Dŵr Cymru
Welsh Water

Enhanced Investment Case: WSH69-PE06 - Increasing Wastewater Treatment Capacity and Stormwater Storage for Peak Flows

Contents

Executive Summary

This investment will increase the Flow Passed Forward (FPF) requirement at Wastewater Treatment Works (WwTW) by increasing the hydraulic capacity at sites the ensure the relationship between permitted DWF, FPF and storm tank capacity is achieved. The objective of this is to reduce the frequency, volume, concentration and duration of storm sewage overflow discharges into receiving waters and contribute to the delivery of the Water Framework Directive (WFD) objectives. Whilst these sites are currently compliant with existing permits, these permits have now been deemed by Natural Resources Wales (NRW), to provide insufficient protection to the environment. The interventions outlined below will prevent the dry day operation of WwTW overflows and increase the degree of headroom within the permitted FPF to allow storm tanks to be emptied as soon as reasonably practicable following storm events under the W_U_IMP5 in the National Environment Programme (NEP). There are no comparable investment sites in the WINEP.

This investment will also look to increase storm tank capacity to provide a greater degree of storm storage and increase settlement duration at WwTW's. This covers WwTW's where NRW have deemed the existing permitted settings and requirements to be insufficient to adequately protect the environment. The additional storage to be provided will be sized in line with NRW / EA guidelines by calculating either the volume of storm storage required for the resident PE at 68 l/h/d or 2 hours retention of peak flow to storm, whichever is the smallest. This follows the W_U_IMP6 driver in the NEP and WINEP.

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

- Need for enhancement investment (7 sections).
- Best option for customers (8 sections).
- Cost efficiency (3 sections).
- Customer protection (3 sections).

Need: This Enhancement Case is driven by regulatory requirements following the W_U_IMP5 and W_U_IMP6 driver methodology as shown in the latest versions of the NEP and WINEP set out by Natural Resources Wales (NRW) and the Environment Agency (EA).

- W_U_IMP5: to increase the FPF flow requirement at WwTW's that were identified as having low FPF / DWF ratios, to prevent the dry day operation of WwTW's storm overflows.
- W_U_IMP6: to increase the storm tank capacity at WwTW's to reduce the frequency, duration and concentration of discharges from storm tanks that have low permitted volume.

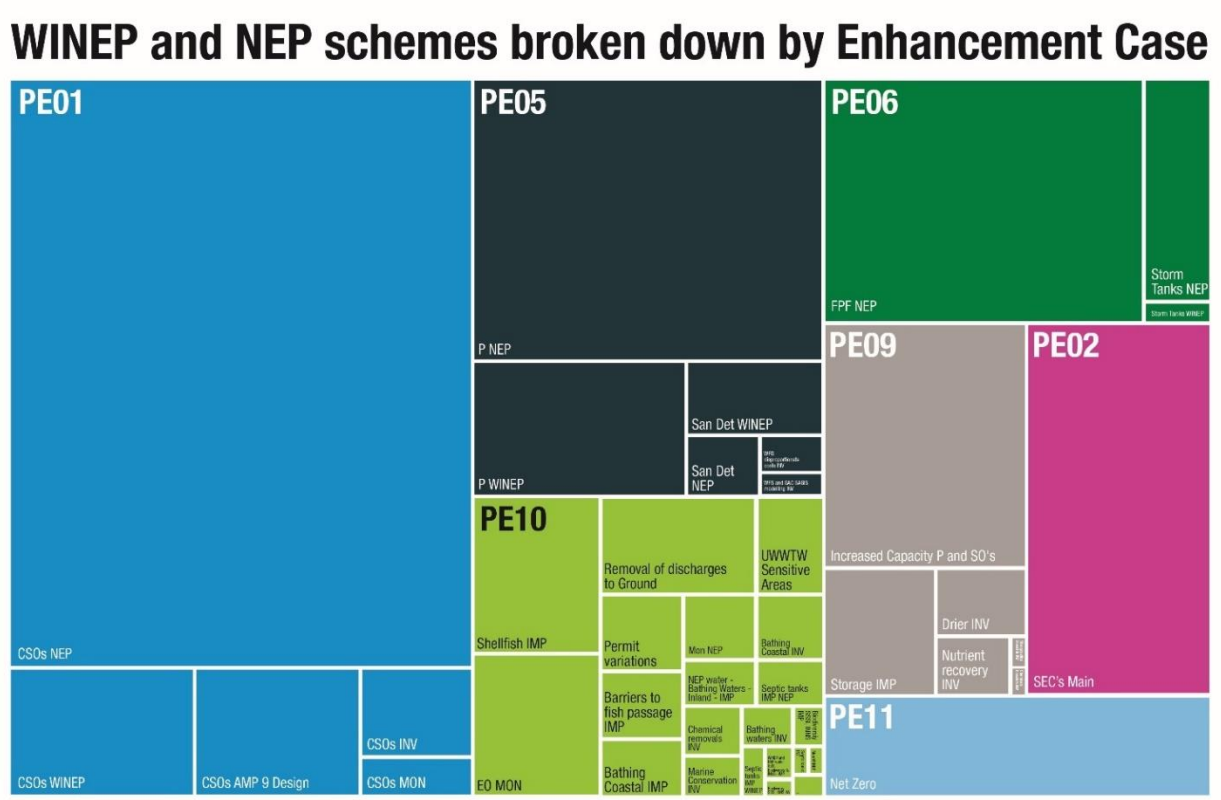
Options: For each of the sites under the W_U_IMP5 driver, we have generated an unconstrained list of options utilising a wide range of potential intervention approaches. These solutions are mainly looking at the most cost-effective means of increasing the capacity on the site to accept increased flow through the works. In most instances our chosen solutions involve either upgrading of existing, or acquiring new assets, the exception to this is the proposed investment at Narberth WwTW, where the most cost effective TotEx solution has been identified as investment at the inlet works in conjunction with the recommissioning of existing Activated Sludge capacity. All solutions will serve to increase the hydraulic capacity of the works which will increase the FPF flow.

