition?
3. Will the predicted increase in demand mean that our existing **FFT (Flow to Full Treatment)** permit condition is insufficient, leading to an increase in storm overflow discharge events?
4. Do we have sufficient **storm tank capacity** for the predicted increase in population, to prevent premature storm overflow discharges to the environment?

The majority of our sewage treatment works (STWs) will be able to accommodate the growth within their catchments using existing treatment capacity. However, some sites will require an upgrade to meet either the current or new permit conditions (as determined by the Environment Agency), to ensure that our assets do not have a negative impact on the health of our rivers and that we deliver against the following expectations of our customers¹:

- Ensure that the wastewater system continues to be reliable, even when put under pressure by population growth and extreme weather
- Reduce the frequency, severity and duration of pollution incidents
- Improve the quality of rivers and waterways

We have a regulatory obligation under Section 94 of the Water Industry Act to provide, improve and extend our system². We are also required to collect and safely treat wastewater from our customers before returning it to the environment, whilst meeting the conditions set out in the environmental discharge permit for each of our sewage treatment works.

Complying with these permits is a necessary foundation for us to achieve our 2050 goals, specifically:

- Keeping all untreated sewage out of rivers
- Lead the improvement of the environment and clean-up of rivers in our region, to become among the healthiest in the UK

2.1 Our Investment Plan

Our plan is based on expanding the capacity of those sites where we have high confidence that they will be unable to meet their discharge permit requirements (effluent quality, dry weather flow, flow to full treatment, storm storage capacity), when the planned growth occurs. We have only included sites that will be impacted by developments that have either already been granted planning permission and / or are included in adopted Local Plans. The solutions for these sites will deliver capacity up to a 2036 design horizon to ensure the delivery is efficient whilst balancing confidence in growth forecasts after 2036.

Table 3 summarises the expenditure in AMP8, the number of works to be extended and the PE increase that is forecast at these sites.

Table 3 - AMP8 expenditure forecast.

	Price base	2025/26	2026/27	2027/28	2028/29	2029/30	Total

¹ *What Customers, Communities and Stakeholders Want*

² *Section 94 Water Industry Act 1991 ([Water Industry Act 1991 \(legislation.gov.uk\)](https://www.legislation.gov.uk))*

Capex (£m)	22/23	69.41	96.06	57.44	63.66	68.26	354.82
OIS (£m)	22/23	0	0	0	0	0.33	0.33
No. of STWs	15						
Forecast PE increase	70,369 during AMP8 at 15 sites 96,709 up to 2036 design horizon at 15 sites						

Note: The data tables were populated prior to detailed profiling and therefore the profile above does not align.

We are currently forecasting that five of our 15 sewage treatment growth enhancement upgrades will be delivered across AMP8 and AMP9. This is to ensure that our investment programme is linked to projected housing delivery and therefore enhancement investment is spent efficiently.

3 Need for enhancement

This Enhancement Case is presented on the basis that Ofwat will assess sewage treatment growth expenditure separately from base costs and use a standalone econometric model for determining investment requirements, as noted in the PR24 final methodology.

We are proposing enhancement expenditure that will enable us to meet the increased needs of our customers in AMP8. Our population is growing and we must ensure that our sewage treatment facilities continue to operate in compliance with their discharge permits, protecting our customers and the environment, and for us to achieve our Vision 2050 goals – particularly to deliver great service and value for our customers by treating wastewater to the required standard. To achieve this, this Enhancement Case is committed to:

- Keeping all untreated sewage out of our rivers
- Taking the lead in improving our region's environment, helping our rivers become some of the healthiest in the UK

3.1 Drivers for Investment

Increased population will mean that 15 of our current wastewater treatment sites do not have sufficient treatment capacity.

The population in our area is forecast to increase by circa 498,000 (+4%) during AMP8 and circa 2.5 million (+16%) from 2025 to 2050. To meet our 100% sewage treatment works compliance ambition, we need to invest to provide additional treatment capacity to accommodate this growth.

There are several cost drivers outside of management control:

- Population growth due to house building and migration results in higher wastewater flows and an increase in sewage load to be treated. National Government set housing targets, with Local Planning Authorities responsible for plans to deliver it.
- The Environment Agency are applying more stringent permit conditions to maintain/improve the environment. These permit changes, particularly in our effluent quality and FFT limits are a significant cost driver. This is explained in more detail in Section 3.7
- The Environment Agency are formalising and standardising their DWF compliance assessment from 2026. In addition to effluent quality discharge permit compliance, the EA will add DWF compliance as a further metric as part of the Environmental Performance Assessment (EPA). To enable compliance once these changes come into force, revised DWF permit conditions will be required for some STWs and these will need to be agreed with the EA. When a new DWF permit condition is agreed, the other aspects of the permit are also revised e.g. effluent quality and FFT. This is explained in more detail in Section 3.6

In addition to the current cost drivers explained above, we have considered future controls on costs and potential cost savings which could be realised, some potential examples are presented in Table 4 below.

Table 4 - Controls on future costs and potential cost savings.

Possible future cost controls	Future potential cost savings
Step change in water efficiency and per capita consumption	This would reduce the volume of wastewater requiring treatment, delivering an Opex saving. In addition, it would delay the need to revise flow permit conditions at STWs, delivering a Capex saving.
Advanced monitoring and control	The use of advanced monitoring and control, potentially using artificial intelligence could enable a step change in efficiency. A smart sewer network could be used to balance flows, reducing peaks and therefore reducing the requirement for STWs to be sized to cater for large diurnal peaks.
New treatment technology	Advanced treatment technologies have the potential to mean that future STW capacity increases could be achieved by modifications to the assets or their operation rather than expensive capital solutions.

Our strategy is to invest just ahead of growth for larger sites. This is because it takes time to put in place upgrades and extensions for these types of sites. For smaller sites we can be more dynamic and invest 'just in time'. Overall, this is a low / least regrets approach as it avoid excess capacity, while ensuring capacity needs can be met in time. Key solutions to deliver our strategy are typically site extensions or upgrades to support intensive treatment processes.

Investing in growth is part of a hierarchy of measures to ensure sewage works remain compliant. This requires both base and enhancement investment as shown in Figure 1.

We only require additional investment via enhancement funding where our process modelling shows that we have insufficient existing capacity/headroom after asset health and process optimisation considerations i.e. our modelling assume that assets are maintained and performing as per their design.

Figure 1 - Intervention hierarchy for STW compliance.



To comply with Section 94 of the Water Industry Act (WIA) we must forecast where the increased demand will occur and provide sufficient additional treatment capacity to meet that demand before it occurs. We have a regulatory obligation to provide, improve and extend our system³. Section 94 of the WIA states it is the duty of every sewerage undertaker to:

(a) provide, improve and extend such a system of public sewers (whether inside its area or elsewhere) and so to cleanse and maintain those sewers and any lateral drains which belong to or vest in the undertaker as to ensure that that area is and continues to be effectually drained; and

(b) make provision for the emptying of those sewers and such further provision (whether inside its area or elsewhere) as is necessary from time to time for effectually dealing, by means of sewage disposal works or otherwise, with the contents of those sewers.

As discussed in more detail in subsequent sections, our sewage treatment growth Enhancement Case is aligned to a plan-based forecast; a forecast driven by a growth in housing stock and therefore the associated population occupying it. This forecast has been used to develop our preferred plan as it aligns to the framework for the production of Drainage and Wastewater Management Plans⁴, specifically the following:

- 'Planned residential new development' is one of the risk-based catchment screening indicators
- 'Companies should make use of the long-term forecasts developed as part of the water resources management plan (WRMP)'. The WRMP is required to use plan-based growth forecasts

This Enhancement Case is essential to reaching our goals and vision. Whilst other areas of investment within our plan will deliver step changes in improvement, this Enhancement Case ensures that population growth does not undo other improvements, e.g. improved river health delivered as part of the WINEP.

³ Section 94 Water Industry Act 1991 (Water Industry Act 1991 (legislation.gov.uk))

⁴ Water-UK-DWMP-Framework-Report_A-C.pdf

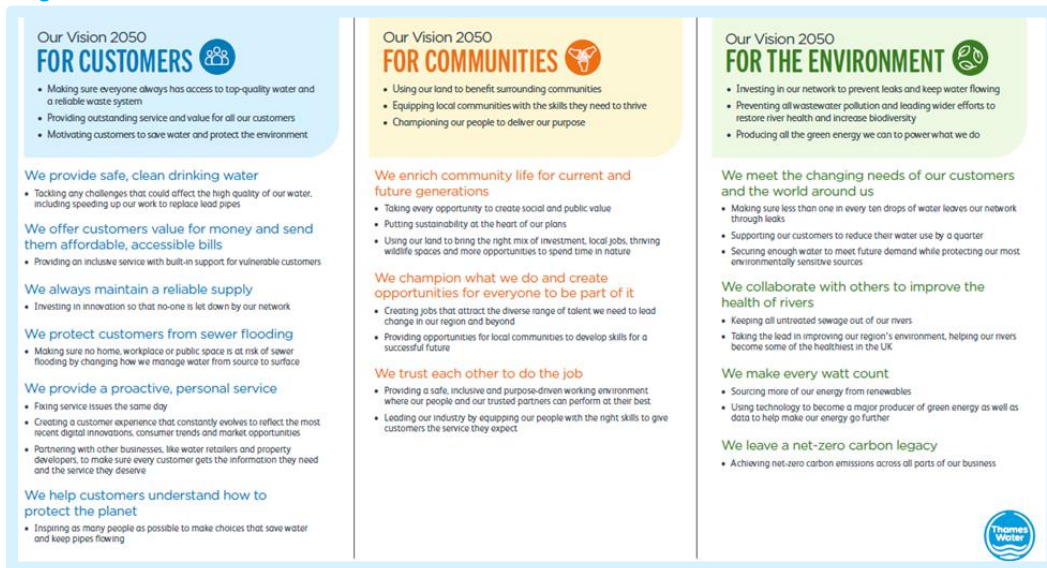
3.2 Alignment with Long Term Delivery Strategy

This sewage treatment growth Enhancement Case is aligned with our long-term delivery strategy. The investment we are seeking in this case will be fully delivered in AMP8, however the benefits will ensure a strong foundation for the future and contribute to our 25-year plan to 2050.

To meet customer expectations, we set our Vision 2050 to help our rivers become some of the healthiest in the UK.

Our Vision 2050 Customer Research⁵ shows that 94% of customers support this goal.

Figure 2 Extract from Vision 2050.



Our Drainage and Wastewater Management Plan (DWMP), together with the subsequent Long Term Delivery Strategy, map out what we need to do over the next five AMPs to maintain compliance with our existing environmental permits, in the face of population growth, to achieve this vision. The population in our area is forecast to increase by 17% from 2025 to 2050. Our AMP8 Enhancement Case is the first phase of this long-term delivery strategy and is set within this context (Table 5).

Investment requirements from 2040 onwards are hard to predict at a granular level. Plan-based growth forecasts are reliant on Local Planning Authority plans, these tend to run for 15 years only. Therefore post 2040, the forecast reverts to the long-term trend (based on ONS data) for the Local Authority. This has the impact of artificially distributing growth evenly across our region and therefore the perceived investment requirement at specific sites is reduced. We aim to work closely with Local Planning Authorities to identify long-term growth locations and will therefore continuously update this forecast as more detail becomes available.

⁵ Insight Sources v16: SP12 Vision 2050 Research, May 2022

Table 5: Summary of AMP8 in the context of a 25-year plan⁶

STW Compliance	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050	Total
Capex (£m)	354.82	716.56	351.23	52.01	76.89	1,551.39
PE increase	498,123	378,912	466,522	517,119	565,667	2,520,414

3.3 Customers and stakeholders consider addressing sewage treatment growth as a priority

A survey carried during the development of our DWMP found ‘planning for the future’ is a key priority for our customers. Survey participants were keen to see Thames Water embrace a long-term focus within their plans to ensure there is a drainage system that works for future generations.



"All day long, future-proofing for me."

Female, Aged 31-45, SEG C1C2



"I've been thinking of population growth and urban creep that goes hand in hand. I lived in London all my life; it went from 6-7 to eight million now. You can imagine how much they've grown in that area alone, never mind Berkshire, where I live, I've moved out here and created that essential population growth. That's probably something they're [Thames Water] already focusing on, so it's like [name removed] said, be one step ahead of the game...."

Male, Aged 31-45, SEG C1C2

We have conducted research into our Enhancement Cases to understand our customer, community and stakeholder views on the need for enhancement and as well as their preference of proposed solutions, where appropriate.

Our engagement approach has combined an ongoing, iterative triangulation of insights over the course of AMP7 as well as targeted research on specific Enhancement Cases for our PR24 plan. A full list of sources used is available in our What Customers, Communities and Stakeholders Want (WCCSW) document⁷, which is our single unifying customer insight framework, underpinned by detailed insight.

Insights: Sewage Treatment Growth	
Support for the need	<ul style="list-style-type: none"> All different customer groups are very concerned about raw sewage entering rivers (storm overflows). They are concerned that this sewage will lower the water quality, which in turn could endanger people, wildlife and the environment (PR24-15) The majority of customers are surprised by the number of sewer spills which occur due to groundwater sewer infiltration and are particularly concerned that contamination to water and surrounding areas will harm the environment and wildlife, as well as lowering the quality of life for customers i.e. causing foul odours in the streets. (PR24-15) Household and non-household customers in particular see this is issue as very important to address, compared with future bill payers. (PR24-15)

⁶ <https://www.thameswater.co.uk/media-library/home/about-us/regulation/drainage-and-wastewater/data-tables.xlsx>

⁷ What Customers, Communities and Stakeholders Want v18. March 2023

	<ul style="list-style-type: none"> • Customers are also concerned that wastewater infrastructure will degrade over time and that external pressures such as climate change and population growth will exacerbate the issue in the future if it goes unaddressed. (PR24-15) • A sizeable proportion of respondents found spills unacceptable in principle (around 1 in 3). This view was slightly stronger in the Thames Valley area compared to London for household respondents, and slightly stronger for household respondents compared to non-households. (SP16) • From PR24 Enhancement Case deep dive research on reducing river spills, customers told us they felt river spills occur too frequently and want faster progress on reducing river spill incidents. However, when customers are educated on the relatively low environmental damage caused by river spills and the occasional necessity of allowing river spills in order to protect homes and property, they become much more accepting of river spills (PR24-6) • From the PR24 Options research, customer informed that while less personally damaging compared with sewage flooding, there is general agreement that Thames Water should be reducing pollution in rivers sooner rather than later. For some, this comes from seeing news stories about sewage being ‘dumped’ in rivers while for others, it is about a wider negative impact on wildlife and the surrounding environment (PR24-12) • Customers and stakeholders have made it clear that they expect ‘Rapid Progress’ on improving our storm overflow performance. • Customers have told us that they want our wastewater systems to be improved to ensure they are resilient today and, in the future, (including future impacts from climate change) and have called for investment in long-term and cost-effective solutions that meet future challenges. (PR24-1) • Keeping rivers clean is our customers’ Public Value top priority; customers expect us to keep rivers clean by preventing unwanted flow from leading to the operation of sewage overflows and sewage spills into rivers; reducing the frequency, severity and duration of pollution incidents as well as improving the quality of rivers and waterways, going above and beyond what we are permitted to spill with our current EA permits. (SP15)
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Across our package of proposed enhancements, customers were generally supportive of the potential enhancements to service in 2025-2030, with greater support given to initiatives impacting core service delivery such as sewage treatment growth and reducing sewer flooding. The combination of media coverage coupled with concerns about lower river water quality leads customers to generally conclude that ‘sewage treatment growth’ should be prioritised for improvement⁸.

- Support for sewage treatment growth enhancement is very strong, with many customers feeling it is part of Thames Water’s core responsibilities.
- Customers believe it is essential for sewage treatment works to be upgraded due to a rising population and climate change.
- Customers feel that the approach of targeting areas most in need is sound.

⁸ PR24-15 PR24 Enhancement Case Deep Dive Research

3.4 Delivering public value

Delivering public value is about maximising the positive impact we have on customers, communities and the environment, as we provide water and wastewater services. It is about us being a force for good in our communities and the environment.

For us, public value is made up of all the things we do to make life better – through our essential services and our wider impact. It’s about finding ways to make the biggest positive difference to customers, colleagues, communities and the environment.

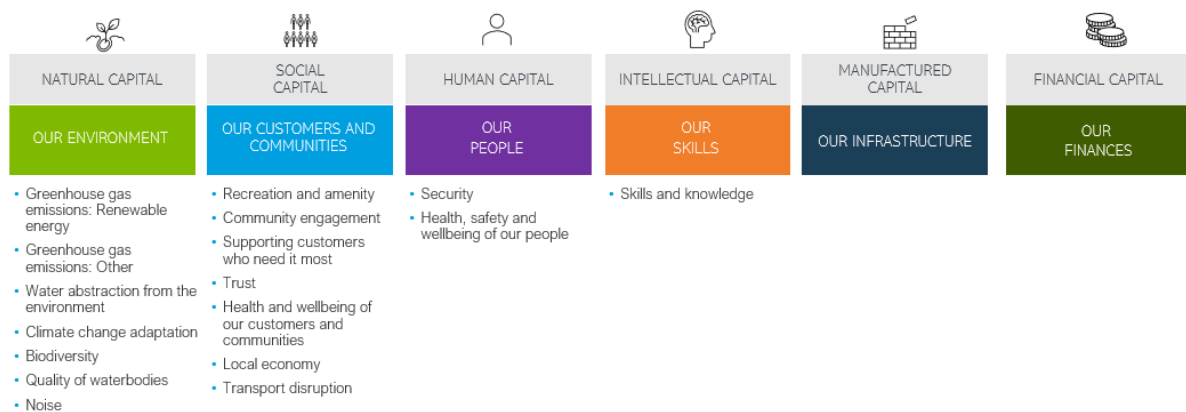
To deliver our purpose, we have committed to incorporating public value within our investment thinking. With this approach we can identify every opportunity to make the biggest positive difference to customers, colleagues, communities and the environment as we deliver our service.

We’re starting to implement a new approach to guide and measure both the public value we create and the delivery of our purpose. The public value framework helps us identify, evaluate and deliver public value which balances cost and value to customers, community and the environment over the long-term.

Our public value framework uses the capitals approach, an international decision-making framework. The capitals are categories of value that can be impacted by our activities.

Our framework uses this approach to understand how our success is directly or indirectly underpinned by natural, social, human and intellectual capital, as well as the traditional consideration of manufactured and financial capital. The capitals, along with Thames Water’s customer-facing language for them and what is considered under each capital is set out in Figure 3.

Figure 3 - The capitals.

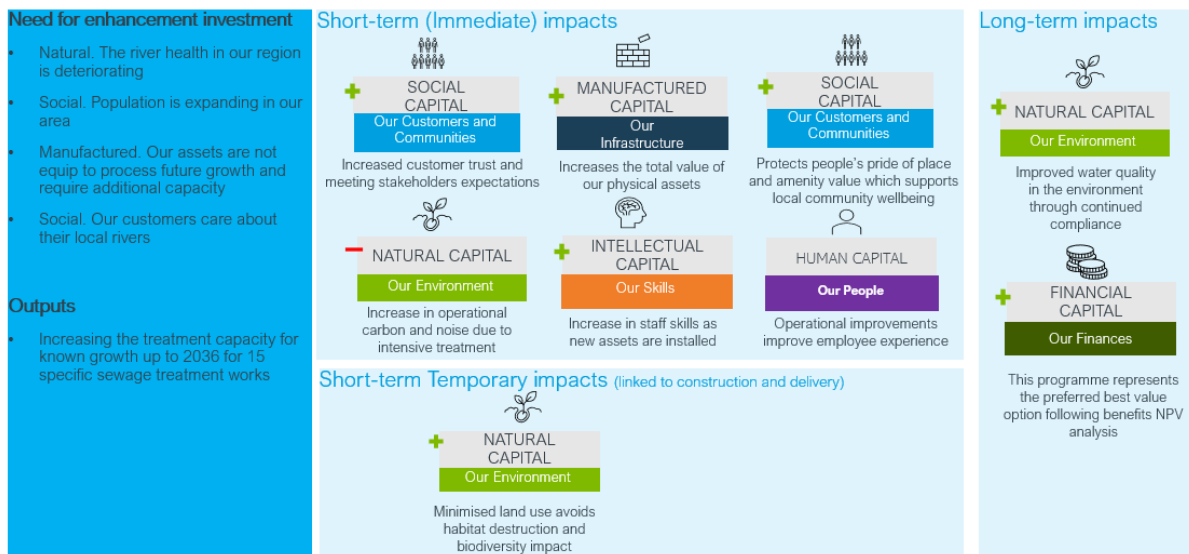


We applied the public value framework to fully understand all benefits and dis-benefits associated with this investment and how these lead to impact on the six capitals. The outputs of our assessment are explained in more detail in Section 4.8.

This investment grows value in social, natural, intellectual and manufactured capital. We discovered a range of short-term temporary, short-term immediate and long-term benefits and dis-benefits. The theory of change infographic in Figure 4 shows how these benefits lead to impact on the six capitals and the public value benefits this investment represents.

Figure 4 - Public Value Infographic.

Sewage Treatment Growth



The public value delivered by this enhancement is summarised below:

- The investment strongly benefits natural capital in one or more measures. Continued compliance with our environmental permits and protection of water quality in the environment is our key driver. The chosen solution seeks to reduce land footprint and remove the need to reduce surrounding habitat to deliver the asset upgrades.
- Nature-based solutions will also benefit biodiversity with the new reed bed creating new wildlife habitat. The new technology increases operational carbon and noise via its daily operation, representing a dis-benefit to natural capital.
- The investment strongly benefits social capital in one or more measures. We have overwhelming customer and stakeholder support to protect our rivers and prevent pollution to watercourses. This investment will generate customer trust and allow us to continue meeting our stakeholder expectations surrounding permit compliance.
- Continuing compliance helps protect the amenity value in our local communities, where people's pride of place can be intrinsically linked to customer health and wellbeing.
- There is a strong benefit to manufactured capital as our asset resilience improves and increases the value of our assets.
- There is a positive benefit to human capital. The upgrades will enable easier operation of the assets to ensure permit compliance which will improve employee experience and reduce stressful experience, positively influencing employee wellbeing.
- There is a positive benefit to intellectual capital. The new treatment technology new to many of these sites. The operating workforce in London will gain training and a new set of skills to operate and maintain the new intensive assets. We expect this to affect employee wellbeing.

3.5 Our proposed enhancement funding does not overlap with base or previously funded projects

The provision of additional capacity to meet predicted population growth is an enhancement activity and therefore all proposed solutions in this case are not included in base. Base expenditure, as defined by Ofwat includes 'routine, year-on-year, expenditure which companies incur in the normal running of their business – to provide a base level of good service to customers and the environment.' Whereas enhancement expenditure is defined as 'generally where there is a permanent increase or step change in the current level of service to a new 'base' level and/or the provision to new customers of the current service.'

In the case of sewage treatment investment there is a clear distinction between our base plan, which includes funding for day-to-day operation and maintenance as well as investment to ensure robust compliance with our existing permits and our sewage treatment growth enhancement spend which will provide a step change in treatment capacity required to serve an increasing population.

Sewage treatment growth expenditure was included within the Botex+ allowance at PR19 with an adjustment depending on whether the company operates in an area with a relatively high or low forecast of population growth, relative to the historical average for the sector. We have used this allowance to deliver upgrades at 12 of our sewage treatment works, these are listed below:

- Beckton
- Mogden
- Crossness
- Burstow
- Chesham
- Bloxham
- Chipping Norton
- Dorchester
- East Shefford
- Fyfield
- Hungerford
- Stanford in the Vale

In addition, we have used growth funding for other drivers e.g. to ensure that WINEP projects are sized appropriately to cater for future growth.

3.6 Any current poor performance is addressed separately in our base plan

Our Enhancement Case will deliver upgrades to 15 of our STWs where future growth, will impact on permit condition compliance and the environment. Table 6 shows the last five years' performance for DWF and effluent quality compliance against permit conditions.

Table 6 - Past five years performance at our enhancement STWs.

STW	DWF Compliance					Effluent Quality Compliance				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Culham	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Chalgrove	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Chipping Norton	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Andoversford	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Arborfield	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Didcot	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Cassington	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Wheatley	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Bicester	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Wantage	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Highworth	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Thame	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Stansted Mountfitchet	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Moreton in Marsh	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Blunsdon	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass

In the five years some of our 15 STWs proposed for inclusion in our Enhancement Case have failed their DWF permit condition due to extreme weather. The majority of these failures occurred in either 2020 or 2021, both of which were either extremely wet or in the case of 2021, suffered from very high groundwater levels. Moreton in Marsh failed in 2019 due to high rainfall during late June and early July, resulting in high flows during the normally lower flow period. Highworth failed in 2019 following the installation of a new batch treatment process (Nereda®), which results in peaks and troughs of flow. The flowmeter has since been repositioned.

Only Chalgrove has failed its effluent quality permit in the last five years. This ammonia failure in 2022 was the result of an unknown substance entering the works.

3.7 Dry Weather Flow permit compliance

Dry Weather Flow (DWF) is the average daily flow treated by a Sewage Treatment Works (STW) during a period without rain⁹. Currently, assessment of compliance with DWF permit conditions at each STW is ad-hoc. The Environment Agency (EA) are formalising and standardising their DWF compliance assessment from 1st January 2026. In addition to effluent quality discharge permit compliance, the EA will add DWF compliance as a further metric as part of the Environmental Performance Assessment (EPA) from 2026 and reported as part of our APR process from 2027.

To enable compliance once these changes come into force, revised DWF permit conditions will be required for some STWs and these will need to be agreed with the EA. When a new DWF

⁹ $DWF = PG + I_{DWF} + E$

where: P = catchment population, G = per capita domestic flow (l/person/day), I_{DWF} = dry weather infiltration (l/d) and E = trade effluent flow (l/d) Source: [Calculating dry weather flow \(DWF\) at waste water treatment works - GOV.UK \(www.gov.uk\)](https://www.gov.uk/guidance/calculating-dry-weather-flow-dwf-at-waste-water-treatment-works)

permit condition is agreed, the following additional changes are made to the other permit conditions at the specific sewage treatment works to ensure no deterioration in the receiving water quality:

- Related changes to flow to full treatment (FFT): FFT conditions determine the flow rate which must be fully treated prior to utilising storm tanks and/or storm overflow discharge permits. FFT conditions are recalculated at the same time as any required changes to DWF since FFT is usually set at roughly three times DWF. However, in recent years the EA have included in this calculation the maximum groundwater infiltration rather than dry day infiltration. Maximum infiltration can be five times higher than dry day infiltration. Depending on the existing ratio between DWF and FFT, this can be a very material driver of cost.
- Related changes to effluent quality limits: these will tighten as the DWF permit increases to ensure that the total pollution load entering the environment does not change.

In previous AMPs we have focussed growth upgrades on biological treatment capacity to maintain compliance with our sanitary permit limits. The implications of the change to the DWF compliance assessment mean that we must be far more rigorous in our assessment of the impact of growth on our existing DWF compliance. It also means that growth upgrades at our STWs must consider revised FFT and DWF as well as sanitary permit limits.

3.8 Forecasting population growth

Local Planning Authorities calculate their housing need and its distribution based upon a statutory planning process. The methodology for defining growth rates through population trends, housing markets and spatial constraints is set out in the National Planning Policy Framework. The outputs from this process are subject to scrutiny by members of the public, stakeholders, and independent planning inspectors.

The ONS population projections e.g. ONS-2018 are a good indication of the population trend at a regional level and are based on natural change (births and deaths) and migration. However, these projections become less useful at geographies smaller than a Local Authority. Planning for growth at our sewage treatment works requires information on the population changes within each sewage works catchment. For example, the South Oxfordshire Local Authority is served by 38 separate sewage treatment works and their catchments. It is not appropriate to plan the future demand for our sewage treatment works based on an assumption that the Local Authority growth projection will be uniform across its area.

We therefore asked Edge Analytics (a specialist demographic data analysis consultancy) to produce two population scenarios to support our planning for AMP8 and beyond.

Figure 5 shows the two population projections for our region, with the eight variants starting from 2050.

Figure 5 - Population scenarios

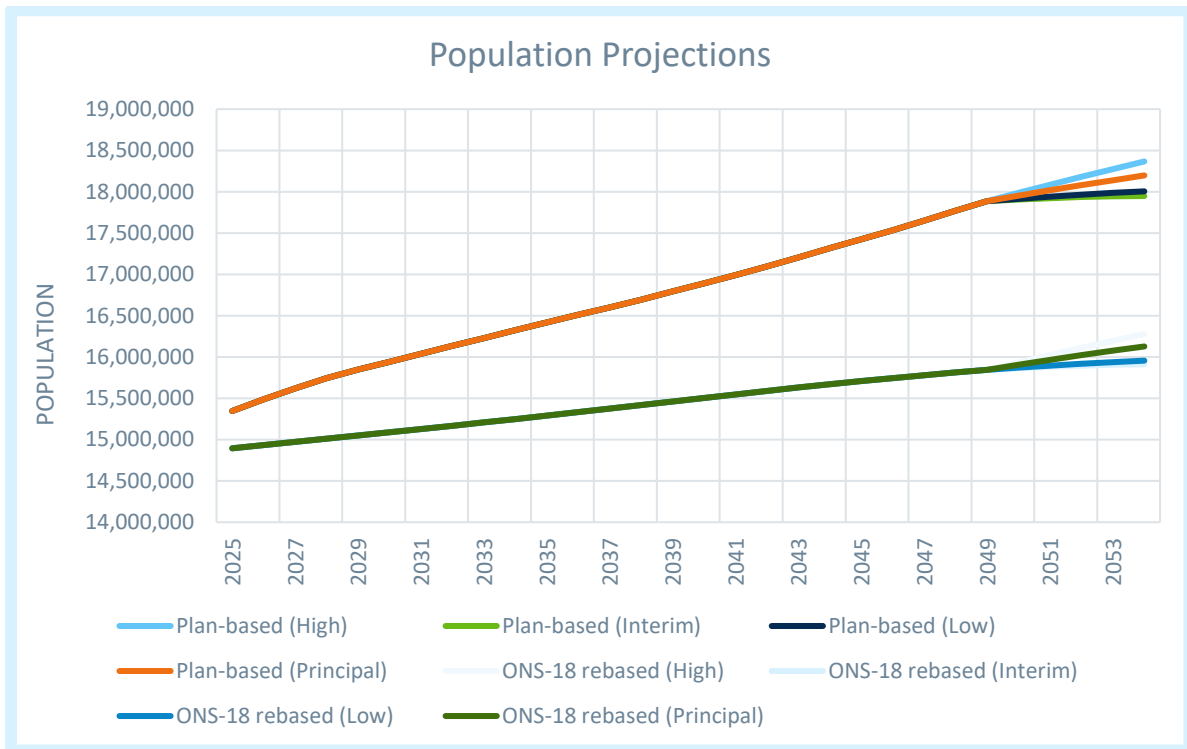


Table 7 summarises the predicted population growth during AMP8, for our two planning scenarios:

Table 7 - Predicted AMP8 population growth

Forecast Scenario	2025-2030 Population change	2025 – 2030 Percentage change
Plan-based	+498,123	3.8%
ONS-18 (rebased to MYE2020)	+196,085	1.3%

Plan-based Forecasts

This is a housing-led scenario, with population growth underpinned by each Local Planning Authority's (LPA) housing growth trajectory. Following the final year of data (usually 15 years from the start of the Local Plan period), projected housing growth in non-London areas returns to the average of ONS-14 and ONS-16 long-term annual growth average by 2050. For London boroughs, housing growth returns to the Greater London Authority (GLA) central scenario long-term annual average by 2050. There are four variants post-2050:

1. **Principal** – Incorporates the mortality and fertility assumptions of the ONS 2018-based National Population Projection (NPP) principal scenario, plus its principal net international migration assumption of +190k p.a. for the UK in total
2. **Low** – Incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus a low net international migration assumption of +90k p.a. for the UK in total

3. **High** – Incorporates the mortality and fertility assumptions of the ONS 2018-based NPP Principal scenario, plus a high net international migration assumption of +290k p.a. for the UK in total
4. **Interim** – Incorporates the mortality and fertility assumptions of the ONS 2020-based interim NPP Principal scenario, plus its Principal net international migration assumption of +205k p.a. for the UK in total

We have carried out an exercise to assess the performance of the 84 significant LPAs in our region in terms of their forecasted housing delivery compared to the actual reported number to the Department of Levelling Up, Housing and Communities. We have used Edge Analytics' Consilium product, which is a Local Plan Housing Database, covering all Local Planning Authorities (LPAs) in England and Wales. It was developed to facilitate the collection, processing, organisation and delivery of Local Plan housing evidence.

The methodology used to assess performance was to compare the LPA completion total forecasted five years prior to the reporting year i.e. actual completions reported in 2021/22 was compared with the LPA forecast for 2021/22 published in 2016. This assessment is designed to show how accurate or not plan-based forecasts are, on average, for five years into the future i.e. a price review, Figure 7 and Figure 8 show LPA performance across the three regions in our supply area. The coloured dots represent each LPA in our region and the red line shows the average in that year.

Figure 6 - East of England – Completions Vs LPA Forecast¹¹

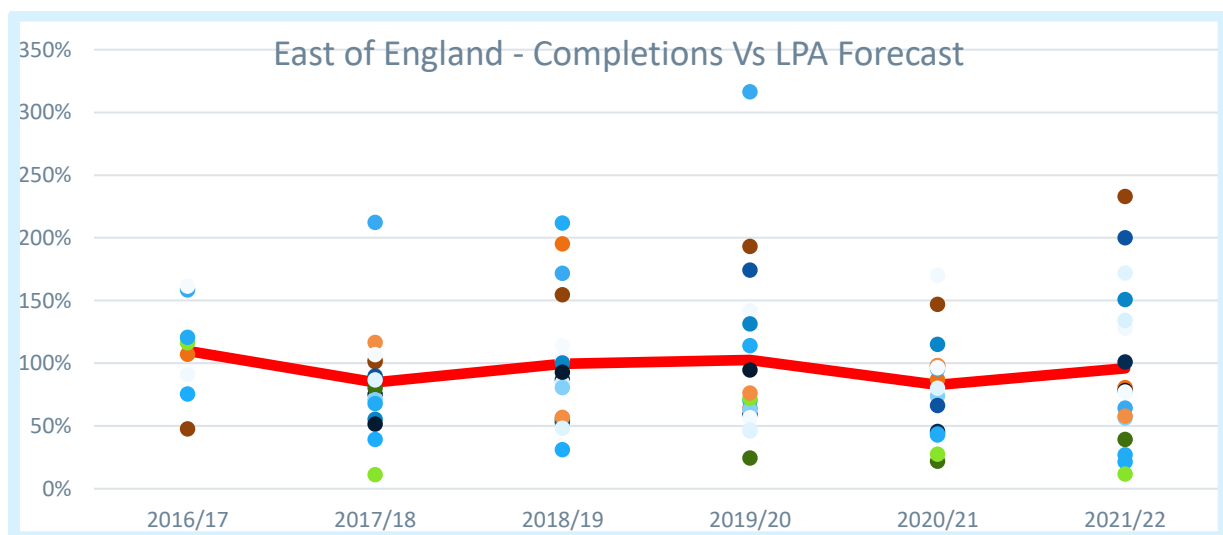


Figure 7 - South-east – Completions Vs LPA Forecast¹⁰

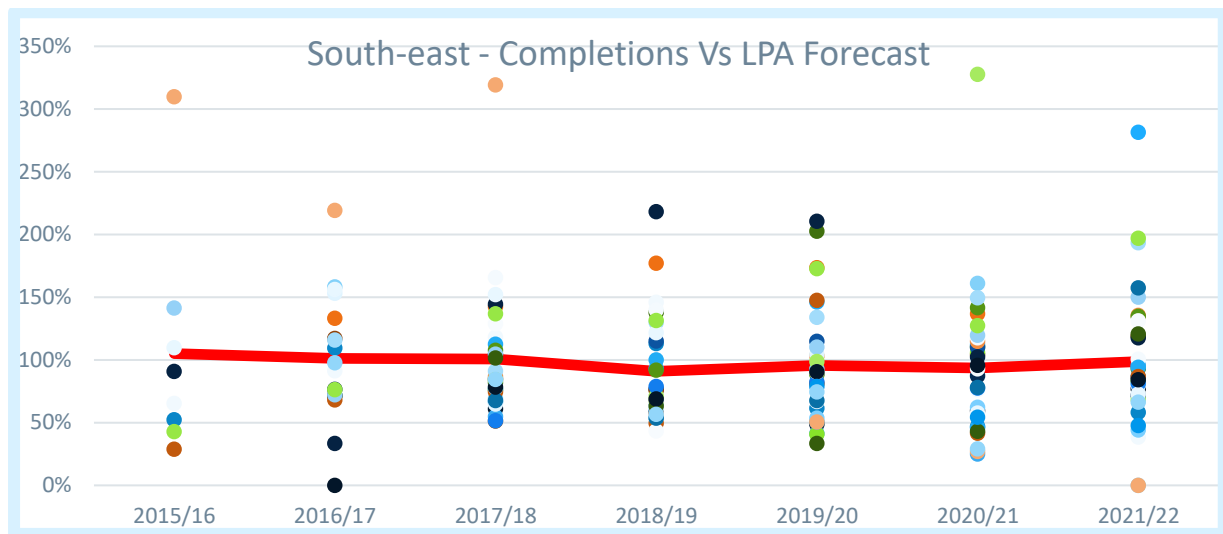
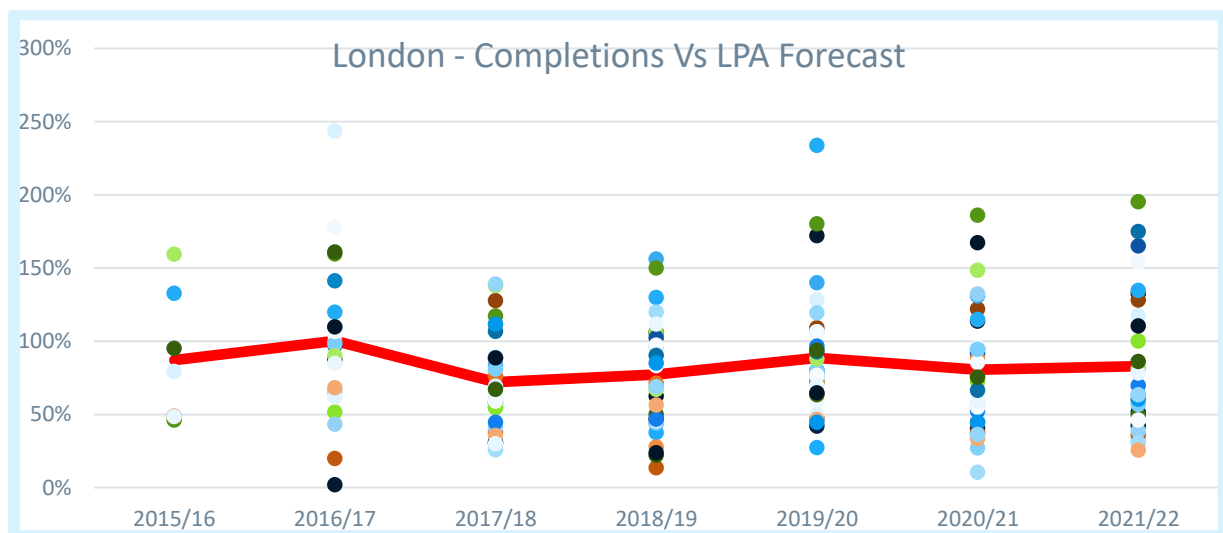


Figure 8 - London – Completions Vs LPA Forecast¹⁰



The average performance across the LPAs in our region is summarised in Table 8. It shows a clear deviation in performance between London and Non-London over the past five years.

Performance was low across all LPAs during the COVID affected years but has improved quicker outside of London. This could be due to the change in demographics and people movement since the pandemic, with employees generally having more flexibility in terms of remote working.

Overall, particularly in non-London LPAs, the data suggests that the plan-based forecast is relatively accurate. All of the 15 sites included for enhancement expenditure are outside of London and we are therefore confident that the need to upgrade them is accurate.

Table 8 Regional LPA performance – Actual vs predicted (five years previous)¹⁰

Region	2015-16 (% delivery)	2016-17 (% delivery)	2017-18 (% delivery)	2018-19 (% delivery)	2019-20 (% delivery)	2020-21 (% delivery)	2021-22 (% delivery)
London	87%	100%	72%	77%	89%	80%	83%
South-east England	105%	101%	101%	91%	96%	94%	99%
East of England		110%	85%	100%	103%	83%	96%

ONS Population Projections

The Office for National Statistics (ONS) produces population projections roughly every two years. These project the future size and age structure of the population based on mid-year population estimates and assumptions of future fertility, mortality and migration. The ONS 2018-based principal sub-national population projection (SNPP), uses a five-year history (2013–2018) to derive local fertility & mortality assumptions and a long-term UK net international migration assumption of +190k. It is important to note that in 2022 net migration was 606,000, over 200% greater than 190,000 used in the ONS-18 projection.

In line with the ONS 2018-based national population projection (NPP), this round of projections includes a reduced UK fertility outlook compared to ONS-16 and a dampened rate of improvement in life expectancy compared to ONS-16. This scenario has been rebased to the 2020 mid-year population estimate from ONS.

Volatility of ONS population estimates at local authority level

Analysis¹¹ conducted by the ONS has found that over 10% of local authorities had a population variance of greater than 5% between the official ONS mid-2021 population estimates, based on

¹⁰ Edge Analytics Consilium Database – based on Department for Levelling Up, Housing and Communities live table 122 and LPA forecasts.

¹¹<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/reconciliationofmidyearpopulationestimateswithcensus2021atlocalauthoritylevel/2023-03-02>

Census 2021 data and the rolled-forward estimates from ONS mid-2020. These local authorities were predominantly concentrated in London and cities with a relatively high student population, and therefore disproportionately affect the Thames Water region.

Figure 9 shows the geographic distribution of the percentage differences. A positive percentage means that the rolled-forward estimate is higher than the census 2021, a negative percentage means that the rolled-forward value is lower. Figure 9 shows that for our region, the ONS-18 population projection understated the population recorded at the Census 2021.

Figure 9 - Mid-year estimates and Census 2021 (Source: Office for National Statistics).

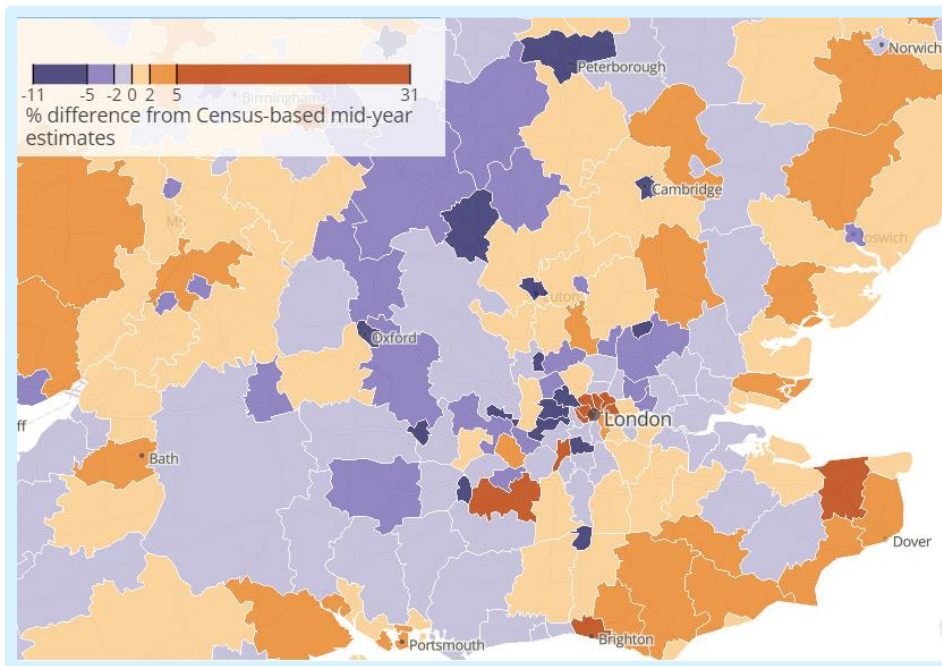


Table 9 shows the top 10 underestimated and overestimated local authorities in England and Wales. The highlighted local authorities are located within the Thames Water region and show that in both cases 7 out of the top 10 are within our region.

Table 9 - Top 10 local authorities – underestimated and overestimated population.