For sites under the W_U_IMP6 driver, we have generated a longlist of options, with our chosen solutions being either building new storm tanks or increasing the capacity of existing assets should this be viable. All solutions will increase storm tank volumes from beyond the current permit requirements to reduce the frequency of storm overflow discharges into the receiving waters.

What We Will Deliver: This Enhancement Case will deliver 31 schemes to meet the FPF requirement (U_IMP 5) and 25 schemes to meet the storm tank requirement (U_IMP6). The U_IMP5 site solutions will increase the hydraulic capacity of the sites as they have a low DWF:FPF ratio by adding new

process units to increase site hydraulic capacity. The U_IMP6 sites will build additional storm tank capacity.

The graphic below shows how and where all the Enhancement Cases are mapped by driver.



WINEP and NEP schemes broken down by Enhancement Case.

Efficient Costing: The costing has been carried out by the Welsh Water costing team using a top-down cost modelling approach through our Unit Cost Database (UCD) Cost & Carbon Estimating Tool (C&CET).

NEP and WINEP costs for U_IMP5 and U_IMP6

Investment Objectives	Regulatory Programme	Number of Sites	CapEx	OpEx	TotEx
Increasing Flow Passed Forward (FPF) W_U_IMP5	NEP	31	£85.425M	£6.915M	£92.340M
Increasing storm tank capacity W_U_IMP6	NEP	25	£17.896M	£0.571M	£18.467M
Total		55	£103.321M	£7.486M	£110.807M

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

Benefits: In line with the NEP requirements this investment will increase FPF at WwTW's to pass greater flows to treatment prior to the need to utilise storm storage. This increased FPF will also enable a more rapid emptying of storm tanks following the storage being utilised under storm conditions.

In addition to increasing the FPF rates at specific sites, this investment will also increase the capacity of storm tanks at certain WwTW's.

In accordance with the Water Framework Directive (WFD) objective of achieving Good Ecological Status (GES) in receiving water bodies, this investment will reduce the potential of ecological and environmental harm by reducing the frequency, volume, concentration, and duration of storm tank discharges to the receiving environment.

Our approach has been independently assessed by Jacobs (Engineering and Costs) and Economic Insight (CBA).