Top 10 underestimated Local Authorities	Top 10 overestimated Local Authorities
Cambridge (-15.66%)	City of London (+25.46%)
Reading (-9.57%)	Camden (+24.97%)
Ealing (-9.39%)	Westminster (+24.28%)
Hounslow (-7.67%)	Islington (+12.47%)
Rushmoor (-7.10%)	Coventry (+10.13%)
Harlow (-6.91%)	Isles of Scilly (+9.88%)

Watford (-6.83)	Kensington and Chelsea (+8.31)
Peterborough (-6.53%)	Tower Hamlets (+7.58%)
Slough (-6.53%)	Hackney (+7.04%)
Burnley (6.09%)	Canterbury (+6.59%)

This analysis further confirms that generally, ONS population projections become inaccurate at geographies granular enough for the planning of wastewater treatment services. Local Authority plan-led forecasts have historically overpredicted growth, but as the analysis above shows, this is less common in recent years, and in our region specifically.

We have based our Enhancement Case on our 'plan-based principal' scenario. This scenario provides the necessary granularity and meets guidance from Defra and the Environment Agency, issued to produce the DWMP, which states that growth should be based on housing forecasts as determined by Local Authority plans.

This scenario has been applied at the sewage treatment works catchment level to determine which specific sites are at risk. A further level of scrutiny has been applied to the plan-based growth data by researching each development site for the likelihood of delivery. Only those sewage treatment works with a high level of certainty of an impact occurring have been included in this case.

3.9 Assessing the impact of population growth

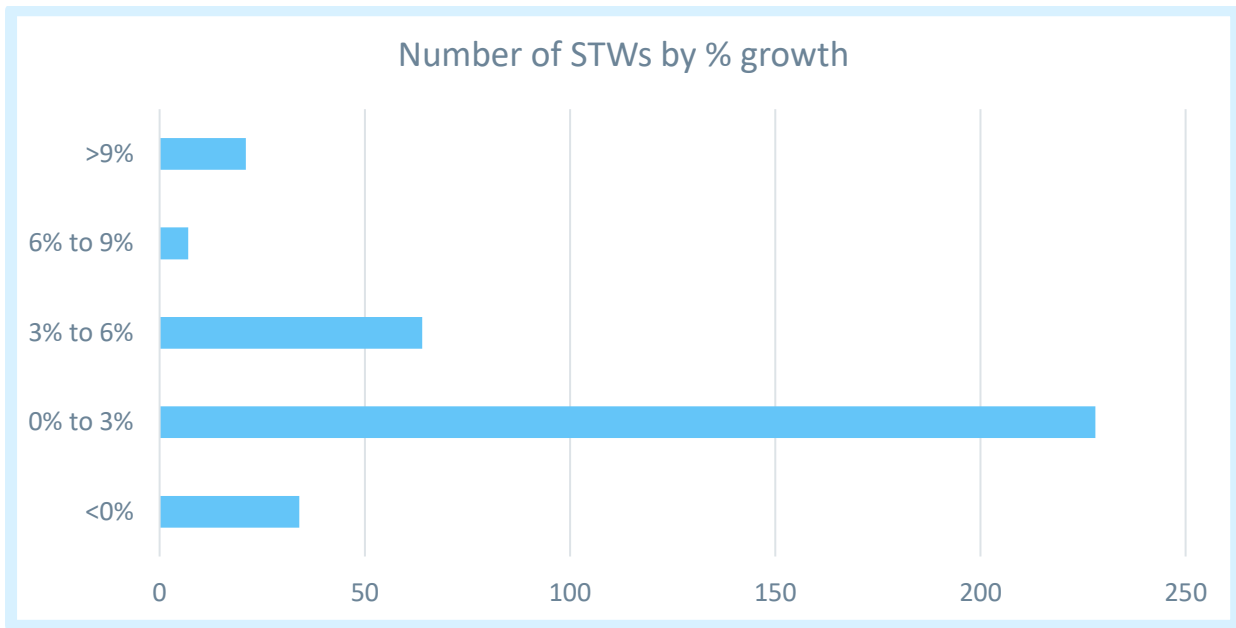
Since PR19, we have made significant improvements to the way that we assess and prioritise growth investment at our sewage treatment works. Previously, our forecasts were updated on an ad-hoc basis and were reliant on Local Planning Authority development data being correctly interpreted. We now receive regular growth data from Edge Analytics, both plan based and ONS population trends. This data is supplied at Census Output Area level which can then be rolled up to our sewage treatment works catchments and inputted into our Strategic Overview of Long-term Assets and Resources (SOLAR) model.

The purpose of the SOLAR process is to produce long-term forecasts of the flow and load at each of our sewage treatment works. The SOLAR process compares measured flow and load samples of crude sewage (where available), with a theoretical population equivalent (PE) based on the latest ONS Mid-year population estimate, along with trade effluent and estimates for short-term residents, irregular migrants, overnight tourists, and commuters. The use of the 'official' ONS mid-year estimate of population ensures that we are able to track our 'plan-based' forecast and ensure that our assumptions on levels of predicted growth remain accurate (this is explained in more detail in Section 7.5: How we monitor pathways). The measured and theoretical estimates are compared with each other, and a 'base' PE agreed for the determined 'base year'.

Annualised changes to the population (net dwelling increase multiplied by the ONS household size projection) are captured through the SOLAR process to forecast how this 'base' will change over time for PE and the associated flows (using the latest per capita consumption forecast).

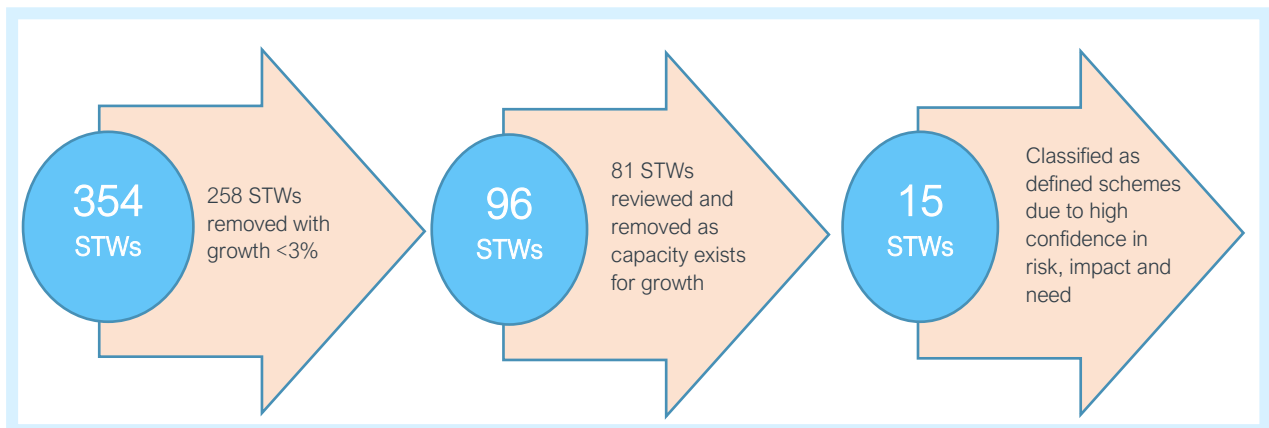
To identify the extent of the investment needs for sewage treatment works growth in AMP8, a review of the risk of permit non-compliance was undertaken alongside an assessment of each site's current capacity. Figure 10 shows the grouping of sewage treatment works by predicted AMP8 PE growth.

Figure 10 - Number of sewage treatment works grouped by percentage AMP8 growth.



Using the forecasts from our SOLAR process, a projection of the percentage PE growth in AMP8 and future AMPs was produced for each of our 354 sewage treatment works, along with a forecast of the DWF, FFT and storm tank volume requirements. Figure 11 shows how the review process prioritised our sites for permit compliance risk and subsequent inclusion in this Enhancement Case.

Figure 11 - Growth Enhancement Case prioritisation methodology.



Details of each of the 15 sites and the type of upgrade required are shown in Table 10.

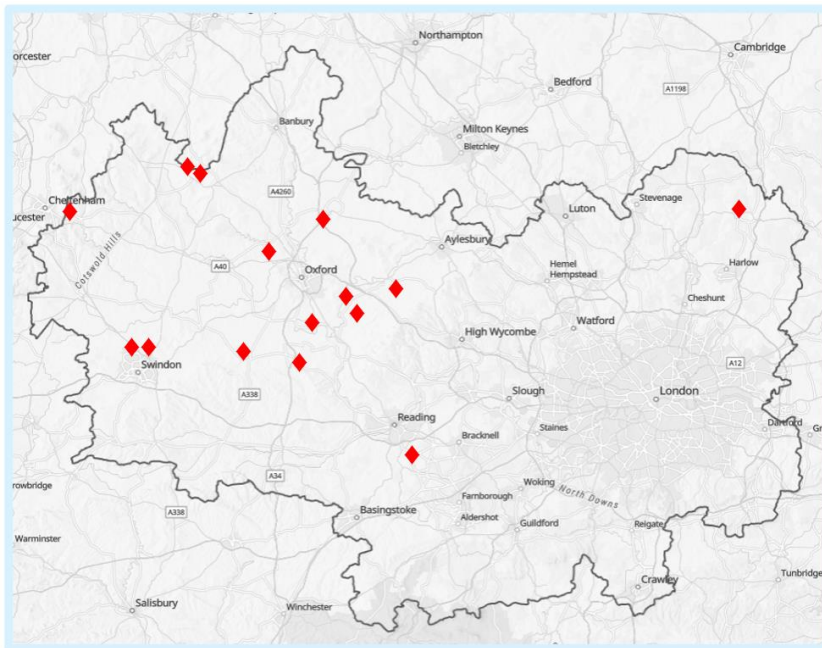
Table 10 - Enhancement site details.

Sewage Treatment Works	2023 PE	% Growth in AMP8	Biological capacity increase required?	DWF increase required?	FFT increase required?	Storm Tank volume increase required?	Capex (£m) (22/23)
Culham	3,987	46%	Yes	Yes	Yes	Yes	4.37
Chalgrove	3,248	74%	Yes	Yes	Yes	Yes	4.27
Chipping Norton	9,363	23%	Yes	Yes	Yes	No	9.56
Andoversford	732	21%	No	No	Yes	No	6.27
Arborfield	20,208	33%	Yes	Yes	Yes	Yes	48.07
Didcot	45,269	36%	No	Yes	Yes	Yes	99.36
Cassington	19,091	24%	No	No	Yes	No	5.22
Wheatley	6,065	8%	No	No	Yes	Yes	4.12
Bicester	54,868	28%	No	Yes	Yes	Yes	50.28
Wantage	30,846	22%	No	Yes	Yes	No	41.13
Highworth	8,688	20%	Yes	Yes	No	Yes	12.15
Thame	13,284	21%	Yes	Yes	Yes	Yes	37.94
Stansted Mountfitchet	12,550	61%	Yes	Yes	Yes	Yes	35.27
Moreton in Marsh	5,952	7%	Yes	Yes	Yes	Yes	8.20
Blunsdon	2,222	37%	Yes	Yes	Yes	Yes	11.78

Note: a timing adjustment of £23.16m has been applied to enhancement total but has not been applied to the bottom-up Totex in the table above

Figure 12 shows the geographic spread of our high-risk growth sites which are included in this Enhancement Case. A large cluster around Oxford is linked to the Oxford to Cambridge Partnership (formally OxCam Arc), which is a cross-government initiative supported by local partners that aims to deliver sustainable growth between Oxford, Milton Keynes and Cambridge.

Figure 12 - Map showing enhancement sites.



3.10 Case Studies

As explained in section 3.9, we have assessed each of the STWs which make up this Enhancement Case in detail. This ensures that we have a clear picture of the timeline, viability and impact of the individual housing developments in the catchment. The following two case studies highlight this assessment.

Culham sewage treatment works

Culham sewage treatment works is a small rural works located in the South Oxfordshire Local Planning Authority area, approximately 7km south of Oxford. The site currently treats the effluent from approximately 4,000 PE that arises from the villages of Berinsfield, Culham and Clifton Hampden, as well as the Culham Science Centre. The PE is expected to increase by 46% by the end of AMP8 and 163% by the end of AMP9.

The catchment is located within South Oxfordshire's Science Vale. There are two large development locations in the catchment: Culham Science Centre and Berinsfield Garden Village. Both development sites have allocations for housing in the Local Plan¹².

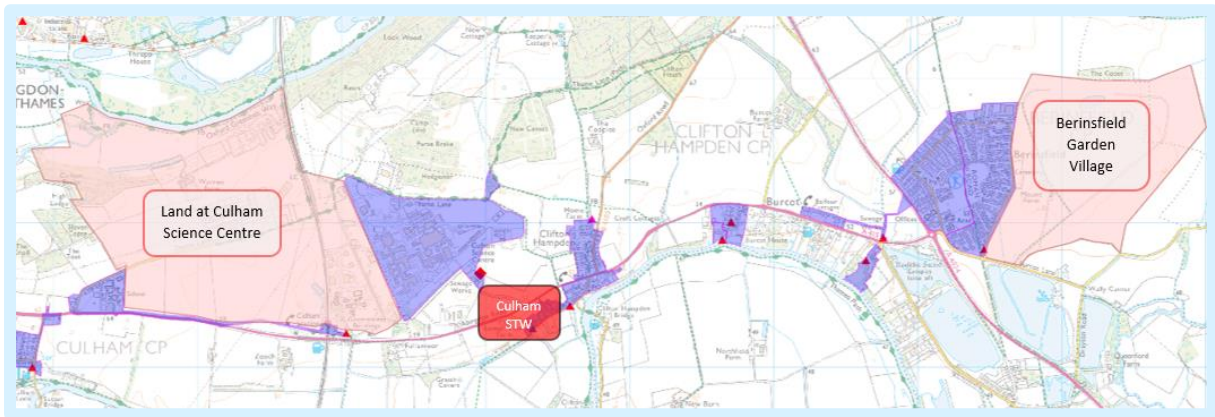
The land around Culham Science Centre has been inset from the Green Belt to enable the land to be developed to deliver approximately 3,500 new homes with occupation starting in 2029¹³.

Land at Berinsfield has also been inset from the Green Belt and was awarded garden village status in 2019. The site will be developed to provide around 1,700 new homes with occupation starting in 2030¹³.

¹² South Oxfordshire Local Plan 2011-2035 (Adopted December 2020)

¹³ South Oxfordshire Housing Land Supply Statement – July 2022

Figure 13 - Culham sewage treatment works catchment.

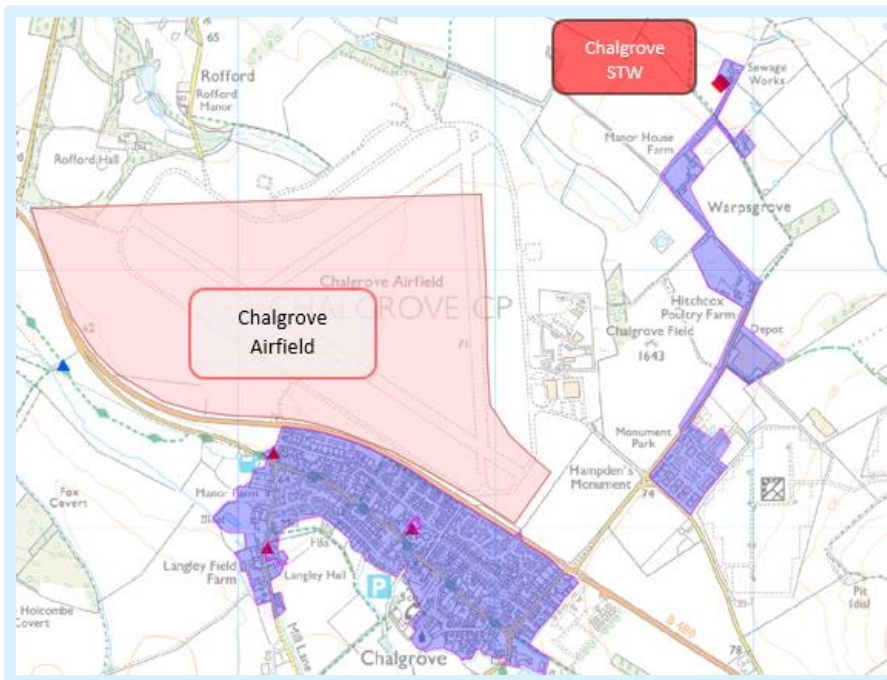


Chalgrove sewage treatment works

Chalgrove sewage treatment works is a small rural works located in the South Oxfordshire Local Planning Authority area, approximately 11km southeast of Oxford. The site currently treats the effluent from approximately 3,250 PE from the village of Chalgrove. The PE is expected to increase by 74% by the end of AMP8 and 287% by the end of AMP9.

Chalgrove Airfield is a former Second World War airfield opened in 1943. The site was transferred from the Ministry of Defence to Homes England in 2016. Homes England, as the landowner has been trying to work with their tenant Martin-Baker to facilitate development. In the event that this is unsuccessful, they will seek to use their statutory Compulsory Purchase Order (CPO) powers to bring this site forward for the development of 3,000 new homes¹².

Figure 14 - Chalgrove STW catchment.



3.11 Timing of sewage treatment growth investment

We are required to be compliant with our effluent discharge permits at all times. As discussed in previous sections, the predicted population growth will increase the pressure on our sewage treatment works to the point where failure with our permits becomes more and more likely until additional treatment capacity is delivered.

The timing of interventions included in our sewage treatment growth Enhancement Case are linked to the latest housing trajectories. We can use these to calculate the risk to permit compliance in each year. Our investment plan and the timing of our schemes are, where possible designed to be implemented in time to cater for new development.

We are currently forecasting that five of our 15 sewage treatment growth enhancement upgrades will be delivered across AMP8 and AMP9. This is to ensure that our investment programme is linked to projected housing delivery and therefore enhancement investment is spent efficiently.

3.12 Scale of sewage treatment growth investment

The scale of investment required at each of the sites within this Enhancement Case has been assessed in detail by our engineering team. Each upgrade has been scoped to enable robust compliance with permits and is linked to published Local Planning Authority growth plans. Our solutions deliver capacity for ten years' (up to 2036) worth of growth.

Local Planning Authority housing trajectories are published by each Authority, but they vary in detail. The majority publish at least a five to ten year look ahead but detail beyond this often deteriorates and is extremely limited post 15 years. Our plan-based growth forecasts are supplied for each of our 354 sewage treatment works by Edge Analytics who source the data directly from the Local Planning Authorities. This data is then verified by our internal planning teams to ensure it aligns with our detailed catchment knowledge.

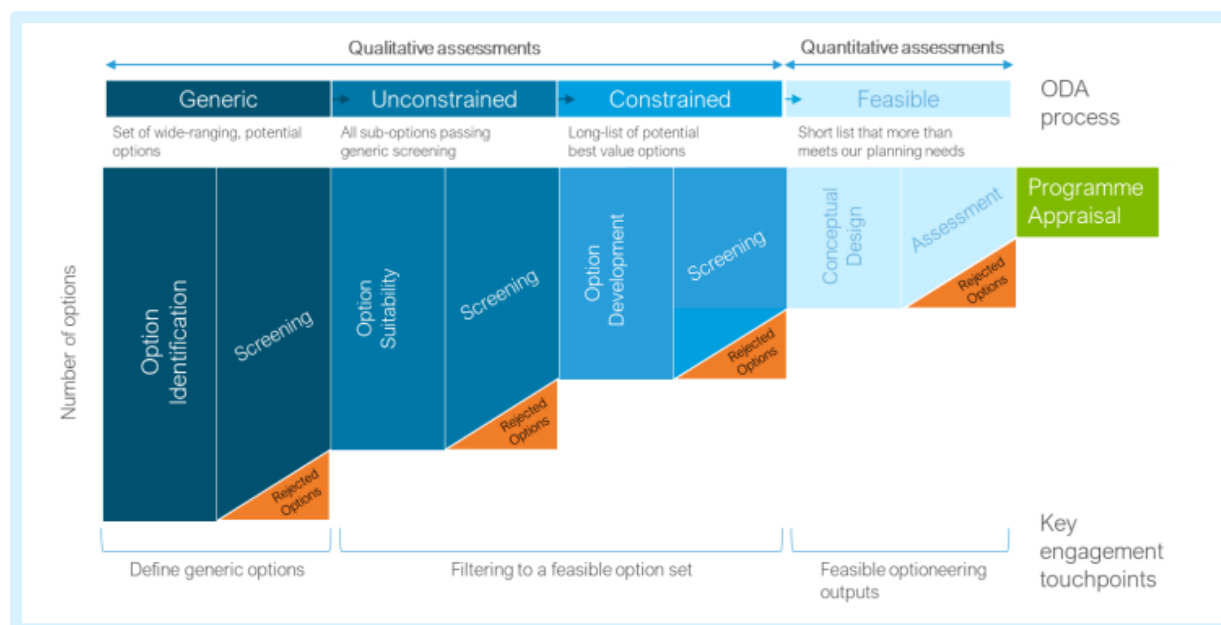
4 Best option for customers

Our sewage treatment growth enhancement programme consists of 15 locations where the impact of new development and growth cannot be met by the current treatment capacity without deteriorating environmental performance. The amount of growth, the current size and complexity of the sewage treatment works, and the current spare capacity all contribute to the cost of each individual project. As described earlier, we have identified the growth sites through a risk-based prioritisation process to ensure that we provide the best option for customers by only focusing on those sites where there is a real and present need for capacity increases. This section details how options were developed for our 15 STW growth sites and how we have ensured that our mix of solutions represents best value for our customers.

4.1 A framework for optioneering – overview of DWMP approach

The sewage treatment growth programme was developed as part of the DWMP. The optioneering stage of DWMP follows a structured approach in line with industry guidance¹⁴, involving a progression of development and appraisal of options, commencing with the broadest possible range and ending with a feasible set of options, at a conceptual design level of development. An overview of this framework is shown in Figure 15; a full account of the optioneering framework is given in our DWMP May 2023 publication¹⁵.

Figure 15 - Overview of the optioneering stage of DWMP.



¹⁴ [Defra DWMP Guiding Principles](#)

¹⁵ [DWMP Technical Appendix D: Options Development and Appraisal](#)

At each stage, the options are screened to remove those options that are not considered feasible for inclusion in the final basket of options. The approach to screening options focused effort on defining options, screening out at each stage those options assessed as disproportionately costly, technically infeasible or having significant and unacceptable environmental impacts.

4.2 Generic option development and screening

We've undertaken a comprehensive exercise as part of DWMP to identify and develop a wide range of generic options that could address the risk to our sewage treatment works posed by population growth. We combined an industry derived list and our knowledge of our catchments with the feedback we received from our stakeholders to help us identify the options.

Our structured approach resulted in the identification of 12 generic options that are listed in Table 11. Expanding on the generic options, a range of linked sub-options have been developed. These provide a more granular level of option definition.

Table 11 - Generic Options.

Generic option title	Description	Option viable?
Treat wastewater in the network	<p>Treating the wastewater in the network either to relieve load transferred to existing treatment works or by removing contaminants that cause problems in the network and/or at the STW.</p> <p>Sub-options:</p> <ol style="list-style-type: none"> 1. Screening in the network 2. Remove fats, oils and grease in the network 3. Primary Settlement in the network 4. Chemical treatment in the network 5. Biological treatment in the network 6. Other within-sewer treatment 	Yes
Increase level of performance in existing STWs	<p>These options are about measures that could increase the efficient use of the existing capacity of the works with the existing assets.</p> <p>Sub-options:</p> <ol style="list-style-type: none"> 1. Optimising maintenance performance 2. Real time control implementation 	Yes
Increase treatment intensity at existing STWs	<p>These options are concerned with increasing the available treatment capacity on the existing footprint of the site.</p>	Yes
Expand existing STWs	<p>These options cover purchasing land adjacent to an existing STW and expanding them. The expansion could be with conventional treatment or with a more intensive treatment option.</p> <p>Sub-options:</p> <ol style="list-style-type: none"> 1. Buy land and expand STW 2. Buy land, relocate sludge treatment and expand effluent stream on remaining land 	Yes

Construct new/additional STWs	These options consider the construction of additional STWs e.g., in catchments where the existing STW capacity is constrained. This can include new STWs for the purpose of treating storm discharges.	Yes
Increase treatment centralisation	This option considers the development of one or more 'mega' treatment works that would take flow and load from a number of existing STWs.	Yes
Catchment management treatment initiatives	These options are concerned with treating either diffuse or point-source non-domestic elements of wastewater before they enter the sewer system, or by treating and controlling the other contributors to the environment. Sub-options: <ol style="list-style-type: none"> 1. Treatment of diffuse pollution sources (inputs to river) 2. Treatment of diffuse pollution sources (inputs to sewer) 3. Treatment of point pollution sources (inputs to sewer) 4. Control of chemicals at source 	Yes
Customer education and awareness	Customer engagement and involvement in the provision of wastewater and drainage services. Over time, customers may become more active participants which could help to reduce the demand on existing wastewater assets by influencing customer behaviour. Sub-options: <ol style="list-style-type: none"> 1. Wastewater awareness campaigns 2. Educational programme for kids and schools 3. Build partnerships for wastewater education and awareness 4. Increase visibility of wastewater operations 	Yes
Influence where growth can occur	Influence where growth can occur and hence mitigate impact on its assets.	No

The only generic option that has been assessed as not currently viable is 'influence where growth can occur'. We have a statutory obligation under Section 94 of the Water Industry Act to both extend public sewers and make the necessary provision for emptying them through sewage treatment works. Delaying growth investment in our treatment assets over the medium to longer term would result in us being in breach of the Water Industry Act and could be seen as abuse of a dominant position under competition law. Short-term restrictions may be applied using planning conditions. However, these would need to be discharged within the life of the planning application.

4.3 Customer and stakeholder engagement

Different investment options relating to sewage treatment growth regulations have been tested with customers as part of our latest Enhancement Case research¹⁶.

¹⁶ PR24-15 PR24 Enhancement Case Deep Dive Research

Insights: Sewage Treatment Growth	
Support for the solution	<ul style="list-style-type: none"> • Customers believe that building new treatment facilities and installing new equipment will effectively mitigate the issue of sewage entering rivers in these high-risk areas. They also appreciate that the bill impacts to customers are negligible (PR24-15) • However, customers want to better understand how nearby residents will be impacted by the works (the amount of extra noise and traffic that will ensue) • Some customers also want to understand how much the issue of sewage entering rivers will be prevented by this enhancement, so they can better judge if they feel Thames Water is doing enough or needs to do more to prevent storm overflows (PR24-15) • When shown our proposed plans to upgrade the sewage network across 13 sites between 2025 and 2030. All different customer groups almost unanimously support Thames Water's plan. (PR24-15)

4.4 Unconstrained / constrained option development and screening

The next step in the process was to assess the unconstrained and constrained list of generic sub-options, to further screen out those that would perform poorly when addressing the AMP8 sewage treatment growth risk.

This task was a qualitative assessment undertaken by our system planners, who have an in-depth knowledge of the challenges faced within individual catchments. Together with consideration of the views and priorities expressed by our stakeholders and customers, this enabled informed decisions to be made as to which options to progress to the feasible option development stage.

The remaining options were reviewed considering the following key screening themes:

- **Deliverability** – does the option remain technically feasible and implementable noting any location specific constraints e.g., land availability, infrastructure suitability, ground conditions
- **Environment** – are the potential/likely effects of the option on the environment considered mitigatable and/or acceptable noting any location specific constraints
- **Resilience** – is there an acceptable likelihood of the option providing sufficient future resilience e.g., climate change, growth
- **Promotability** – does the option comply with policy requirements local to the area over which it will be implemented e.g., does the option give rise to an acceptable risk of it obtaining planning approval? Are customers, regulators, and stakeholders likely to accept the option when considering the area over which it will be implemented?
- **Social** – are potential effects of the option on our customers and their communities considered acceptable, when considering the area which it will be implemented?

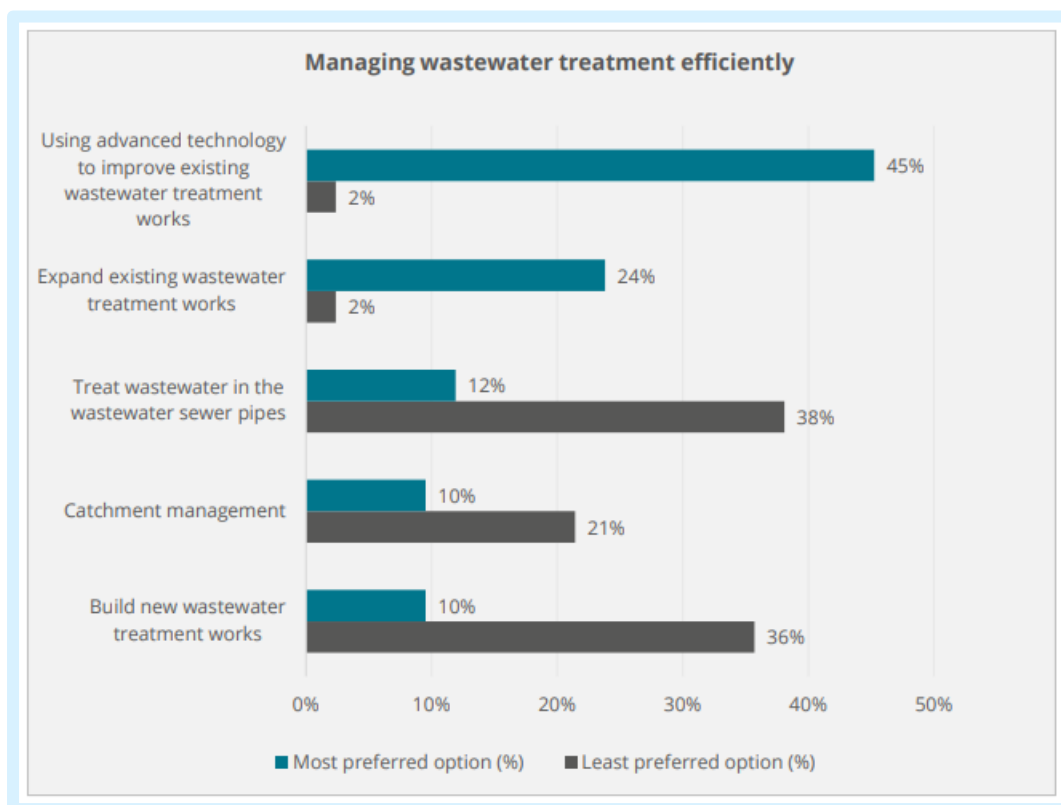
4.5 Feasible option development and screening

Having identified the types of options that can be used to address long-term challenges, we undertook research to understand our customers preferences, to find out, for example, if any options were more or less acceptable to them and why.

Key findings from the customers research were:

- The preferred option for addressing treatment capacity at our sewage treatment works is to use advanced technology to improve existing sewage treatment works.
- Customer preference is to use technology to increase capacity at existing sites, followed by expanding existing sites.
- No options were either universally supported or rejected. Customers showed strongest support for options that they considered to be realistic to implement and/or already proven to work. Customers preferred options that they considered were sensible and the right thing to do, such as managing rainwater (green infrastructure).
- Views on catchment management were mixed, with some participants supporting a natural solution approach whilst others were concerned about the effectiveness of relying on other parties.
- Participants supported larger 'new infrastructure' options, though their support tended to be more conditional as they recognised the practicalities of such options.
- Customer support was more limited for options that they considered did not solve the underlying problem or options that they considered to be unproven and higher risk or unrealistic to implement.

Figure 16 - Customer engagement of solution types.



4.6 Option Assessment

The views expressed by our stakeholders and the outcomes of our customer research conducted as part of our DWMP, were considered when developing options and deciding which options to take forward and incorporate into our Enhancement Case.

Table 12 below summarises the main option types that were considered to meet our need at the 15 sites. The options in green were retained for fine screening, and those in red were discounted.

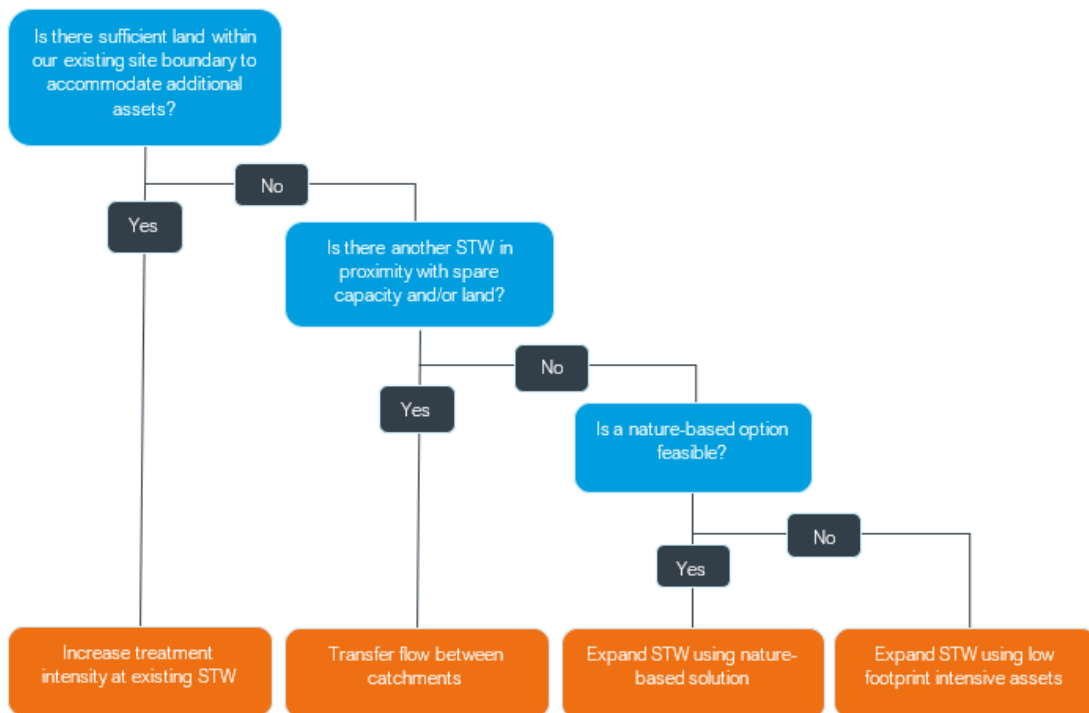
Table 12 Main Option types.

Category	Option considered	Option retained ?	Reasons	Sites where option is feasible
Capital investment	Increase treatment intensity at existing STWs	Yes	Efficient use of existing Thames Water owned land.	<ul style="list-style-type: none"> ➤ Arborfield ➤ Wheatley ➤ Bicester ➤ Didcot ➤ Cassington ➤ Stansted ➤ Mountfitchet ➤ Wantage ➤ Blunsdon ➤ Chipping Norton ➤ Highworth ➤ Moreton in Marsh ➤ Thame
	Expand STWs	Yes	Where available is limited it will be necessary to expand our footprint. This option keeps sewage treatment in one locality and utilises existing infrastructure e.g., roads and power.	<ul style="list-style-type: none"> ➤ Culham ➤ Chalgrove
	Construct new/additional STWs	No	New sites may impact on neighbouring communities during construction and in the longer term. Land availability, environmental impact and permit granting needs to be carefully considered.	
	Transfer flow between catchments	Yes	Create new connections between existing catchments. These connections could be used to optimise capacities and to find the best balance of flow and load.	<ul style="list-style-type: none"> ➤ Chalgrove
	Increase treatment centralisation	No	Close multiple smaller STWs and centralise treatment at a larger STW. This option would require significant planning, both in terms of locating appropriate land and assessing the environmental impact.	
Nature-based	Expand existing STWs	Yes	It is possible that in some locations nature-based solutions could be used to treat additional flow after it has had partial treatment by the existing STW assets.	<ul style="list-style-type: none"> ➤ Andoversford
Operational measures	Increase level of performance in existing STWs	N/A	This will always be our first option and any enhancement spend will be layered on top of base spend to ensure our STWs are performing as designed.	
Modular or adaptive options	Treat wastewater in the network	No	Apart from the screening of sewage debris this is not typically used in the UK and therefore the technology needs further investigation and trials.	
Partnership working	Influence where growth can occur	No	Delaying growth investment in our treatment assets over the medium to longer term would result in us being in breach of the Water Industry Act and could be seen as abuse of a dominant position under competition law.	

			Short-term restrictions may be applied using planning conditions. However, these would need to be discharged within the life of the planning application.	
Catchment management	Catchment management treatment initiatives	No	This option is more important as part of the WINEP as it can play an important role in improving river quality. However, it will not reduce the treatment load arriving at the STW due to population growth.	
Behavioural change	Customer education and awareness	No	Using less water will reduce the amount of flow that is required to be treated at the STW. However, it will not reduce the pollution load of the wastewater that requires treatment. It is therefore a long-term option.	

We then developed a methodology to determine the possible option types that were feasible for each of the 15 STW sites in scope. The flow chart (Figure 17) has been used to determine the main option types.

Figure 17 Main option type selection flow diagram



Where there is more than one feasible option type at a site, we have undertaken a robust assessment to determine the best mix of options for customers.

The option scenarios are outlined below:

1. Maximise available land with low footprint intensive treatment and NBS.

Preference for Nature Based Solutions (NBS) and to enhance the treatment intensity at the existing STW.



Pros

- Enables existing STWs to treat the extra wastewater from population growth
- Opportunity to maximise the use of existing STWs

Cons

- May impact on neighbouring communities due to increase in noise or bigger buildings/plant etc

2. As option 1 with flow transfer where possible

Where sites have multiple feasible compliant solutions, preference for transfer flow.



Pros

- Centralising sewage treatment can lead to more efficient treatment
- Can reduce environmental risk in the catchment being transferred i.e. reduce storm overflow discharges

Cons

- Involves major widespread construction which may cause disruption and noise
- Treated wastewater may need to be pumped back to maintain river levels

3. As option 1 with traditional treatment and NBS

Where sites have multiple feasible compliant solutions, preference for expanding works where possible.



Pros

- Enables existing STWs to treat the extra wastewater from population growth
- Traditional treatment technologies e.g. percolating filters tend to be more energy efficient

Cons

- Requires additional land to be purchased
- May have detrimental impact on local environment e.g., habitat loss

A detailed breakdown of the option type considered at each site in each option scenario is detailed in Table 13.

Table 13 - Site details in each option scenario.

	Viable Options		
Site Location	Option scenario 1 Maximise available land with low footprint intensive treatment and NBS.	Option scenario 2 Transfer flow where possible	Option scenario 3 As option 1 with traditional treatment and NBS
Andoversford	NBS (Storm wetland)	As per option scenario 1	Traditional upgrade (storm tank)
Arborfield	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Bicester	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Blunsdon	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Cassington	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Chalgrove	Buy land and expand STW	Transfer to other STW (Watlington)	Buy land and expand STW with traditional assets (percolating filter opt)
Chipping Norton	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Culham	Buy land and expand STW	As per option scenario 1	Buy land and expand STW with traditional assets (percolating filter opt)
Didcot	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Highworth	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Moreton in Marsh	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Stansted Mountfitchet	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Thame	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Wantage	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1
Wheatley	Increase treatment intensity at STW	As per option scenario 1	As per option scenario 1

Table 13 shows that there are only three site locations that have alternative viable options.

[Options assessment criteria](#)

To promote a consistent and robust assessment of the three option scenarios, we developed a set of quantitative and qualitative assessment criteria. We set out our assessment criteria in Table 14.

Table 14 - Option assessment criteria.

Criterion	Description
Cost	We have ranked options from least cost (1, best) to highest cost (3, worst). For each option, we assessed the total expenditure (Totex) 'Cost efficiency' for our cost estimation methodology.
Expected benefits	We undertook a cost benefit analysis for each feasible option and ranked 1 (best) to 3 (worst).
Customer views	We evaluated the extent an option aligns with customer preferences.
Risks and uncertainties	We identified likely risks and consequences for each/multiple options. Where appropriate, we proposed any mitigations measures and consequential impacts on option cost or benefits.

We first assessed the options against our cost criterion, before considering the benefits of each option.

Our cost assessment, summarised in Table 15, concluded that Option 1 was the least cost solution for customers.

Table 15 - AMP8 enhancement Totex (£m) (22/23) for each option scenario.

	Costs		
	Option scenario 1: Maximise available land with low footprint intensive treatment and NBS	Option scenario 2: Transfer flow where possible	Option scenario 3: As option 1 with traditional treatment and NBS
Andoversford	6.27	As per option scenario 1	8.71
Arborfield	48.39	As per option scenario 1	As per option scenario 1
Bicester	50.28	As per option scenario 1	As per option scenario 1
Blunsdon	11.78	As per option scenario 1	As per option scenario 1
Cassington	5.22	As per option scenario 1	As per option scenario 1
Chalgrove	4.27	8.25	9.63
Chipping Norton	9.56	As per option scenario 1	As per option scenario 1
Culham	4.37	As per option scenario 1	9.29

Didcot	99.36	As per option scenario 1	As per option scenario 1
Highworth	12.16	As per option scenario 1	As per option scenario 1
Moreton in Marsh	8.20	As per option scenario 1	As per option scenario 1
Stansted Mountfitchet	35.27	As per option scenario 1	As per option scenario 1
Thame	37.94	As per option scenario 1	As per option scenario 1
Wantage	41.13	As per option scenario 1	As per option scenario 1
Wheatley	4.12	As per option scenario 1	As per option scenario 1
TOTAL	355.15	382.30	391.03

4.7 Cost benefit Analysis

We determined expected benefits by using the Thames Water Public Value Framework (PVF) and a cost benefit analysis of each option. This analysis was conducted with a third-party: Baringa Partners LLP, who provided technical expertise and assurance. For each investment alternative, we incorporated the PVF outputs into the qualitative decision making of the investment programme, by scoring the public value benefits from strongly negative to strongly positive for each of the feasible options.

After using the PVF to identify the range of benefits, we determined monetised benefits across the range of measures. We have followed Ofwat's hierarchy for sourcing robust marginal benefit values from the Outcome Delivery Incentive (ODI) rate research for the WINEP and then to other publicly available, robust valuations. The identified benefits across all three option scenarios, and those benefits that could be robustly quantified are listed in Table 16 and Table 17.

We identified the following benefits that apply to all options in this Enhancement Case:

Table 16 - Benefits that apply to the option scenarios.

Benefit	Description of benefit application:
Risk of pollution incidents	Contribution toward Performance Commitment target, monetised through ODI rate. Options all meet same target design criteria, not quantified as no substantial difference between options.
Sewage treatment works discharge quality compliance	Contribution toward Performance Commitment target, monetised through ODI rate. Options all meet same target design criteria, not quantified as no substantial difference between options.
Storm overflow discharges reduction	Contribution toward Performance Commitment target, monetised through ODI rate. Options all meet same target design criteria, not quantified as no substantial difference between options.
Climate change adaptation	Contribution of nature-based solution through habitat creation and carbon sequestration.

Land-use, area of wetland or floodplain	Considered where Nature Based Solution is an option. Monetised through 2010 WINEP data.
Collaboration with local stakeholders/ NGOs	Considered through creation of NBS. Not quantified as no collaboration in this case, as private land ownership and security concerns of connection to wastewater treatment plant.
Increased flows to the environment, reduced abstraction	Considered through transfer flow. Not quantifiable.
Greenhouse gas emissions, construction	Considered the carbon emissions of each option. Monetised through UK Greenbook.
Greenhouse gas emissions, whole of life operational	Considered the whole of life carbon emissions of each option. Monetised through UK Greenbook.
Traffic or transport disruption	Considered contribution of pipework for transfer flow and impact on local traffic. Quantified and monetised

After screening for feasible options, we undertook a workshop to identify and quantify benefits and units (e.g. hectares of land, quantity and type of road disruptions) across the three different option scenarios. This process aimed to determine where benefits varied or remained consistent across the options and why.

During the cost benefit analysis (CBA) process, we recognised that certain benefits lacked a robust approach to estimate their quantified impact, or the quantification of benefits would be the same for all three option scenarios, meaning there was no difference in the benefit value. This is the case for all PC benefits in this case.

As a result, only the benefits that could be quantified effectively by publicly available third-party sources or Performance Commitments, and those that had different quantities of benefit between options were included in the analysis of each option scenario, as listed in Table 16. This approach ensured that the CBA focused on reliable and measurable quantifiable benefits, allowing for a more accurate assessment and comparison of the option scenarios. Benefits that did not meet this criterion were excluded to maintain the integrity and validity of the analysis.

Those benefits that could be monetised were quantified, based on the assumptions identified in Table 17.

Table 17 - Quantified and monetised benefits.

Benefit	Basis of quantification & profile
Land-use, area of wetland or floodplain. Water quality impacts & biodiversity.	Option Scenario 1: Current NBS capacity design profiled to meet requirements to 2055, to align with 30-year design life. Benefit apportioned annually. Assumed that capacity of NBS will remain constant to meet population needs over design life. Assume construction complete mid-year 5 of AMP8, full benefits attributed in year after complete. Option Scenario 2: No benefit attributed.