1. Introduction

Welsh Water has a total of 827 wastewater treatment works (WwTW) in Wales and England that treat wastewater before discharging it to the environment. WwTW's are designed to treat peak dry weather flows (DWF) as well as additional flows from surface run-off. A number of WwTW's are designed to treat all wastewater that is received, with others being designed with a permitted Flow Passed Forward (FPF). Those with a FPF are designed with a minimum setting for storm overflows to ensure the maximum flow is passed forward to treatment prior to a discharge occurring as an overflow to either storm tanks or the environment depending upon the permit requirements.

NRW and the EA set the FPF (generally as a litres/second figure), which means that works are not allowed to discharge to the storm tanks or overflow until this rate of flow is being passed forward into the treatment works. The permitted FPF flowrate should be maintained for the duration of the storm overflow operation.

The aim of this Enhancement Case is to increase the site FPF in line with the increased permit requirement to prevent 'dry day' overflow operation to storm tanks and to allow a sufficient margin to empty storm tanks as soon as reasonably practicable. Additionally, the objective is to reduce the frequency, duration, and concentration of discharges from storm tanks.

This case supports the W_U_IMP5 and the W_U_IMP6 driver under the National Environmental Programme (NEP) for NRW for WwTW's in Wales and the WINEP framework for the EA for WwTW's in England.

There is a single WwTW in England identified under the W_U_IMP6 driver with the rest located in Wales, whereas all the WwTW's identified under the W_U_IMP5 driver are located within Wales.

Eign WwTW in England is under the W_U_IMP6 WINEP framework directive whilst all the other sites in Wales under W_U_IMP5 and W_U_IMP6 are under the NEP framework directive.

Table 1: NEP and WINEP costs for U_IMP5 and U_IMP6

Investment Objectives	Regulatory Programme	Number of Sites	CapEx	OpEx	TotEx
Increasing Flow Passed Forward (FPF) W_U_IMP5	NEP	31	£85.425M	£6.915M	£92.340M
Increasing storm tank capacity W_U_IMP6	NEP	25	£17.896M	£0.571M	£18.467M
Total		55	£103.321M	£7.486M	£110.807M

1.1 Structure of this Document

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

ID from Appendix 9		Abbreviated Assessment Criterion	Addressed in
A1.1.1 Need for enhancement investment	a	Is there evidence that the proposed investment is required?	Section 2.1
	b	Is the scale and timing of the investment fully justified?	Section 2.1
	c	Does the proposed investment overlap with base activities?	Section 2.2
	d	Does the need and/or proposed investment overlap/duplicate with previously funded activities or service levels?	Section 2.3
	e	Does the need clearly align to a robust long term delivery strategy within a defined core adaptive pathway?	Section 2.4
	f	Do customers support the need for investment?	Section 2.1
	g	Have steps been taken to control costs, including potential cost savings?	Section 2.5
A1.1.2 Best option for customers	a	Have a variety of options with a range of intervention types been explored?	Section 3.1
	b	Has a robust cost-benefit appraisal been undertaken to select the proposed option?	Section 3.1
	c	Has the carbon impact, natural capital and other benefits that the options can deliver been assessed?	Section 3.2
	d	Has the impact of the proposed option on the identified need been quantified?	Section 3.2
	e	Have the uncertainties relating to costs and benefit delivery been explored and mitigated?	Section 3.3
	f	Where required, has any forecast third party funding been shown to be reliable and appropriate?	Not applicable for this case
	g	Has Direct Procurement for Customers (DPC) delivery been considered?	Please refer to WSH50-IP00 Our Approach to Investment Planning (Section 3.4.1)
	h	Have customer views informed the selection of the proposed solution?	Please refer to Stepping up to the Challenge: Business Plan 2025-30 (Section 2.2)
A1.1.3 Cost efficiency	a	Is it clear how the company has arrived at its option costs?	Section 4.1
	b	Is there evidence that the cost estimates are efficient?	Section 4.2
	c	Does the company provide third party assurance for the robustness of the cost estimates?	Section 4.1
A1.1.4 Customer protection	a	Are customers protected if the investment is cancelled, delayed or reduced in scope?	Section 5.1
	b	Does the protection cover all the benefits proposed to be delivered and funded?	Section 5.1
	c	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments?	Not applicable for this case

2. Need for Enhancement Investment

This section will set out the drivers behind the Enhancement Case and describe the context within which it has arisen. The need to invest is driven by the statutory requirements in the NEP and WINEP. We set out the WwTW's identified, any overlaps with our Base Maintenance programme and how the timing of investment has been agreed with the NRW and the EA. The proposed investment aligns with our WSH01 Long Term Delivery Strategy– responding to the need for long term stewardship and improvement in service. The seven sub sections below correspond to the seven criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A1.1.1.

2.1 Evidence that Enhancement is Needed

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

The schemes put forward in this investment case are driven by statutory requirements driven by the Urban Wastewater Treatment Regulations 1994 (UWWTR). The key drivers that we have followed are the W_U_IMP5 and W_U_IMP6 as set out by NRW/EA in the NEP/WINEP. These are summarised as the following:

W_U_IMP5

Increasing Flow Passed Forward (FPF) at WwTW's that were identified in PR19 as having low permitted FPF / DWF (Dry Weather Flow) ratios and were subsequently deferred until PR24 with the written agreement of NRW.

The aim of this Enhancement Case is to increase the site FPF to prevent 'dry day' overflow operation to storm tanks and to allow a sufficient margin to empty storm tanks as soon as reasonably practicable. Additional benefits to the enhancement are that there will be a reduction in spill numbers and/or volume of storm overflow.

Using FPF flow monitoring and overflow operation monitoring installed in AMP7 under the W_U_MON4 and W_U_MON3 drivers respectively, sites have been identified where the overflow that controls FPF into a WwTW is operating on dry days. Based on this flow data, we have confirmed the WwTW's deferred in PR19 under the W_U_IMP5 output need to be included in PR24.

The sites identified with low FPF / DWF ratios are identified in Table 2 below.

Table 2: Sites identified in PR24 with low FPF / DWF Ratios

Site name	FPF / DWF Ratio	Site name	FPF / DWF Ratio
ABERERCH	2.43	**LLANYSTUMDWY (W PORTHMADOG) A***	1.81
BEDDGELERT	2.14	**LLWYNCELYN (S OF ABERAERON)***	2.27
BETWS-Y-COED	1.97	**MACHYNLLETH**	1.95
BLAENAU FFESTINIOG	1.74	**MOLD**	1.93
CAERNARFON	2.54	**NANTGAREDIG**	2.58
CAREW	2.57	**NARBERTH WEST**	2.20

Site name	FPF / DWF Ratio	Site name	FPF / DWF Ratio
CLAWDD-NEWYDD	2.99	**PONTLLYFNI**	2.35
CRYNANT (NE OF NEATH)	1.72	**PONTSTICILL**	2.13
DENBIGH EGLWYSWEN	2.43	**PWLL-GLAS (RUTHIN)**	2.38
FFAIRFACH*	2.75	**RUTHIN**	2.40
LLANDDAROG	2.67	**SALEM**	2.01
LLANFARIAN (ABERYSTWYTH)	2.29	**TALYBONT-ON-USK**	2.52
LLANFYRNACH	2.95	**TAVERNSPITE**	1.94
LLANGADOG	1.61	**TREBANOS**	2.01
LLANRUG	1.39	**TREGARON**	2.32
LLANRWST*	2.62		
		***sites under W_U_IMP5 and W_U_IMP6 drivers**	

Interventions aim to provide sufficient headroom within the permitted FPF to allow storm tanks to be emptied as soon as reasonably practicable after storm events, so storm storage is available for subsequent storms. The driver is not an alternative to resolving sewer infiltration issues. It covers WwTW overflows to storm tanks, and direct discharges to the environment where there are no storm tanks.

W_U_IMP6

This is investment for increasing storm tank capacity beyond that currently permitted, to provide adequate settlement and detention at WwTW's.

The interventions focus on reducing the frequency, duration, and concentration of discharges from storm tanks that have too low permitted volumes. We aim to achieve this by identifying sites where additional storm tank capacity is required by calculating storm volume via resident PE at 68 l/h/d at the permitted DWF or 2 hours retention for flows above FPF, whichever is the lesser.