	Option Scenario 3: Benefit profile realised as per Option 1.
Greenhouse gas emissions, construction	Construction profile assumed. Assumed benefit to commence in full year (FY) after 100% of construction completed. Total units for Options 2 & 3 are profiled relative to Option 1.
Greenhouse gas emissions, whole of life operational	Annual profile to commence in the FY after 100% construction commenced. Assumption that no further STW expansion to 2050.
Traffic or transport disruption	Option 1 & Option 3: No quantitative change attributed. Option 2: Impact from pipe laying for transfer flow on the option is assumed as: <ul style="list-style-type: none"> • Pipelaying will be via opencut trench. • Pipe laying speed: 10m = 1 day. • Length of pipe laying per road type: • A Road = 30m, 3 days interruption. B Road = 15m, 1.5 days interruption.

The monetised benefits were put through the benefit Net Present Value (NPV) model to determine an NPV of benefits for each of the three option scenarios.

It is important to note that only four benefits could be monetised and used to determine an NPV of benefits for each of the three option scenarios. The values are negative as all benefits considered are *dis-benefits*, meaning that the benefits considered provide a negative value. When comparing options, the lowest negative number is considered to have the largest benefit, or smallest disbenefit.

The benefit options were compared on a site location basis for the three sites where there are viable alternative options to compare (shown in Table 18).

The sites where there is only one viable option were not included in the CBA, as the benefits are consistent and therefore do not materially impact the section criteria.

Table 18 – Viable options at site level.

Andoversford	Benefit NPV (£m)	Cost NPV (£m)	Incremental value from the least cost option
Option Scenario			
1 - NBS (Storm wetland)	-£1,761	5.200	1
3 – Traditional upgrade (storm tank)	-£1,934	7.173	-88.19

Chalgrove	Benefit NPV (£m)	Cost NPV (£m)	Incremental value from the least cost option
Option Scenario			
1 – Buy land and expand STW	-3,160	13.89	1
2 - Transfer to other STW (Watlington)	-3,910	26.19	-60.98
3 – Buy land and expand STW with traditional assets (percolating filter opt)	-7,091	31.25	-226.44

Culham	Benefit NPV (£m)	Cost NPV (£m)	Incremental value from the least cost option
Option Scenario			
1 - Buy land and expand STW	-2,173	10.74	1
3 – Buy land and expand STW with traditional assets (percolating filter opt)	-3,405	21.98	-109.6

The options for each of the three sites with viable alternative options were normalised to the least cost option, demonstrating an incremental value from 1 (least cost). In all three sites, the benefits are *disbenefits*, with the larger the negative number the larger the disbenefit. At all three sites the least cost was the best value option.

The options were then grouped on a programme level, to include all 15 sites into the analysis, with three options compared to consider the variable options as described in Table 13.

Table 19 shows the results of the cost benefit analysis for the three option scenarios. It shows that our preferred plan performs the best of the three option scenarios.

Table 19 - Results for CBA, (£M 2022-23).

	Option Scenario 1: Maximise available land with low footprint intensive treatment and NBS (£m)	Option Scenario 2: Transfer flow where possible (£m)	Option Scenario 3: As option 1 with traditional treatment and NBS (£m)
Benefit NPV	-126,170	-128,117	-129,958
Cost NPV	267.5	293.0	269.6
Incremental value from Option Scenario 1	1	-76.35	-1804
Choice:	1	2	3

Preferred solution:

Considering the benefits NPV, costs NPV, customer preferences and risks and uncertainties, the preferred best option and least cost for customer solution is Option Scenario 1.

Cost and benefit uncertainty

There are constructability and deliverability uncertainties associated with all flow transfer options. We have assumed that a feasible route path is possible between a site and the receiving works. Potential uncertainties associated with crossing other infrastructure e.g., roads or gas pipelines can drastically alter a projects' cost, as can river crossings, soil type and heritage considerations.

We have also made the following assumptions:

- The receiving STW has capacity to accept additional flows.
- No permit changes are required at the receiving STW.

The alternative solution options have been costed and the quantification assessed top down:

- Cost and quantification of alternative options considered at high level, not through EES (Engineering Estimating System) assured process.
- Assumption that appropriate land is available to be used or purchased at the required site.
- Cost of land assumed to be in 2022 standard land rates. Sites selected are rural locations and are not expected to have significant land value increases through to 2030.

We included the following assumptions in our CBA modelling of the options:

- Benefits are applied in full the year after they commence, no benefits have been applied part way through the year.
- Disbenefits have been taken as negative values.
- Cost NPV for all options is calculated through the PR24 data tables (WW15).
- We have taken the mean forecast of costs and benefits for each option over the 30-year time horizon.
- The discount of benefits over time has been taken as the social time preference rate, as set in The Green Book, which is 3.5%.
- Costs and benefits have been adjusted to 2022-23 price base.

4.8 Our best value plan and the public value framework

A best value plan should 'consider factors alongside economic cost and seek to achieve an outcome that increases the overall benefit to customers, the wider environment and society¹⁷'.

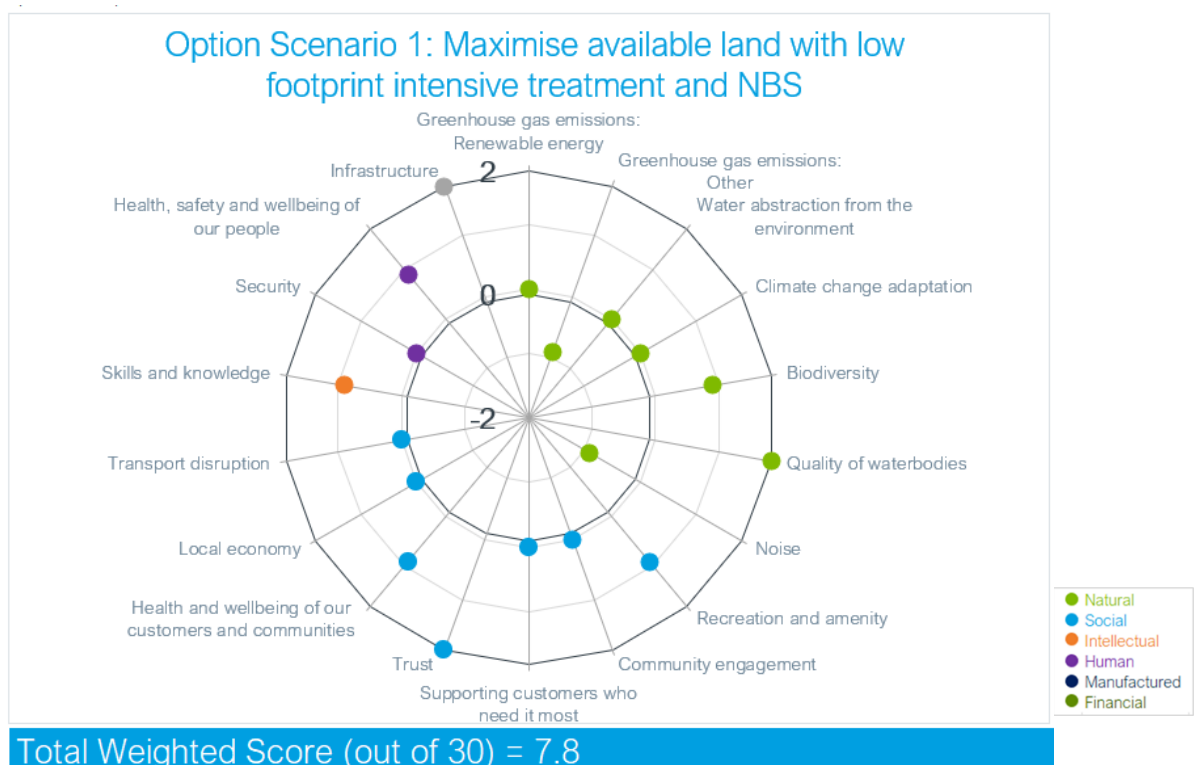
A best value approach therefore differs from a cost-benefit analysis in that it considers a broader range of factors, rather than just cost and monetised benefit. Some wider benefit factors cannot be easily monetised, for example natural capital, biodiversity enhancement and wellbeing, hence the best value assessment is based on our public value framework. Our best value plan assessment is explained in more detail and in the context of adaptive planning in Section 7.1.

¹⁷ <https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline#section-9--aspects-to-consider-in-compiling-a-best-value-plan>

Our public value framework uses a semi-quantitative, multi-criteria analysis approach, where values are weighted using customer preferences¹⁸. There are nineteen measures in our public value framework which are used to assess an option.

The public value framework assessment includes a wide range of measures such as biodiversity, waterbody quality, recreation, amenity and local economies, while the financial capital measure continues to be captured in other parts of our investment planning processes. The framework considers both short and long-term impacts, looking approximately 30 years ahead.

Figure 17 - Preferred option scenario PVF.



Our three option scenarios have been scored using this public value framework. Option scenario 1 being our preferred option includes solutions which aim to maximise available land and use nature-based solutions, where possible. The results are detailed below.

Summary by Capital of preferred solution and what has been taken into account.	
Natural	<p>The investment strongly benefits natural capital in one or more measures. Continued compliance with our environmental permits and protection of water quality in the environment is our key driver. The chosen solution seeks to reduce land footprint and remove the need to reduce surrounding habitat to deliver the asset upgrades</p> <p>Nature-based solutions will also benefit biodiversity with the new reed bed creating new wildlife habitat. The new technology increases operational</p>

¹⁸Public value research, May 2022 Verve

	carbon and noise via its daily operation, representing a dis-benefit to natural capital.
Social	<p>The investment strongly benefits social capital in one or more measures. We have overwhelming customer and stakeholder support to protect our rivers and prevent pollution to watercourses. This investment will generate customer trust and allow us to continue meeting our stakeholder expectations surrounding permit compliance.</p> <p>Continuing compliance helps protect the amenity value in our local communities, where people's pride of place can be intrinsically linked to customer health and wellbeing.</p>
Intellectual	There is a positive benefit to intellectual capital. The new treatment technology new to many of these sites. The operating workforce will gain training and a new set of skills to operate and maintain the new intensive assets. We expect this to affect employee wellbeing.
Human	There is a positive benefit to human capital. The upgrades will enable easier operation of the assets to ensure permit compliance which will improve employee experience and reduce stressful experience, positively influencing employee wellbeing.
Manufactured	There is a strong benefit to manufactured capital as the upgrade improves our asset resilience and increases the value of our assets
Financial	No impact

Option Scenario 2 focusses on transferring flow to nearby larger STWs, where possible and Option Scenario 3 prioritises traditional larger footprint treatment types over minimising land purchase.

Figure 18 - Option Scenario 2 PVF.

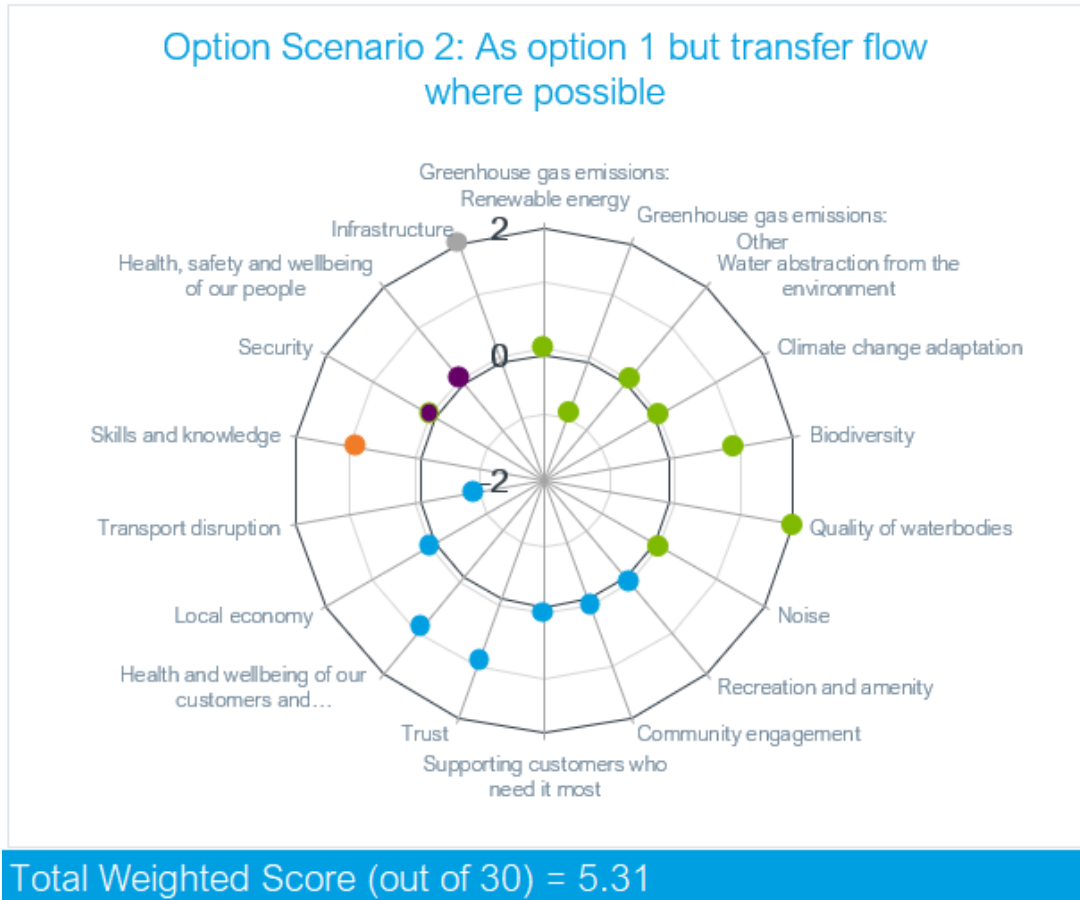
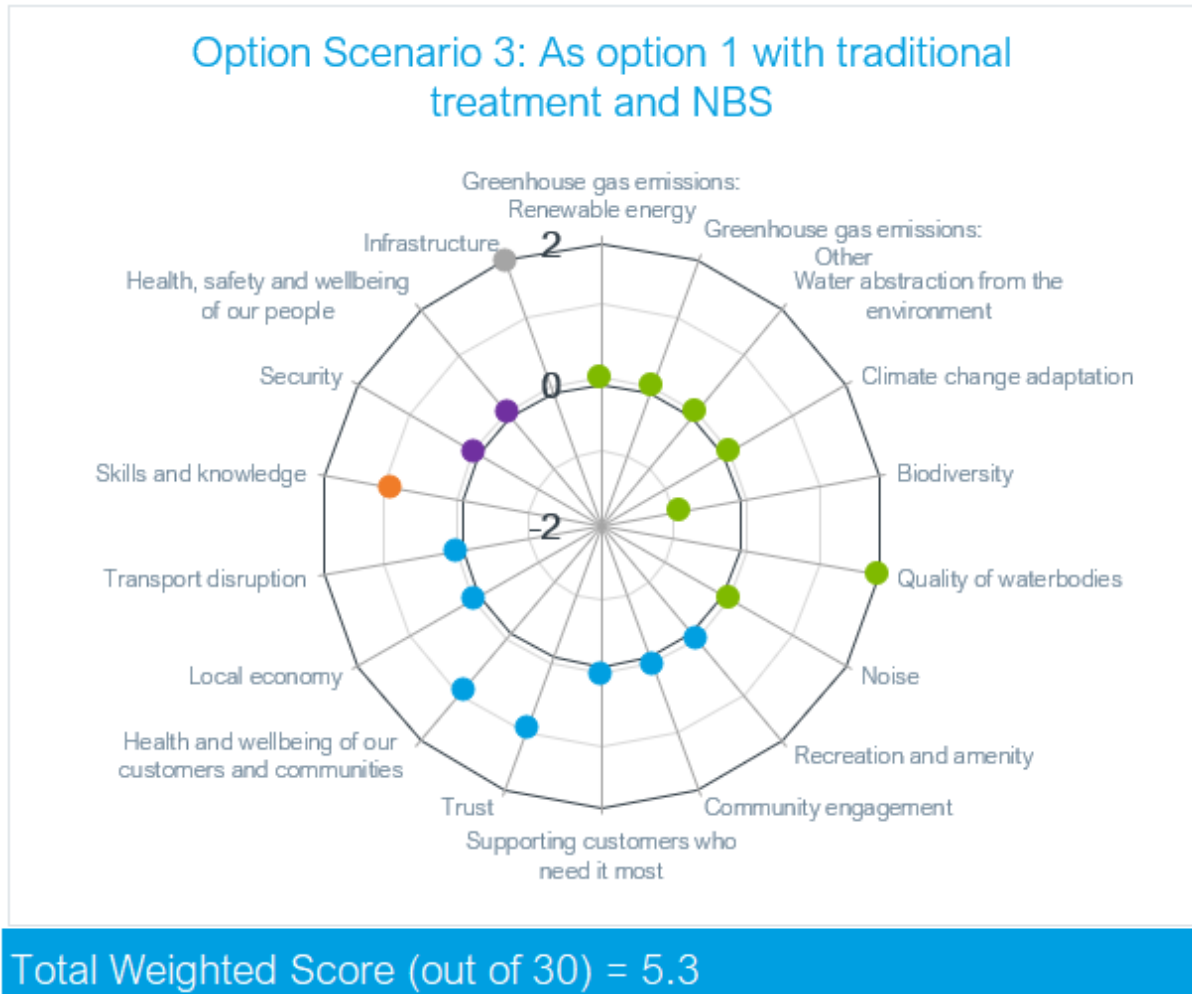


Figure 19 - Option Scenario 3 PVF.



4.9 Delivering enhancement at the most efficient time

We are currently forecasting that four of our 15 sewage treatment growth enhancement upgrades will be delivered across AMP8 and AMP9. This is to ensure that our investment programme is linked to projected housing delivery and therefore enhancement investment is spent efficiently.

These four sites are:

- Culham STW – The largest development site at Culham Science Centre (3,500 additional homes) is not due to start until 2029¹⁹
- Chalgrove STW – The largest development site; ‘Land at Chalgrove’ (3,000 additional homes) is not due to start until 2029²⁰
- Cassington STW – The existing STW has sufficient capacity to accept the first phases of the two main development locations: ‘Salt Cross Garden Village’ and ‘Land west of Eynsham’. The majority of the development will take place from 2029²¹

¹⁹ South Oxfordshire five-year housing land supply – July 2022

²⁰ South Oxfordshire five-year housing land supply – July 2022

²¹ West Oxfordshire District Council, Salt Cross Garden Village Area Action Plan, Inspector’s Report – March 2023

- Bicester STW - The existing STW has sufficient capacity to accept the first phases of the main development sites; 'North west Bicester Eco Town', 'South east Bicester' and 'Graven Hill', with the majority of housing delivered post AMP8²²

4.10 Third-party funding

This Enhancement Case is assessed as not suitable for third party funding.

²² Cherwell District Council Housing Land Supply Statement – February 2023

5 Cost efficiency

In this section, we cover the approach we have taken to arrive at our option costs and how we have considered a stretch efficiency of our proposed option.

Firstly, we set out the overall approach we have taken to developing our costs for this case. We describe in detail the bottom-up engineering costing and demonstrate how we have challenged these bottom-up costs through the application of different operational efficiency levers. We describe the process we have followed and show how we arrived at our costs alongside the supporting evidence, calculations, and key assumptions.

We then set out how we have considered the cost efficiency of our proposed costs using benchmarking. We describe our approach and how this has informed the considerations Ofwat should make when assessing the cost efficiency of our Enhancement Case.

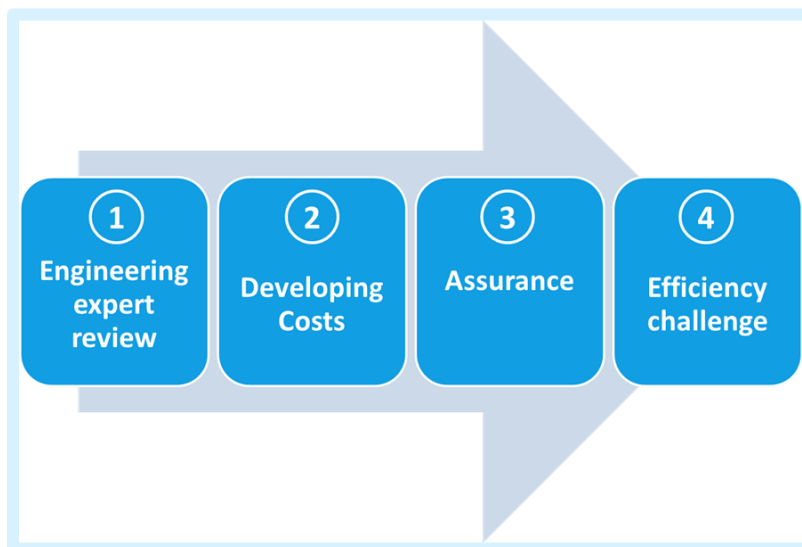
Finally, we provide a recommendation for how Ofwat should assess the cost efficiency of our proposed enhancement.

5.1 How we have developed our costs for this case

In this section, we set out how we have applied our cost efficiency approach to Sewage Treatment Growth.

Figure 20 below shows the bottom-up cost process we have followed for Sewage Treatment Growth. More information can be found in TMS33 Capital Cost, Efficiency and Assurance.

Figure 20 - Sewage Treatment Growth bottom-up cost process



We have developed our bottom-up costing of each of the 15 sewage treatment works primarily using our Engineering Estimating System (EES).

The amount of growth, the current size and complexity of the sewage treatment works and the headroom available all contribute to the cost of each individual project and have been considered as part of the cost breakdown, by individually assigning appropriate activities, labour and material.

In evidencing that our cost estimates are efficient, we have considered different approaches to cost efficiency. We have assessed the suitability of these approaches for sewage treatment growth, these are set out in TMS33 Capital Cost, Efficiency and Assurance.

For this case, we recognise that Ofwat is likely to use a standalone econometric model. We provide our view of the approach to determining cost efficiency and considerations Ofwat should make in section 5.5 and 5.6.