Table 3: NEP W_U_IMP6 Sites

Site	Current storm tank volume m^3	Increase in storm storage volume required, m^3	New total storm tank volume m^3
BANCYFELYN	26	36	62
BRECON	452	367	819
BUILTH WELLS	150	104	254
COSLECH	1201	364	1565
DYFFRYN ARDUDWY	94.5	176	270.5
FAIRFACH*	142	99	241
FIVE FORDS (WREXHAM)	5846	2184	8030
GLYN CEIRIOG	34	24	58
GRESFORD	610	903	1513
LITTLE MILL	25	11	36
LLANBEDR	684	28.5	712.5
LLANFOIST WWTW	1365	125	1489
LLANGOLLEN	177	360	537
LLANLLYFNI	230	105	335
LLANNON	11	127	138
LLANWRST*	209	138.6	347.6
LLANSANNAN	unknown	42	42
LLANYSTUMDWY*	37	55	92
LLWYNCELYN*	19.5	29	48.5
OVERTON	67.4	54	121.4
RHUDDLAN	1750	357	2107
TREFNANT	63.6	201	264.6
TREGARTH	94.5	82.5	177
WICK	33	48	81
			***sites under W_U_IMP5 and W_U_IMP6 drivers**

Table 4: WINEP W_U_IMP6 Sites

Site	Current storm tank volume m^3	Increase in storm storage volume required, m^3	New total storm tank volume m^3
EIGN	5900	1921	7821

2.1.1 Evidence of Customer Support

Welsh Water has undertaken a series of online surveys, focus groups and interviews to gauge customer views on our long-term ambition. From the analysis of these outputs, we can demonstrate that there is growing concern over declining river quality, river health and impact on the environment. A sample of our customers has shown that reducing pollution and improving river quality is a top priority (ranking second only behind reducing major supply interruptions) with 84% of customers advocating additional expenditure in this area.

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

2.1.2 Scale and Timing of Investment

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

We have worked closely with NRW to agree the phasing of the work set out in this Enhancement Case. There is a clear legislative driver and its interpretation into a delivery program has been established by NRW.

For U_IMP5, the work outlined in the PR19 proposal was agreed with the environmental regulator to form the basis of a two AMP delivery programme between 2020 and 2030. We have invested at 4 sites in the current AMP period and now include investment proposals to address the remaining 31 cases in AMP8.

The sites included for AMP8 investment are scheduled to be delivered between 31/3/2027 and 31/3/2030, depending on the site, and agreed as the latest compliance date in the NEP.

2.2 Overlap with Activities to be Delivered through Base

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

This investment case is solely enhancement under the W_U_IMP5 and W_U_IMP6 drivers within the NEP and is focussed on where increasing hydraulic capacity either through the treatment process, and/or by increasing storm tank capacity to reduce the frequency of storm discharges to the environment is an additional requirement.

This increase in hydraulic capacity is independent of Base Maintenance. We will, however, continue our Base Maintenance activities, to ensure that as much flow as possible is passed through the full treatment process to meet existing permit requirements.

2.3 Overlap with Funding from Previous Price Reviews

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

This Enhancement Case represents a second distinct phase in our FPF investment and does not overlap or duplicate activities from previous price reviews.

At PR19 the U_IMP5 programme was agreed with NRW to be proposed for funding over a two AMP period with the level of investment being relatively evenly spread over both. Our Final Determination (FD), however only made allowance for investment at 4 sites which we are on track to deliver in line with NRW / EA expectations.

The AMP7 FD has led to a greater level of investment now being put forward for AMP8 investment than had been envisaged at the time of PR19.

Table 5: AMP7 U_IMP5 investment

Site	Statutory Date to deliver by
BALA	2025
GARNSWLLT	2025
LOWER CLEEVE	2025
PONTRILAS	2025

In AMP7 we are making investment at 6 sites under the AMP7 U_IMP6 driver. Discussions are however still ongoing to determine the most sustainable solutions at one of these – Lower Cleeve WwTW. The 6 schemes where investment is being made during AMP7 are:

Table 6: AMP7 U_IMP6 investment

Site	Statutory Date to deliver by
BALA	2025
CHESTER	2025
LOWER CLEEVE	2025
PONTRILAS	2025
NORTHOP	2025
PETERCHURCH	2025

2.4 Alignment with the Long Term Delivery Strategy

Is the need clearly identified in the context of a robust long term delivery strategy within a defined core adaptive pathway?

– Ofwat's final methodology for PR24, Appendix 9, A1.1.1e

All viable solutions are considered with respect to adaptive planning to ensure they remain effective throughout their operating lives. For example, any known growth has been accounted for in optioneering to ensure that designs are robust up until at least 2040.

Within the WSH01 Long Term Delivery Strategy we have a core pathway for environmental protection where we undertake to comply with all statutory requirements. This Enhancement Case is therefore a low/no regret because it is needed to meet statutory requirements in the 2025-2030 (AMP 8) period. We have a legal obligation to deliver this by 2030 as this Enhancement Case only includes investment needed to meet statutory requirements under the UWWTD.

Welsh Water has several long-term ambitions linked to enhancing the environment and biodiversity. These include outputs related to river and coastal water quality and pollution incidents. The WINEP and NEP programmes of work are central to achieving Welsh Water's long-term outputs and have formed the basis for the core pathway in the WSH01 Long Term Delivery Strategy. Further details can be seen in Welsh Water's WSH01 Long Term Delivery Strategy.

It is our policy to comply with all statutory requirements.

2.5 Management Control of Costs

Is the investment driven by factors outside of management control? Is it clear that steps been taken to control costs and have potential cost savings been accounted for?

– Ofwat's final methodology for PR24, Appendix 9, A1.1.1g

The investment under drivers W_U_IMP5 & W_U_IMP6 is outside of management control as the WwTW's in question, whilst in compliance with their original design and existing permits, are hydraulically / biologically undersized to adequately protect and achieve current and future environmental needs and requirements.

Wherever possible Welsh Water has sought to optimise the WwTW to maximise flows through the treatment process. The assets included within this investment case are not physically capable of achieving either the increased FPF requirement or the increased volume of storm storage capacity.

All options have been considered in our investment process from long listing, through to short listing and ultimately further development of the most cost-effective preferred solution. Where we are investing in similar assets in the AMP7 period we will ensure as part of our 'business as usual' practices that any lessons learned, innovations or cost efficiencies that are identified are continued into the delivery of this program.

The W_U_IMP6 driver was implemented to ensure that the storm storage volumes provided at wastewater treatment works match the permitted DWF and associated population equivalent which has changed over time. Most of the additional storm storage at sites is driven by the existing DWF permit because works flow is generally only measured after storm separation and is therefore unknown. However, where information is available on existing peak flows to the works or where the flow to the works is controlled by a terminal pumping station and 2 hours storage at the max flow to the storm tanks results in a lower volume this criterion has been used for sizing. Undoubtedly climate change has made storms more intense resulting in increases in peak flows. However, this will only have an impact on the sites where storing maximum flow to the storm tanks for 2 hours is the criteria used for sizing.

3. Best Option for Customer

In this section we will describe how we have developed options for addressing the need identified above. We identify options to expand hydraulic capacity for each of these WwTW's and deliver on the required improvements in flow performance and for installing the required storm tank capacity. We have considered alternative technologies and processes to address the need where appropriate. Cost benefit assessment has been used to help inform decision making.

The remainder of this section is split into sub-sections which correspond to the eight criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A1.1.2.

3.1 Identification of Solution Options

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

3.1.1 W_U_IMP5 Sites

An unconstrained list of options was generated for each of the sites. These solutions ranged from network through to WwTW solutions and from chemical to nature based, as well as hybrids of both.

The unconstrained solutions were then screened and scored to provide the top 3 solutions which were advanced to the short list options. These are identified in 7 below.

Table 7: Longlist Options Considered

Option	Type of Option	Brief Description of Option and Comments	Potentially Viable, i.e., progress to shortlisting?
1	Manage demand	Not Viable. Demand in this context is 3DWF which can only be reduced by removing infiltration (which would be done in base maintenance).	✗
2	Manage operation or use of the existing asset or service	Not viable for most sites. Calculations show an increased FPF is required. Existing asset will be retained and supplemented. NB: Narberth is the exception – see below.	✗
3	Maintain the existing asset or service	Not viable. Calculations show an increased FPF is required. Existing asset will be retained and supplemented.	✗
4	Replace the existing asset like-for-like	Not viable. Calculations show an increased FPF is required. Existing asset will be retained and supplemented.	✗
5	Enhance/upgrade the existing asset or service	Potentially viable, progress to shortlisting. This option varies per site – see below.	✓
6	Mothball/dispose of the existing asset or service	Not viable. Providing this service is a statutory requirement.	✗