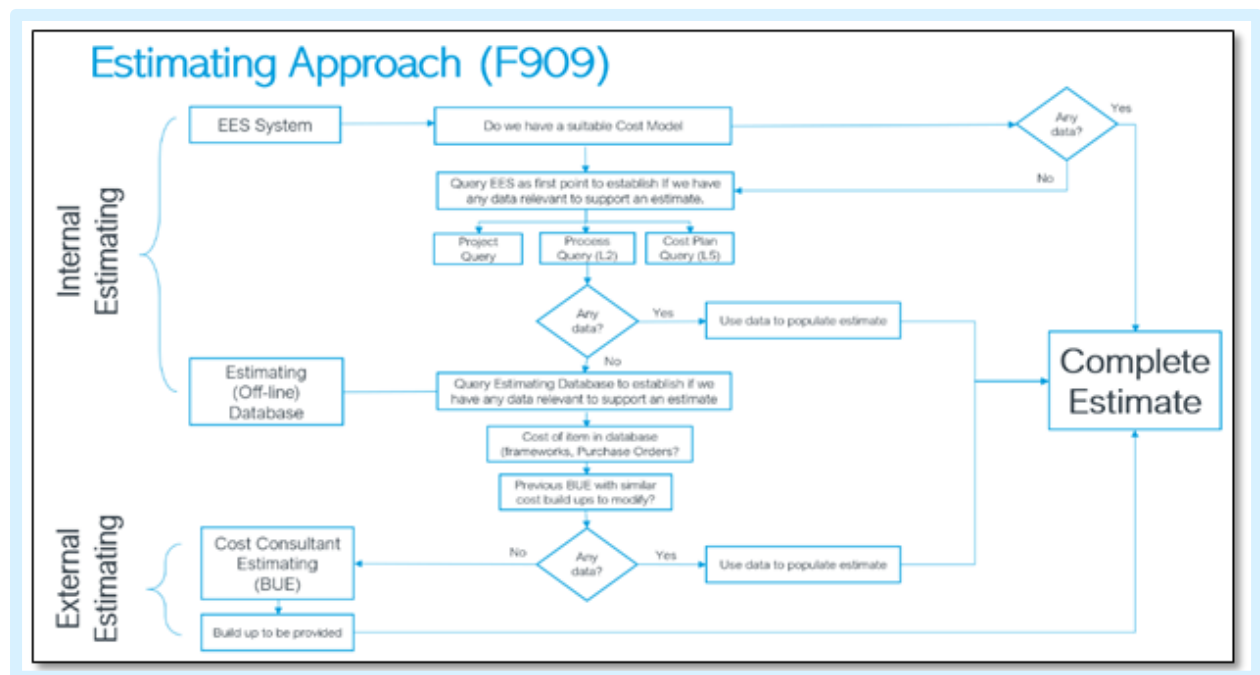
5.2 How we arrived at our bottom-up engineering costing

Figure 21 shows an overview of our end-to-end estimating process undertaken through our EES F909 estimating tool. It links both internal and external estimates (where required) to produce a capex project cost.

Where EES is unable to cost items, such as new technology or limited data we obtain quotes or use the services of an experienced cost consultancy to develop and produce bottom-up estimates.

Depending on the design maturity of a project and significance of unknown factors, we overlay an additional complexity/risk factor to apply a contingency allowance. Depending upon the project this could cover unknowns such land acquisition, power upgrades, access restrictions, planning, service diversions temporary works and/or SCADA interactions.

Figure 21 - Thames Water's estimating approach.



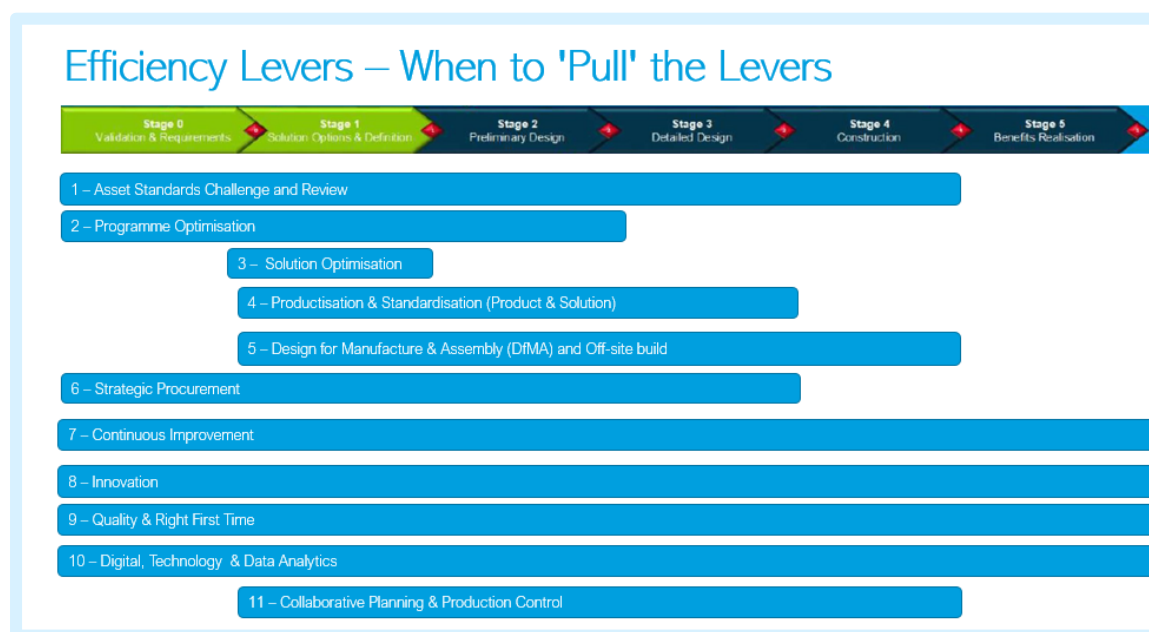
5.3 How we have challenged our proposed costs

At a high-level, efficiency can be broken down into three components:

1. Effectiveness – ‘Spend wisely’
2. Economy – ‘Spend less’
3. Productivity – ‘Spend/do things well’

The efficiency levers provide a framework for project teams to identify, quantify, record, evidence, report and share opportunities to maximise the efficiency benefit and organisational learning.

Figure 22 - Efficiency levers adopted during our PR24 submission.



We have considered eight efficiency levers in defining our enhancement costs. For this specific Enhancement Case, the application of each lever is summarised in Table 20

Table 20- Efficiency Levers.

Efficiency lever	Description	Opportunity	Cost	Effort
Strategic Procurement	We procure a large number of projects, products and services. Due to scale, there can be significant benefits to be realised through long-term planning, optimising framework agreements and procuring long-lead time items.	Low	Medium	Medium
Programme Optimisation	<u>Continuous Improvement</u> – If implementing the same solution multiple times, delivery is expected to become more efficient as well as remove/minimise non-value-added activities from the delivery of the solution	Low	Low	High
	<u>Quality flight & first time</u> – Ensuring that quality checking and governance supports successful outcomes from project start. Removing the need for projects to be ‘shelved’ in the later stages.	Medium	Medium	Medium
	<u>Collaborative Planning & Production Control</u> – Regular team planning over short-term or long-term and short interval reviews of production progress and risk mitigation.	Low	Medium	Medium
Solution Optimisation	Risk analysis, constructability assessment and technical assurance to ensure an optimised, deliverable solution. The no-build/low-build/smart-build hierarchy should be used to	High	High	Medium

	determine the optimum solution (lowest cost to deliver the required outcome).			
Innovation	The use of innovation execution techniques to identify, assess and implement innovative products and techniques.	Low	Medium	High
Asset Standards	Identification of specific scope items that could be changed for the benefit of the project. This deviation from the standard can deliver additional benefits to the project.	Zero	Already accounted for in design therefore no further efficiency possible	
Product & Standardisation	The design of 'standard' products or solutions which can be used on multiple occasions with a principle of 'design it once, use it many times'. Standard products reduce complexity and significantly reduce cost compared to bespoke equivalents.	Zero	Limited opportunity, only 10 sites	
Design for Manufacturing & Assembly and Off-site build	The construction of elements of the project in an off-site factory environment rather than the 'traditional' on site construction.	Zero	Medium	Low
Digital, Tech & Data Analytics	The use of digital technology and solutions to improve project delivery, such as Building Information Modelling (BIM), Asset Information Modelling (AIM), digital rehearsals using 4D, the use of augmented solutions and virtual reality. The implementation of digital paperwork solutions, on-site tablets etc. This can be integrated with drones, laser scanning, LIDAR, digital data capture.	Low	Medium	High

5.4 Our proposed costs

Our 15 sewage treatment growth sites have been analysed on future growth needs. Housing development plans obtained from Local Planning Authorities have informed us of the extent of growth for the next 25 years. The plans indicate current population levels and the new areas set for new residential and industrial development. Assumptions have been made to translate these areas to flow rates.

Each of our sewage treatment works has been assessed for its current headroom with regard to its current permit. The treatment processes considered have been: Preliminary, Primary, Secondary and Tertiary (including P removal). Sludge handling or treatment has not been considered and is treated as part of our Bioresources price control.

Each process stage is considered acceptable with a minimum headroom. Increases over the period to 2036 are assessed as being achievable for each process stage either by stages being enlarged or by the addition of process units as capacity is required. Where process stages have been extended previously, they may have reached a tipping point and no longer suitable at a larger scale, a change of process type may therefore be considered. Should more than one process be affected in this way, a pump away to another treatment works has been considered if there is a suitable receiving STW in close proximity.

Standard approaches have been used in the process choices and largely match existing processes on site. A modular approach has been adopted wherever possible to match the expected growth more closely with installed process capacity and therefore reduce exposure to less than expected growth predictions.

Each treatment works has been assessed to understand the requirement for any necessary land acquisition. The land may be needed for any new space requirements that arise due to new process units not being able to be accommodated within the existing works boundaries.

5.5 Assessing our submitted plan against cost efficiency approaches

We have considered the most appropriate approach to assessing efficiency using the framework set out in TMS33 Capital Cost, Efficiency and Assurance. We reviewed the Enhancement Case against each of the criteria to determine whether we could undertake modelling, unit cost comparisons or demonstrate efficiency through our bottom-up engineering estimates. We discuss each of the relevant criteria in our framework below.

The benchmarking process

Currently, Ofwat are planning to assess sewage treatment growth (STW) costs through a standalone econometric model separately from base expenditure. To inform this assessment, Ofwat commissioned Arup to provide a view on the feasibility and viability of conducting an assessment for sewage treatment (STW) growth in this way. Arup concluded that 'a standalone econometric model is a viable option for assessing growth at wastewater treatment works cost at PR24²³', however they also provided a recommendation for Ofwat to 'consider supplementing the econometric models with a cost adjustment claim process similar to that used at PR19²⁴'.

Following this view, Ofwat published their econometric base cost models for PR24 in April 2023 which confirmed: 'Arup concluded that a standalone econometric model may be a viable option for assessing these costs. We will continue to assess this. If a robust standalone cost model is not feasible, we may revert to including growth at sewage treatment works costs in the base cost models.'²⁵

It therefore appears that Ofwat has a preference for standalone modelling but is considering following the PR19 approach by integrating STW growth into base expenditure models.

We agree with Arup that STW growth can be modelled separately from base expenditure. Specifically, we agree that STW growth costs are sufficiently material to merit their own modelling and can be reasonably accurately separated from base expenditure²⁶. However, we also disagree that STW growth could be included in base expenditure models, because the drivers of STW growth are very different to the drivers of base expenditure. This is illustrated by Ofwat and Arup's own analysis. The variables that Ofwat is considering for its baseline modelling of sewage treatment are²⁷:

- Scale, measured by load
- Treatment complexity, measured by the percentage of load with ammonia permits $\leq 3\text{mg/l}$
- Economies of scale in sewage treatment, measured by three variables: (i) load treated in size bands 1 to 3, (ii) load treated in STWs that serve $\geq 100\text{k}$ people, (iii) weighted average treatment size

²³ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 44

²⁴ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 45

²⁵ [Econometric base cost models for PR24 final.pdf \(ofwat.gov.uk\)](#) Page 13

²⁶ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 37.

²⁷ [Econometric base cost models for PR24 final.pdf \(ofwat.gov.uk\)](#) Page 48,

By contrast, Arup identify the following variables as key drivers of STW growth²⁸:

- Capacity headroom
- Intensity of treatment, which they proxy through the load requiring tertiary treatment
- Change in population equivalent

As explained in the section on comparability below, we disagree with the variables used by Arup but the drivers that we consider appropriate are also different to those selected by Ofwat for the base expenditure modelling.

Since STW growth is driven by different factors to base expenditure, the inclusion of STW growth in base expenditure would lead to inaccurate modelling results. This means that the assessment of STW growth should be standalone but, for the reasons we discuss below, a standalone econometric model would also not be appropriate and therefore a deep dive is suggested.

Although we have not conducted a detailed review of the models proposed by Arup for STW growth, we find at least three significant issues with them. While our existing review has not allowed us to definitively conclude whether these issues are the direct results of the problems we discuss in the sections on comparability and availability, we nevertheless consider them to be important considerations for Ofwat to bear in mind when determining the approach that should be taken to STW growth. We also note that SVE have found several similar issues with Arup's modelling²⁹.

First, the results of Arup's modelling are very sensitive to the aggregation method applied to water company costs, whether Arup run the model over cumulative costs (effectively removing the time dimension from their panel dataset) or annual costs. This sensitivity arises in two areas:

- In the cumulative specification, Arup find that the variables used in their regressions are statistically significant and have the expected sign³⁰. However, in the annual specification very few of their coefficients are statistically significant. Indeed, in the 4 annual models estimated over the full 10-year dataset, only one has a statistically significant variable, and that variable is the constant³¹. This is unusual because the annual models have a sample size of 89 while the cumulative models have a sample size of 10³² and if an explanatory variable was to have a 'real' relationship with an outcome variable, one would expect it to be stronger with a larger dataset.
- The signs on the coefficients of the 'Volume WW change' and 'Load treated in WwTW size bands' change between the cumulative and annual specification.³³

In short, we are concerned by the fact that Arup has had to rely on a less granular (i.e., cumulative cost) model (with only 10 observations) to secure sensible and statistically significant regression

²⁸ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 39

²⁹ SVE, [SVE PRE Cost Adjustment Claims](#), Page 25-27

³⁰ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Section 5.4

³¹ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 72

³² [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 42, 72

³³ [Arup Growth related Costs Final.pdf \(ofwat.gov.uk\)](#) Page 42, 72

coefficients and consider that the poor performance of the annual model is likely indicative of a poorly specified model.

Second, the ratios of actual to predicted costs produced by Arup's models are very far from 1, ranging from 0.4 to 1.7 for one model, and 0.5 to 1.9 for the second model³⁴. Arup justifies this range with reference to the PR19 model for P-removals, which had a range of 0.5 to 1.4. It is unclear why the PR19 model is considered an appropriate benchmark, as the range implied by the PR19 model is also very substantial, although narrower than that of the STW growth models. Regardless, if the largest and smallest ratios are removed from the PR19 model, the range narrows substantially, to 0.71-1.17³⁵. By contrast, removing the largest and smallest ratios from the STW growth model only narrows the range to 0.7-1.7 for one model, and 0.7-1.6 for the other. This may indicate that the PR19 model was better at predicting actual costs than Arup's models.

Arup appear to acknowledge the limitations of these very high and very low ratios, as they subsequently suggest that a cost adjustment process could be added to the econometric benchmarking.³⁶

Third, we consider that performing STW growth analysis on a company-wide basis is inappropriate, because the drivers of STW growth costs are site-specific. Specifically, the costs that we are planning to incur will depend on which specific sites need to be upgraded (which will in turn depend on the impact of the above permitting changes, as well as other factors such as capacity headroom, expected load, etc.) and the costs of upgrading those sites (which will in turn depend on the size of the site, the expected future growth, etc.). The sum of all the efficient site-specific costs would then constitute the cost allowance that a company should receive. Due to this, benchmarking approaches that rely on company data rather than site-specific data will mis-state company allowances: this may be why the ratios of actual to predicted costs in Arup's modelling are so large.

The problems with a company-wide approach can be illustrated by considering a simplified version of one of Arup's models, where the costs of wastewater treatment are regressed on the Population Equivalent (PE) change served by the STWs³⁷. As company-wide measures of PE change will average across the PE change in areas served by individual STWs, two companies could have very similar average PE changes, but different cost requirements. For example, if expansion was generally needed when PE change for a given site was more than 5%, a company with an average historic growth of 4% but with very little site-specific variance (say uniformly distributed between 3.5 and 4.5%) would not require any STW growth CAPEX. By contrast, a different company with the same level of average historic growth, at 4%, but with a higher variance in site-specific growth rates (say uniformly distributed between 0% and 8%) would require CAPEX for the sites that have over 5% growth. Due to this, the predicted costs produced by the regression would mis-state STW growth costs for companies. Specifically, companies which have a high variance in site-specific PE change (meaning they are more likely to have some sites which require expansion) could be under-compensated by the model, while companies with a low variance in site-specific PE change will be over-compensated.

³⁴ [Arup_Growth_related_Costs_Final.pdf \(ofwat.gov.uk\)](#) Figure 9.

³⁵ Ofwat [Wholesale Wastewater Enhancement feeder model: P-removal](#), 'Analysis' sheet

³⁶ [Arup_Growth_related_Costs_Final.pdf \(ofwat.gov.uk\)](#) Page 44

³⁷ [Arup_Growth_related_Costs_Final.pdf \(ofwat.gov.uk\)](#) Table 11

We consider that Arup's acknowledgement of the potential need for cost adjustment is the result of underlying problems that lend STW growth better to a bottom-up deep dive than an econometric analysis. We discuss this further in the sections below.

Comparability

The main comparability-related problem with STW growth is that for AMP8, the key cost drivers for STW growth are going to be the historic and future regulatory changes implemented by the EA in addition to increases in population growth or treatment complexity. Arup have focussed solely on the latter two. This issue has also been explained by SVE and WSX in their cost adjustment claims³⁸. The specific regulatory drivers of STW growth costs are going to be that:

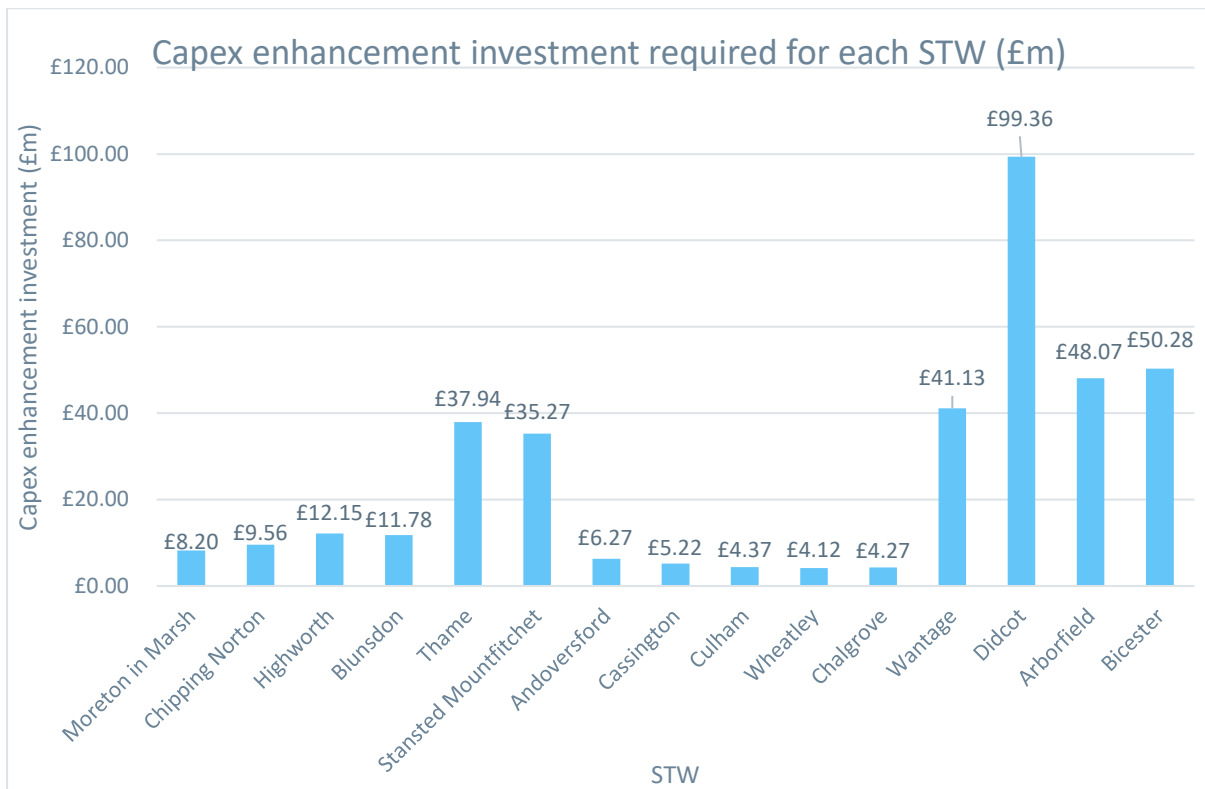
- From 2026, the EA is changing its assessment of compliance with Dry Weather Flow (DWF) consents, by considering that an STW is failing if it has breached its DWF permit levels in 3 or more of the previous 5 years. This will require water companies to become more cautious and expand their STWs in order to ensure compliance, causing a step-change in investment relative to what has happened in the past;
- As a result of the DWF changes, Flow to Full Treatment (FFT) permits will also need to be updated, which will again require water companies to consider whether their existing STWs are going to be compliant with the new FFT permit levels;
- As a result of the DWF permit changes, there may also be changes to other effluent quality limits, which will again prompt some STWs to expand.

Due to this, both our own and other water company historic data will not provide a reliable guide as to the future costs of STW growth. This is because previous AMPs did not have an exogenously determined step-change in the level of investment required in STWs, as will be the case in AMP8 due to decisions taken by the EA.

Furthermore, it is likely to be very difficult to build a model that adequately controls for all the factors that determine the costs of expanding STWs. As discussed above, these costs will be driven by the requirements of the new permitting regulations, the effects of which are not present in any historic data. However, they will also be affected by other factors, such as the costs of site expansion in particular locations and the expected growth in load. Figure 23 below shows that there is a high level of variation in the costs of expanding sites, with the costs of expanding our own sites ranging from £4m to over £90m. Due to the high level of variation in these costs, and the difficulty of robustly modelling these differences, it is likely that an econometric approach will not be appropriate.

³⁸ [SVE PRE Cost Adjustment Claims](#) Section 2. WSX, [Base cost adjustment claims](#).

Figure 23 - CAPEX for the 15 sites that we expect will require enhancement.



Data Availability

As discussed above, the key drivers of STW growth spend in AMP8 are likely to be the regulatory changes introduced by the EA, in addition to population growth and treatment complexity. As these changes are yet to be introduced, the impacts of these changes will not be present in any historical data. This will mean that it is not possible to use models based on historic costs to benchmark expenditure in this area.