Option	Type of Option	Brief Description of Option and Comments	Potentially Viable, i.e., progress to shortlisting?
7	Create/acquire a new asset or service	Potentially viable, progress to shortlisting. This option varies per site – see below.	✓

Below is a summary of the TotEx hierarchy used in the long-listing exercise:

1. Eliminating, reducing or delaying the need for change (e.g., manage demand)

2. Maintaining the effective risk controls already in place (e.g., maintain, replace the existing asset like-for-like, or mothball/dispose of the existing asset or service)

3. Enhancing existing or adding new resources

As per the table above and the TotEx hierarchy, we have only found three viable options to take forward into the concept design stage:

- Option 2: Manage operation or use of the existing asset or service (Narberth only).
- Option 5: Upgrade the asset.
- Option 7: Create/acquire a new asset.

The viable options were then shortlisted, and a desktop engineering review conducted to assess individual solutions at a site-by-site bases. The solutions considered site specifics for the requirement to increase the hydraulic and / or biological capacity. 8 outlines the preferred solution for each site, with these representing the least cost solution for that site and for having the best cost: benefit ratio, which is explained in WSH50-IP00 Our Approach to Investment Planning (Section 4.10). All monetary values are expressed in 2022/23 prices and are prior to portfolio adjustments for corporate overheads and efficiency challenge.

Table 8: W_U_IMP5 Preferred Options with CapEx and Benefit to Cost Ratio

Site	AMP 8 Delivery Cost (£k)	Annual OpEx Cost (£k)	Whole Life Cost (£k)	Whole Life Benefit (£k)	Whole Life Value (£k)	Cost Benefit Ratio (£k)
ABERERCH	£1,475	£26.8	£1,863	£11,072	£9,209	5.94
BEDDGELERT	£1,684	£0	£1,652	£11,000	£9,348	6.66
BETWS-Y-COED	£2,762	£0	£2,038	£10,961	£8,923	5.38
BLAENAU FFESTINIOG	£4,797	£63.5	£6,116	£17,316	£4,499	1.74
CAERNARFON	£2,334	£58	£3,540	£10,745	£7,204	3.03
CAREW	£2,527	£29.5	£2,260	£11,003	£8,742	4.87
CLAWDD-NEWYDD	£873	£2.67	£633	£11,202	£10,568	17.68
CRYNANT (NE OF NEATH)	£5,108	£190	£8,661	£9,760	£1,098	1.13

Site	AMP 8 Delivery Cost (£k)	Annual OpEx Cost (£k)	Whole Life Cost (£k)	Whole Life Benefit (£k)	Whole Life Value (£k)	Cost Benefit Ratio (£k)
DENBIGH EGLWYSWEN	£2,343	£171	£5,167	£10,577	£5,409	2.05
FFAIRFACH*	£2,147	£13.5	£2252	£11,095	£8,842	4.9
LLANDDAROG	£1,444	£27.18	£1,901	£11,054	£9,152	5.81
LLANFARIAN (ABERYSTWYTH)	£1,641	£23.2	£1,920	£11,083	£9,162	5.77
LLANFYRNACH	£1,244	£7.2	£1,308	£11,149	£9,840	8.52
LLANGADOG	£1,758	£14.2	£1,946	£11,109	£9,163	5.71
LLANRUG	£1,495	£13.7	£1,697	£11,112	£9,415	6.55
LLANRWST*	£800	£11	£1,020	£11,130	£10,109	10.9
LLANYSTUMDWY* (W PORTHMADOG) A	£1,213	£11	£1,383	£11,144	£9,761	8.05
LLWYNCELYN* (S OF ABERAERON)	£1,346	£7.2	£1,394	£11,111	£9716	6.97
MACHYNLLETH	£1,719	£6.06	£1,823	£11,141	£9,318	6.11
MOLD	£4,802	£81.9	£6,167	£10,439	£4,271	1.33
NANTGAREDIG	£1,337	£6.9	£1,352	£11,114	£9,761	3.79
NARBERTH WEST	£378	£6.4	£529	£11,197	£10,667	21.13
PONTLLYFNI	£1,077	£7.9	£843	£11,160	£10,317	13.24
PONTSTICILL	£1,774	£11.7	£1,223	£11,146	£9,922	9.11
PWLL-GLAS (RUTHIN)	£1,214	£25.3	£1,698	£11,072	£9,373	6.52
RUTHIN	£3,057	£60	£4,170	£10,692	£6,522	2.56
SALEM	£1,135	£32.6	£1,775	£11,096	£9,321	6.25
TALYBONT-ON-USK	£2,204	£20.8	£1,986	£11,006	£9,020	5.54
TAVERNSPITE	£2,731	£36.5	£2,071	£11,078	£9,007	5.35
TREBANOS	£25,251	£418	£28,006	£5,880	-£22,126	0.637
TREGARON	£2,382	£78.5	£3,878	£10,902	£7,024	2.81