Furthermore, even under Arup's approach to STW growth modelling (which ignores the above-mentioned regulatory drivers) it was not possible to identify data that could be used to estimate capacity headroom, one of the key drivers of STW growth spend according to Arup³⁹. The absence of such a key variable would likely lead to inaccuracy and potentially even bias in the econometric models and may be a reason why the ratios of actual to predicted costs in Arup's models are so far away from 1.

Due to this, we do not consider that either the standalone econometric model or the inclusion of STW growth costs and cost drivers in base modelling will be an effective methodology for assessing the cost of STW growth.

³⁹ [Arup_Growth_related_Costs_Final.pdf \(ofwat.gov.uk\)](#) Table 10

5.6 Considerations Ofwat should make when determining our cost efficiency

Based on the issues outlined above, we consider that Ofwat should only apply a methodology that considers the fact that the cost drivers in this area are site-specific, and that historic costs will not be good indicators of future costs due to the impact that the change in the EA's approach to DWF permitting will have on the need for sewage treatment works.

Furthermore, we would advise Ofwat to review the theoretical and empirical robustness of the econometric models proposed by Arup, particularly regarding our view that a company-wide approach is not appropriate and that the models have been calibrated on a very small sample, are sensitive to small changes (switching from a cumulative to an annual model) and perform poorly in predicting actual costs.

5.7 Recommendations

We believe the only way for Ofwat to effectively assess costs for sewage treatment growth at PR24 would be to carry out a deep dive exercise on our proposed costs. This ensures that the individual cost elements are considered and given appropriate cost allowances to effectively manage growth in our region. This also allows for a site-specific bottom-up estimate to be produced.

6 Customer protection

We propose implementing a Price Control Deliverable (PCD) to safeguard customers from non-delivery of sewage treatment upgrades to cater for growth for this multi-period enhancement.

6.1 Price control deliverable

We summarise our proposed PCD parameters in Table 21, and following this, set out our proposed incentive payments.

Table 21 - Price Control Deliverable mechanism

Scheme delivery expectations	
Description	<p>Upgrading sewage treatment works (STWs) to increase capacity for forecast population growth. The company has identified 15 STWs in need of capacity upgrades to meet the needs of 96,709 population equivalent (PE). PE forecasts can be subject to change as new housing development opportunities are identified, therefore the exact sites upgraded may vary to ensure forecast PE is accommodated at the most necessary sites.</p> <p>Upgrades includes activities such as:</p> <ul style="list-style-type: none"> • Expanding the STW footprint and capacity • Constructing a storm wetland • Transferring flow to an alternative STW.
Output measurement and reporting	<p>Extent of new capacity for forecast population equivalents, reported to zero decimal places.</p> <p>Report annually Population Equivalent capacity delivered through APR, with parallel reporting on breakdown of PE.</p> <p>The company will report in parallel on the sites that commence at the end of AMP8 for completion in AMP9.</p>
Conditions on scheme	<p>The company will deliver the additional capacity for the forecast increase in PE but will adjust the number of sites to reflect the latest forecasts.</p> <p>Excludes interim Totex for schemes that will begin in AMP8 but deliver the additional PE in AMP9.</p>
Assurance	<p>The company must commission an independent, third-party assurer to assure, to our satisfaction, that the conditions below have been met and the outputs have been delivered.</p>

Deliverable	Unit	Forecast deliverables (cumulative)					AMP9	
		2025/26	2026/27	2027/28	2028-29	2029/30	2030/31	2031/32
Cumulative PE capacity delivered	Number	-	-	9,451	13,994	53,887	53,887	96,709

PCD payment

We propose to calculate our end of period PCD payment rate based on an average cost:

PCD payment unit	Calculation	PCD payment (£m)
£m per PE	$355.15 \div 53,887$	0.00659

We have calculated the PCD payment to reflect the works that will be completed in AMP8. We will require an extension of the PCD at PR29 to protect customers for the PE that will be delivered in AMP9, along with any new sewage treatment growth sites identified. Accordingly, we have calculated the Totex sub-total for the sites that will deliver PE improvements in AMP8.

We understand Ofwat will apply cost sharing as part of its draft determinations and the end of period reconciliation will occur with the Totex reconciliation models, including the time value of money adjustment.

We propose the PCD payment should be calculated from the difference between forecast 2029/30 deliverable and actual 2029/30 deliverable. As per Ofwat's guidance, IN 23/05, we consider where the difference is due to schemes that are going to be delivered early in AMP9, this amount should be excluded.

6.2 ODI impacts

The principal objective of this enhancement investment is to ensure future compliance with our sewage treatment works permit conditions and allows us to operate in a way that protects the environment.

We have estimated that the impact of our Enhancement Case on meeting our Performance Commitment targets is small. In addition, the ODI rates combined do not meet the PCD threshold for us to consider PCs as an alternative to a PCD.

We consider the following Performance Commitments are related to this case but do not offer sufficient protection for late delivery:

- **Discharge permit compliance** – This Performance Commitment is designed to ensure that we operate and maintain our treatment works so that discharges into rivers meet our permit parameters. This Performance Commitment ensures that we deliver timely upgrades so that our sewage treatment works do not fail their permit conditions due to growth and is an indicator of appropriate capital maintenance and good operational practises.
- **Storm Overflows** – This Performance Commitment is designed to reduce harm from storm overflows, protect public health and improve people's enjoyment of the environment. It, among other things ensures that we upgrade our sewage treatment works so they are able to deal with the additional flows without increasing the frequency of storm discharges.
- **Pollution incidents (total and serious)** – These Performance Commitments are designed to incentivise companies to reduce the number of times that harmful substances impact waterbodies. Pollution incidents can occur at sewage treatment works due to asset failure, operator error or due to a lack of robust capacity to deal with the incoming flows and load. One of the most serious of these is the discharge of sludge from settlement tanks due to

flows greater than the design of the sewage treatment works being experienced for prolonged periods. Investing for growth at the appropriate time will help to prevent this happening.

6.3 Time incentive (TI)

For annualised customer protection for late delivery, we propose a time incentive payment rate based on the PCD payment:

TI payment unit	TIM calculation	TI payment (£m)
£ per late PE	PCD payment x 0.035	0.00023

We propose the time incentive payment should be calculated from the difference between forecast deliverable and actual deliverable for each year of the AMP.

7 Adaptive planning

Adaptive planning provides a framework for exploring how sensitive a plan may be to alternative scenarios, risks and uncertainties, to ensure that the plan is flexible and resilient to different futures. The approach identifies where thresholds and trigger points for alternative adaptive pathways exist, providing the basis for monitoring and review of the strategy and interventions, mitigating the risk that short-term decision making might reduce or jeopardise choices in the future.

Adaptive pathways provide clarity on the decisions that may need to be taken to address future uncertainties, and agility/flexibility to respond to the latest data; for example, climate science, population growth, or understanding and innovation in the range and type of options that may be deployed. This avoids the risk of being 'locked-in' to specific inflexible solutions and helps communicate and make more timely decisions on investment.

Adaptive planning is central to Ofwat's Long Term Delivery Strategy (LTDS) guidance. We have followed this guidance by prioritising no or low regret activities, demonstrating the benefits of planned investment against future uncertainties and risks; and deferring investment until the benefits are more certain. Our approach to adaptive pathway planning has considered:

- A range of plausible futures
- A broad range of feasible solutions that could be deployed to meet the future scenarios
- Thresholds and trigger points that determine alternative decisions or pathways
- A framework for monitoring against those thresholds and trigger points
- Those solutions that are common to all futures and which may form the core of the strategy formulation
- The range of alternative decision or pathways and the potential trade-offs and risks of investing in emerging options sooner or later

The population in our area is forecast to increase by 17% from 2025 to 2050. In order to meet our 100% sewage treatment works compliance ambition, we need to invest to provide additional treatment capacity to accommodate this growth.

Our strategy is to invest just ahead of growth forecasts for larger sites. This is because it takes time to put in place upgrades and extensions for these types of sites. For smaller sites we can be more reactive and invest 'just in time'. Overall, this is a low / least regrets approach as it avoids excess capacity, while ensuring capacity needs can be met in time. Key solutions to deliver our strategy are typically site extensions or upgrades to support intensive treatment processes.

Investing in growth is part of a hierarchy of measures to ensure sewage works remain compliant. This requires both base and enhancement investment (figure 1). We only require additional investment via enhancement funding where our process modelling shows that we have insufficient existing capacity/headroom after asset health and process optimisation considerations.

It takes time to put in place upgrades and extensions at larger sites and we pace our delivery to be just ahead of growth forecasts, for smaller sites the pace is more reactive. Our larger sites will

require upgrades in the 2030-35 period when our investment over time will peak. In addition, spend between 2025 and 2040 is significantly greater than between 2040 and 2050 this is because:

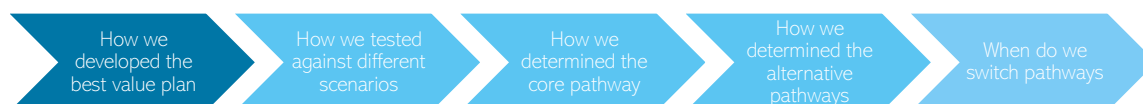
- Delivery of upgrades at our largest STWs are required to comply with updated guidance from the Environment Agency related to DWF and FFT.
- Our best value pathway represents a 'no regrets' plan for 2025-30, while we monitor future demand, technology and climate change scenarios.
- If we experience high growth, upgrades will be required to many of our larger STWs in the 2030-35 period.
- By 2040 we will have invested to be more resilient to growth and to have upsized many of our STWs to deliver other benefits i.e. storm overflows.

Table 22 - Best value pathway⁴⁰

STW Compliance	2025-30	2030-35	2035-40	2040-45	2045-50
PE increase	498,123	378,912	466,522	517,119	565,667
Capex (£m)	354.82	716.6	351.2	52.0	76.9

The chevron graphic below shows how we have structured our narrative on adaptive planning. Full details can be found in Appendix G⁴¹ of our DWMP.

7.1 How we developed our best value plan



A best value plan is defined within the regulatory guidelines for water resources planning and is described as one that, 'considers factors alongside economic cost and seeks to achieve an outcome that increases the overall benefit to customers, the wider environment and society'⁴². We have utilised this approach in developing our optioneering stage via the DWMP framework.

A best value approach therefore differs from a cost-benefit analysis in that it considers a broader range of factors, rather than just cost and monetised benefit. Some wider benefit factors cannot be easily monetised, for example natural capital, biodiversity enhancement and wellbeing, hence the best value assessment is based on a benefit scoring system. The selection of a best value plan takes into consideration many competing factors, opinions and influences (for example, encompassing technical, environmental, social and economic aspects). A full account is provided in our DWMP optioneering appendix⁴³.

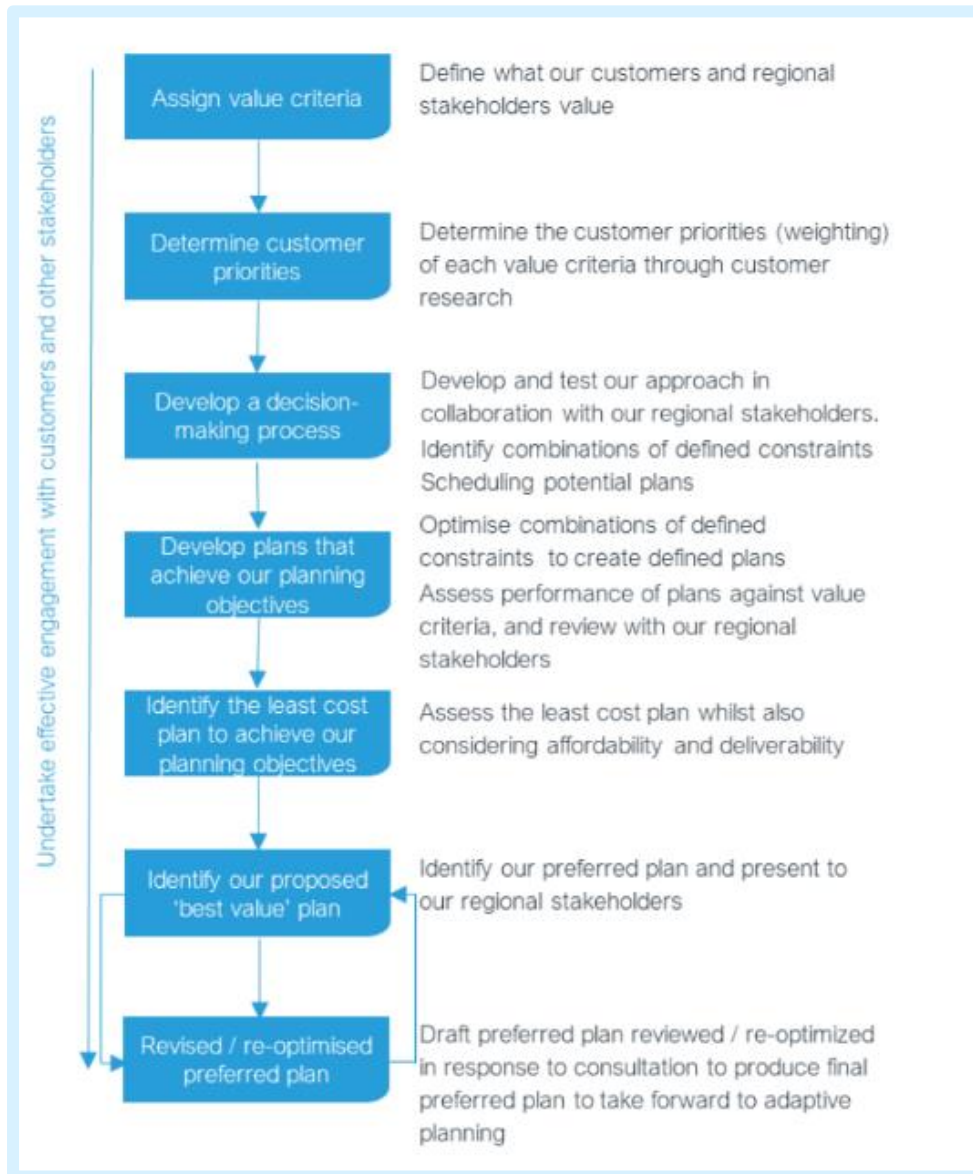
⁴⁰<https://www.thameswater.co.uk/media-library/home/about-us/regulation/drainage-and-wastewater/data-tables.xlsx>

⁴¹ [DWMP – Appendix G: Adaptive Pathway Planning](#)

⁴² [Water Resources Planning Guidelines](#)

⁴³ [DWMP Technical Appendix Options Development and Appraisal](#)

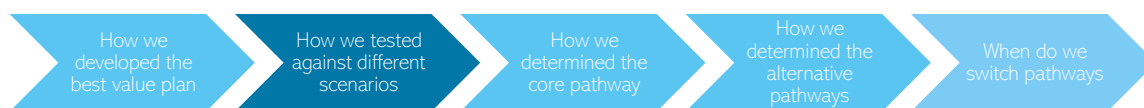
Figure 25 below shows the steps we have taken in deriving our best value plan.



We have developed a best value plan, informed by the strategic DWMP, but built bottom up in the near term, via assessment of additional capacity required at our 354 STWs. The key aspects of our best value plan are:

- We have considered a broad range of options, with 11 different solution types in our unconstrained optioneering phase. These option types were agreed with stakeholders as part of the optioneering stage of DWMP.
- We have narrowed this down to a hierarchy of 4 key options as illustrated in Figure 17
- We have included a wide range of benefits in our assessment of best value options including; wellbeing, carbon, biodiversity, greenhouse gas emissions and traffic disruption
- We have selected a plan that scores highest in our value criteria framework used in DWMP and in the near term the optimum in our public value framework (see Section 4.8)
- Our plan has considered the role of base with benefits from asset maintenance and process optimisation built into our process modelling such that we only request additional funding when our models show that we cannot offset growth via base.

7.2 How we tested against different scenarios



We followed Ofwat’s LTDS guidance by considering ‘common reference scenarios’ to test against our preferred plan. The common reference scenarios are a set of benign and adverse scenarios covering four material drivers of uncertainty (climate change, technology, demand and abstraction reductions). We focussed on demand and technology as they are likely to have the most significant impact on our solutions for sewage treatment growth. Abstraction reductions will not impact sewage treatment growth solutions in any significant way.

Assessment of the impact of climate change on STWs would require consideration of associated regulatory changes to permitting requirements (e.g., particularly in response to low flows in receiving waters). The impact of our solutions will be a function of whether changes are permanent or temporary (for example, in response to a weather event). Permanent changes could lead to effluent discharge quality for downstream works to be re-evaluated by the Environment Agency with resulting requirements for treatment permits to be updated to reflect the changes. Temporary changes are difficult to predict and by their nature are potentially short-term. In both case the impact will be site specific and dependant on regulatory framework changes. We have therefore not assessed the best value plan for sewage treatment growth against the climate change common reference scenario and focussed on the impact of the demand and technology scenarios. Research into potential impacts is needed to enable us to assess scenarios within our planning framework. Therefore, further consideration of climate change scenarios and their impact on our sewage treatment works has been deferred to PR29.

Table 23 summarises how we defined the forecast for the different scenarios.

Table 23: Detail of different scenarios used in testing.

Common reference scenario		How we changed our preferred plan to represent common reference scenarios
Demand	High and Low	<p>Forecasts used:</p> <ul style="list-style-type: none"> • Plan-based: the use of forecasts based on Local Planning Authority data relating to house building trajectories. • Office for National Statistics: the 2018-based population projection was used which is based on mid-year population estimates and assumptions of future fertility, mortality and migration <p>When considering the preferred plan at a company-wide level, Local Plan forecasts provide a high (adverse) scenario, but when considering at a catchment level, the opposite may be true. Therefore, we separately assessed every catchment against Local Plan and Office for National Statistics forecasts, to create a new adverse (high) or benign</p>

		(low) forecast, depending on which forecast was used in our Best Value plan
Technology	Faster and slower	The main impact of the benign and adverse scenarios is the impact on wastewater volumes received at STWs which will vary depending on the speed of penetration of smart metering. We examined those sites earmarked for investment in our best value plan which appeared to have a high risk of becoming non-compliant by 2050 and calculated the impact of the scenario on headroom under Dry Weather Flow permits. Where a scheme was needed, we derived a factor to adjust costs of achieving compliance.

What we learned from our testing of the best value plan

Results from our testing of the best value plan are summarised in Figure 24. The benign demand scenario (low growth) has a significant impact on our solutions to address sewage treatment growth. A greater level of investment is needed in all adverse scenarios compared to benign scenarios.

There are very minor differences across all scenarios, up to 2035. The technology scenarios have a limited impact when compared to our best value plan. We have assessed emerging wastewater technologies e.g. Nereda® and the impact they could have on our long-term plan. The benefits of these technologies have the potential to be significant at our very largest STWs, due to a lack of available land. However, the benefit is likely to be more borderline at our smaller, more rural or suburban STWs where land availability is less restrictive. Our DWMP (Appendix G) includes detailed adaptive pathway analysis for our larger London STWs, including the impact of new technology. We have therefore found that at a programme level the largest technology impact on our sewage treatment growth investment is likely to come from smart water meter penetration as this reduced per capita consumption and therefore the volume of wastewater required to be treated, this has a direct impact on dry weather flow and flow to full treatment permit condition compliance.

Figure 24 - Comparing our best value plan to the scenarios we tested.

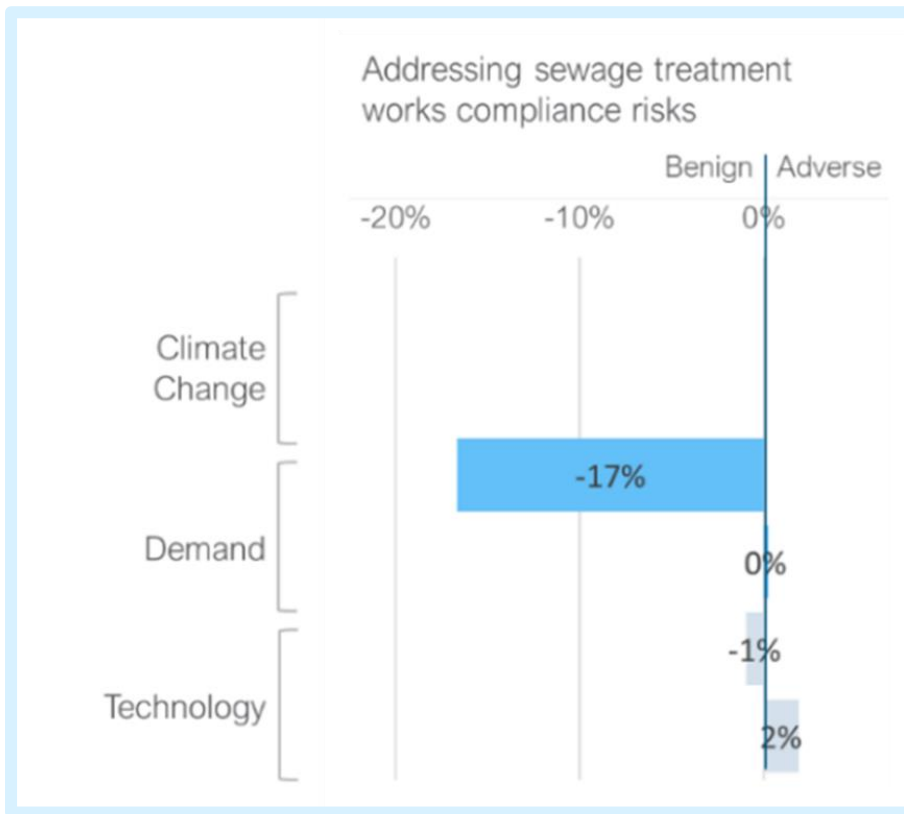


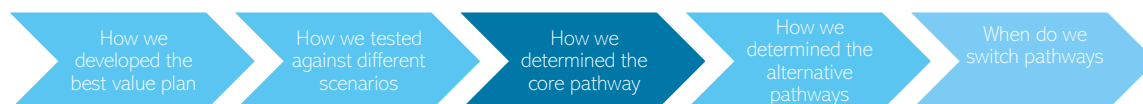
Table 24 shows the impact of individual scenarios on the package of solutions within our best value plan and the overall cost. The impact of both demand (growth) and technology (mostly smart meter penetration) scenarios can be seen after 2030 as the assumption is that in the short-term the plan-based demand scenario is common to both demand scenarios as it includes development sites being promoted by Local Planning Authorities and/or which have planning permission.

In contrast the impact of the technology scenarios is relatively small, noting that these impacts also start to be felt from 2030. This is because of the relatively small effect on expenditure of differing rates of smart metering penetration on demand compared to underlying population and economic growth.

Table 24: Impact of scenarios on Best Value Plan – Sewage treatment growth.

Investment	Planning horizon	Best Value Plan (£m)	Demand Low (£m)	Demand High (£m)	Tech Faster (£m)	Tech Slower (£m)
Sewage treatment growth	2025-2030	355.15	355.15	355.15	355.15	355.15
	2030-2035	716.56	507.33	720.58	711.97	734.57
	2035-2040	351.23	297.18	351.23	344.28	361.04
	2040-2045	52.01	56.69	52.01	50.36	52.78
	2045-2050	76.89	71.86	76.89	75.24	78.87
	Total	1,551.51	1,287.88	1,555.53	1,536.67	1,582.08
	The scope (and cost) of solutions is the same or more than the best value plan					
	The scope (and cost) of solutions is less than the best value plan					

7.3 How we determined the core pathway



Based on the results of our testing of the preferred plan against common reference scenarios, we then determined a range of plausible futures. Each common reference scenario represents a ‘plausible extreme’ However, if combined, they would represent a very low probability scenario. Therefore, when assessing the range of plausible futures, we avoided combining high or low drivers of uncertainty. This aligns with Ofwat’s LTDS guidance.

We used the same approach to identify a ‘core adaptive pathway’. This is a pathway that drives a programme of no and low regret investments, as per Ofwat’s LTDS guidance. For most solutions in our preferred plan, the benign demand scenario generated the no and low-regret programme of investments, except for three sewage treatment works, where the benign technology scenario resulted in no/low-regret investment. Therefore, the core scenario was assessed by selecting the no/low-regret investment for each preferred solution, across the demand and technology scenarios, not a combination of benign scenarios only for each driver of uncertainty. The core pathway solutions include allowances for monitoring, investigations and other activities to ensure other options can be efficiently implemented should the need to switch pathways arise in the future

Table 25 shows the programme of investment selected in the best value plan compared with the core pathway. The table shows there is a significant difference in sewage treatment works investment between the core and other pathways from 2030 onwards. Beyond 2030, we consider our preferred plan pathway to be the best assessment of future uncertainties, based on the data that has informed our current forecasts. We have devised alternative pathways to ensure that our ambition can be met across the range of plausible futures.

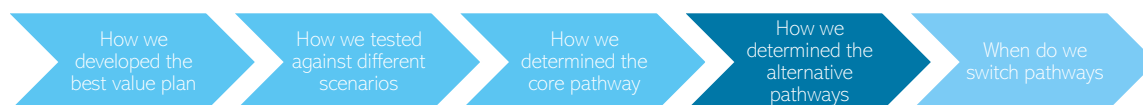
Table 25 - Comparing the best value plan to the core pathway.

Investment	Planning horizon	Best Value Plan (£m)	Needed in all scenarios	Needed in most scenarios	Needed to keep future options open	Needed in the short-term	Core Pathway (£m)
Sewage treatment growth	2025-2030	354.82	Yes	No	No	Yes	354.82
	2030-2035	716.56	No	Yes	No	No	507.33
	2035-2040	351.23	No	Yes	No	No	297.18
	2040-2045	52.01	No	Yes	No	No	56.69
	2045-2050	76.89	No	Yes	No	No	71.86
	Total	1,551.51					1,287.88

	The scope (and cost) of solutions is the same as in the best value plan
	The scope (and cost) of solutions is less than the best value plan
	The scope (and cost) of solutions is more than the best value plan

*2022/23 price base

7.4 How we determined the alternative pathways



Having established our best value plan and core pathway we developed and tested alternative pathways that meet our long-term ambition over a range of plausible futures. For simplicity we included our most adverse pathway for comparison which uses a high demand scenario, adjusted to reflect a central forecast for the technology scenario (See Table 26).

Table 26 - Description of alternative pathways.

Pathway	Decision/Trigger Dates	Description
Best Value Plan		The plan which we believe best addresses future uncertainties.
Most adverse	2030-2035	A high demand scenario, adjusted to reflect a central forecast for the technology scenario.
Core Pathway	2030-2035	A low demand scenario.

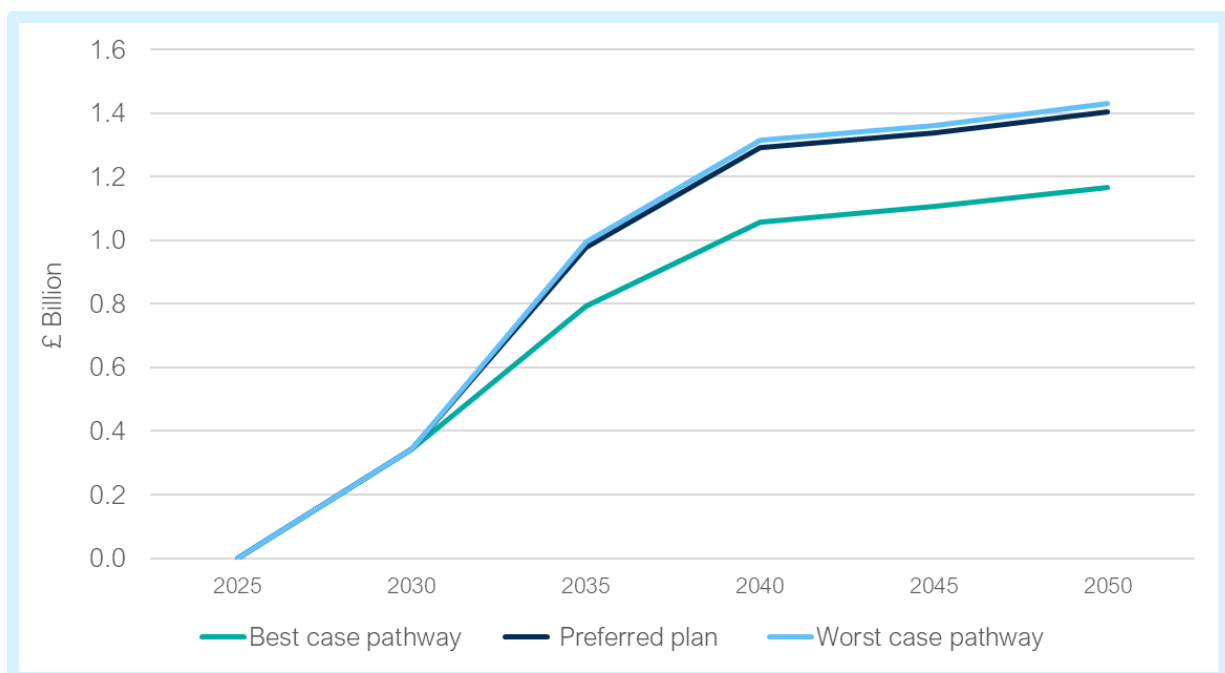
When considering our sewage treatment growth investment, the key factor ‘triggering’ a move to an alternative pathway is change in demand forecasts. Adaptive planning for our sewage treatment works is generally at a more granular level than for our networks. Our ‘demand benign’ pathway has been generated using the Office for National Statistics (ONS) 2018 based population projection. We keep demand forecasts under constant review and plan investment accordingly. Our trigger point for the alternative pathway (Trigger A) has been set at 2030. The plan-based

population forecast (as used in our best value pathway) tend to be relatively accurate for the first 5-10 years of a plan for two key reasons:

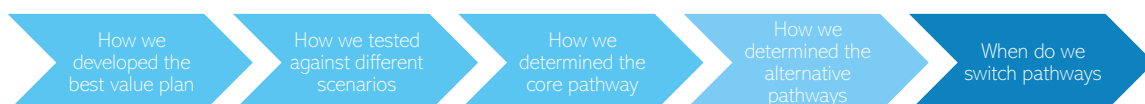
- It is based on specific identified development sites, which either have planning permission or have been allocated for development by the Local Planning Authority
- Unlike the ONS population forecast (demand benign pathway), the plan-based forecasts are location specific. The ONS 2018-based sub-national population projection is produced at a Local Authority level and therefore is not granular enough to plan wastewater treatment upgrades. For example, South Oxfordshire Local Authority is served by over 30 STWs, including some high growth areas like Culham and Chalgrove. The ONS population forecast applies population growth based on natural change (births, deaths and migration) and is evenly dispersed across the entire Local Authority area.

Our sewage treatment growth upgrades are designed to be delivered 'just in time' i.e. constructed ahead of growth but only when firm commitment of development delivery has been established. This ensures that capacity is not delivered which is un-necessary or includes stranded assets. We also ensure that modular upgrades are used for long-term growth areas or those which span multiple AMPs. This allows additional capacity to be added in phases as and when new houses are constructed.

Figure 25: Impact of different futures on our investment profile (addressing sewage treatment works growth).



7.5 When do we switch pathways



Strategic decision points are generally driven by planning requirements that may or may not be directly related to compliance risks. For example, an indirect water reuse scheme utilising crude sewage that currently flows to Mogden sewage treatment works is being considered within the context of our Water Resources Management Plan (WRMP). Implementation of the scheme will have a direct benefit to compliance risk (decrease) at Mogden sewage treatment works; however, the decision to implement the scheme will be a function of the WRMP need rather than as a direct option to manage any compliance risk within the context of the DWMP.

Technology advances, such as innovation in new treatment processes, enable a change to an alternative delivery mechanism. For example, advances in low-footprint treatment technology, or the ability to achieve large scale energy generation from wastewater. We have identified a number of dependencies where emerging or developing technologies may provide more effective and efficient solutions to our wastewater challenges.

Changes in forecasts for drivers of uncertainty, such as growth and climate change, will also impact compliance and performance. To manage the inherent uncertainty in forecasts we have developed options / delivery mechanisms that can provide flexibility to deal with risks under alternative future scenarios.

Figure 26 - Alternative pathway diagram (addressing sewage treatment works growth).



The investment profile of the alternative pathway, compared to our preferred plan, is shown in Table 27.

Table 27: Cumulative cost of the alternative pathway (addressing sewage treatment works growth) (£m).

Pathway	Up to end 2030	Up to end 2035	Up to end 2040	Up to end 2045	Up to end 2050
Preferred Plan	354.82	1071.38	1422.61	1474.62	1551.51
Switch to the core pathway in 2030	354.82	862.15	1159.33	1216.02	1287.88

Our preferred plan comprises a range of different types of solutions of different sizes, dispersed across our catchments. This provides the basis for developing an adaptive response to a range of different futures.

Our sewage treatment growth solutions generally have a long asset life, but we have considered emerging technology such as Integrated Fixed Film Activated Sludge (IFAS) which provides a greater degree of flexibility to delivering additional biological capacity.

7.6 How we will monitor pathways

Growth Forecasts

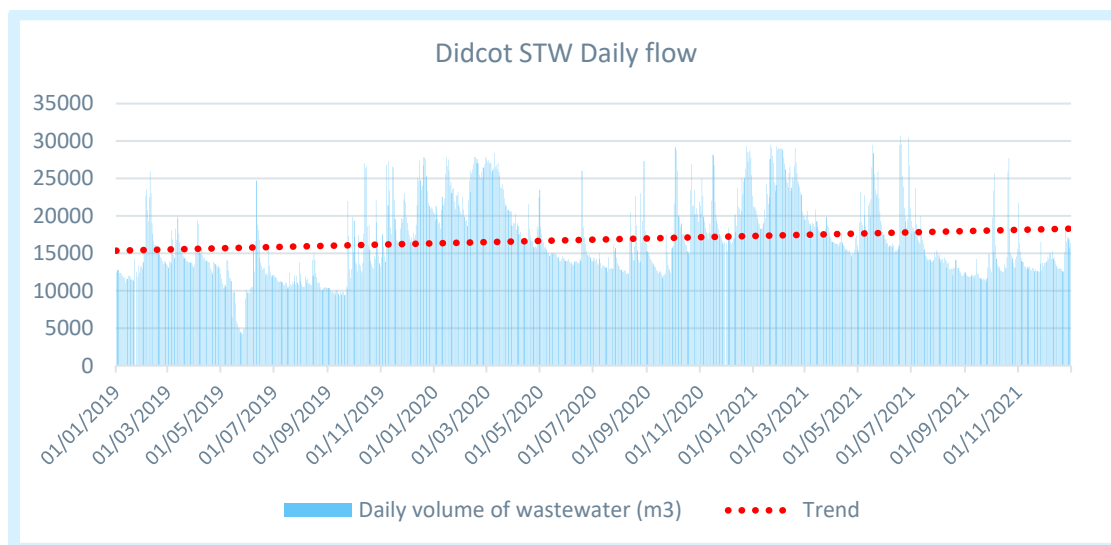
Our plan-based growth forecast is updated annually. The most up to date Local Planning Authority housing trajectories are provided by Edge Analytics via their Consilium database. The impact of updated forecasts is assessed for each catchment.

The ONS population forecast is updated as and when new sub-national forecasts are released.

Volume of wastewater treated

The volume of wastewater treated each day is monitored and analysed for assessment of DWF compliance. This data is used to inform our base DWF on which predictions of how it will change in the future are based. The data can also be used to highlight STWs with an upwards trend. Figure 27 is an example for Didcot STW showing an increasing trend in the daily volume of wastewater treated. A detailed assessment is required to understand the trend as growth, weather, water consumption and demographics e.g., pandemic lockdowns can all have significant impacts.

Figure 27 - Didcot STW daily flow.

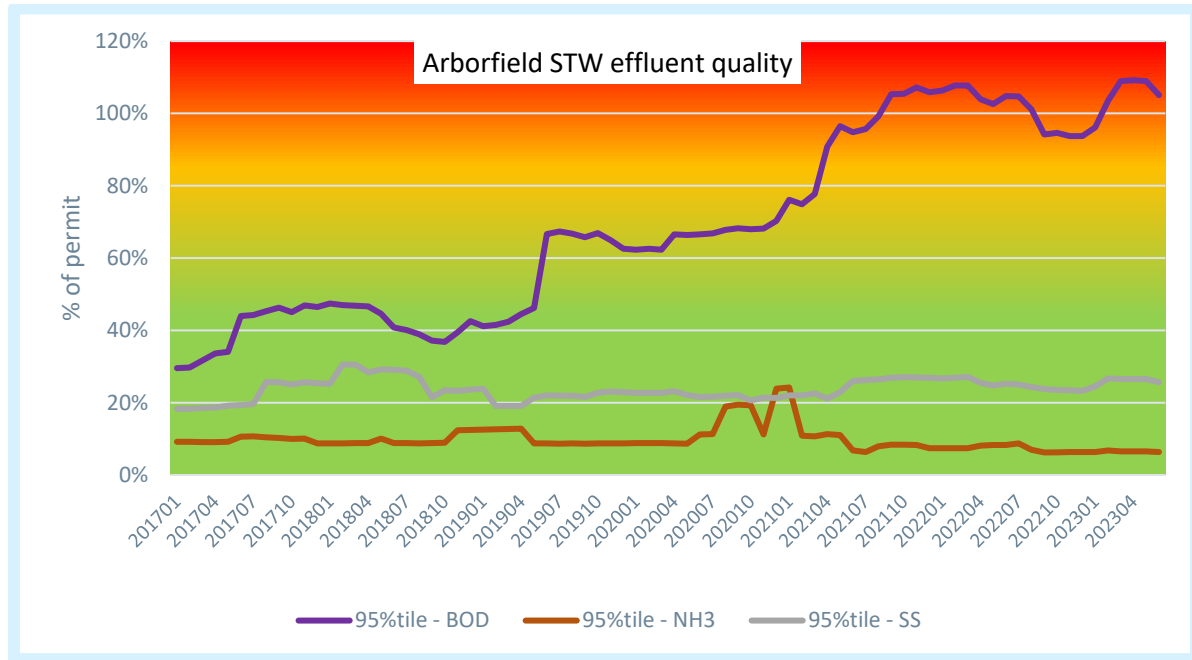


Effluent quality discharge compliance

Regular treated effluent samples are taken at our STWs, both regulatory samples which are submitted to the Environment Agency, and operational spot samples. These sample results can build a long-term trend of the performance of our STWs. Figure 28 shows the performance of Arborfield STW for the last 6 years. The individual samples have been converted to a monthly average as a percentage of the permit limit. The deteriorating trend can be clearly seen for Arborfield STW.

This data is reviewed monthly, and analysis undertaken as growth, weather, demographics and asset deterioration can all have significant impacts. Current poor performance at Arborfield STW is being addressed separately as part of our base plan in AMP7 to ensure that AMP8 enhancement expenditure is not used to address past issues.

Figure 28 - Arborfield STW effluent quality.



Base PE assessments using flow and load.

The 'base' or current PE served by each STW is reviewed on a rolling basis, on average every three years. This process involves a detailed comparison of the actual measured amount (flow) and strength (load) of the incoming sewage against the theoretical population reported by the ONS in their mid-year estimate. The assessment aims to agree a base PE from which forecasts can be based on. The crude sewage samples are converted to a PE based on industry standard grams per person. For example, a crude sewage sample may have an ammonia concentration of 200 mg/l, this is multiplied by the measured total volume received to calculate the total ammonia load received for that day. This can then be divided by the industry standard grams produced per person per day to produce an ammonia PE for that day. The trend can then be analysed, as shown in Figure 28.

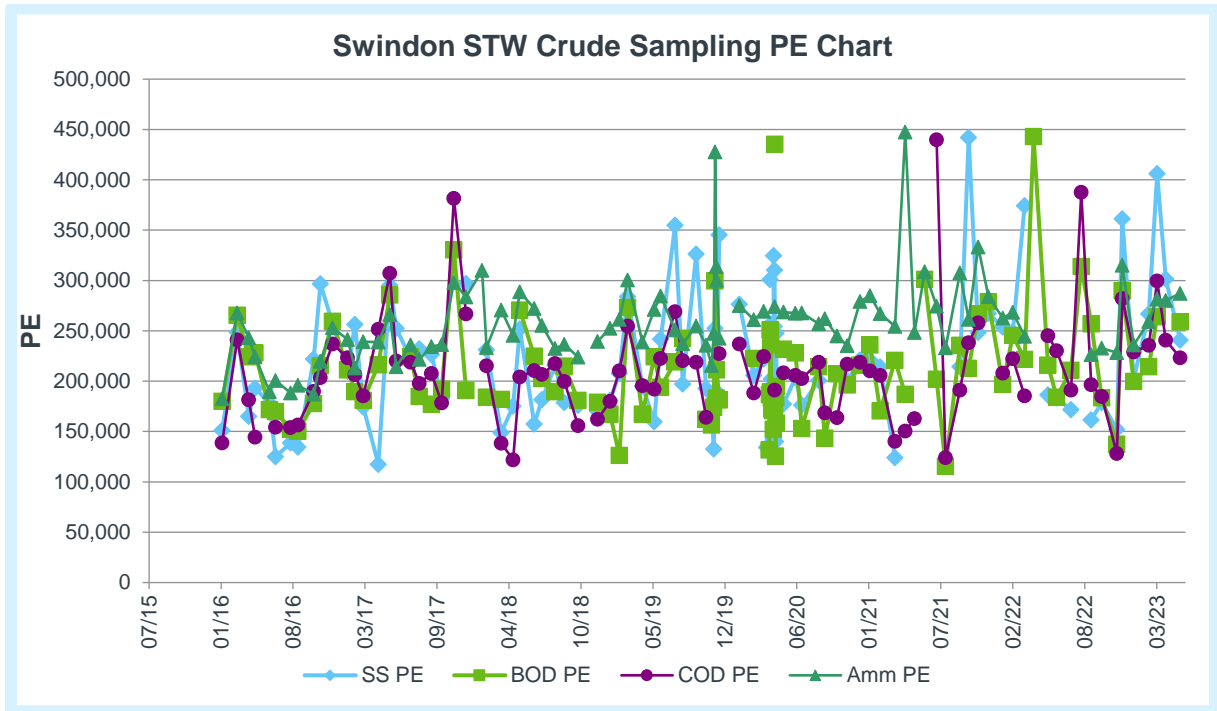
The base PE for Swindon STW was last reviewed in June 2023, the measured average PE was calculated as 224,450. This was compared to the theoretical PE of the catchment based on the following constituents:

- ONS 2021 mid-year population estimate for Swindon STW catchment (build from census output area population data)
- Short-term residents
- Irregular migrants
- Overnight tourists

- Trade effluent
- Cess and Septic

The total of these constituents gives a PE of 229,476. There is therefore a clear alignment between the measured PE and theoretical PE. This 'base' PE can be used to monitor the pathway for individual STWs.

Figure 29 - Swindon STW crude sewage PE.



Annex 1

Further detail of how feasible options were considered in Options assessment.

Hierarchy of feasible options	Option Type	What conditions will make this viable as an option / part option
Can we modify / optimise the existing asset base to meet the new regulatory requirements	Optimise	<p>Low growth as a percentage</p> <p>Process units have the capability to meet or get close to anticipated new consent – ref Asset Standards</p> <p>Existing site performance indicates performance is anticipated growth flows and consents</p>
Could we deliver a Nature Based Solution	NBS	<p>Small sites <up to 2000pe?></p> <p>Permits aligned to capabilities of nature based solutions</p> <p>Land availability – either currently owned or acquisition probable at sensible cost</p> <p>Where this is potential it is compared with the on-site solution (optioneering)</p>
Could we transfer to another site > potentially transfer could be lower cost	Transfer Flow	<p>Only suitable for small sites / small growths in population</p> <p>Receiving site has pe 10X greater than source site and can accommodate additional flows without major investment, i.e. it has the hydraulic and process headroom</p> <p>Receiving site <10km, ideally <5km</p> <p>Where this is potential it is compared with the on-site solution (optioneering)</p>
Is there space on site for the additional processes > develop in existing site boundaries	On site 'traditional'	<p>Check always done > if not available we move to acquisition</p>
Can we acquire land as opposed to building more intensive, higher WLC solutions > solution based on land acquisition	Acquisition	<p>PR24 based on the assumption that we can acquire land, i.e., we can see land that is used for additional lower WLC process solutions</p>
Install small footprint, intensive, high WLC solutions.	intensify	<p>Option of last resort – not proposed anywhere in Growth Programme</p>

Site	Evaluation Criteria*						comments
	Optimise	NBS	Transfer	On-site	Acquisition	Intensify	
Bicester	No	No	No	Yes	n/a	n/a	
t.b.c	no	yes	no	yes	no	no	