*Llanwrst, Fairfach, Llwyncelyn and Llanystumdwy have the storm tank element costed for in U_IMP6. These costs represent 64%, 82%, 79% and 76% of the total for the scheme, respectively, which is attributed to the FPF element.

Table 9 outlines, as an example, the alternative options that were considered for some of the WwTW's where identified, although many schemes had only one viable option (noted as N/A). This is intended to demonstrate the process and not the complete list.

Table 9: Example of W_U_IMP5 Alternative Options

Site name	Alternative option 1	Alternative option 2	Alternative option 3	Alternative option 4
ABERERCH	N/A			
BEDDGELERT	N/A			
BETWS-Y-COED	N/A			
BLAENAU FFESTINIOG	N/A			
CAERNARFON	New PST, new aeration lane, refurbished FSTs **CAPEX: £3.645M**	New PST, new aeration lane, new FSTs. **CAPEX: £3.171M**	PST, Hybacs **CAPEX: £3.181M**	PST, ASP to carbonaceous and additional nitrification works. **CAPEX: £3.560M**
	New aeration lane, reinstate FSTs, side stream settlement. **CAPEX: £3.597M**	New aeration lane, new FST and side stream settlement. **CAPEX: £2.886M**	Revert ASP to carbonaceous, additional nitrification process, side stream settlement. **CAPEX: £3.331M**	Convert storm to PSTs, old FSTs to storm, new anoxic tank, existing anoxic to aeration and replacement diffusers. **CAPEX: £3.195M**
	Salsnes for primary, new anoxic, existing anoxic to aeration, replacement diffusers **CAPEX: £3.242M**			
CAREW	N/A			
CLAWDD-NEWYDD	N/A			
CRYNANT (NE OF NEATH	New storm tank, inlet works, PST, RBCs, HST: refurb reed beds + additional reed beds, new disc filter. **CAPEX: £6.548M**	New storm tank, inlet works, side stream lagoon; refurb reed beds + additional reed beds. **CAPEX: £8.618M**	N/A	N/A

3.1.2 W_U_IMP6 Sites

For the optioneering phase, a longlist of options was generated however, the only solution that is truly viable is to build new additional storm tanks.

Table 10: UIMP_6 Longlisting options.

Option	Type of Option	Brief Description of Option and Comments	Potentially Viable, i.e., progress to shortlisting?
1	Manage demand	**Not Viable**. Demand in this context is max flow to works which can only be reduced by removing infiltration. Network monitoring is required to assess feasibility.	✗
2	Manage operation or use of the existing asset or service	**Not viable.** Calculations show an increased storm storage volume is required. Existing asset will be retained and supplemented.	✗
3	Maintain the existing asset or service	**Not viable.** Calculations show an increased storm storage volume is required. Existing asset will be retained and supplemented.	✗
4	Replace the existing asset like-for-like	**Not viable**. Calculations show an increased storm storage volume is required. Existing asset will be retained and supplemented.	✗
5	Enhance/upgrade the existing asset or service	**Not viable**. Calculations show an increased storm storage volume is required. Existing asset will be retained and supplemented. The existing assets are not in a good enough condition to add additional height and extend the storm storage volume.	✗
6	Mothball/dispose of the existing asset or service	**Not viable**. Calculations show an increased storm storage volume is required. Existing asset will be retained and supplemented.	✗
7	Create/acquire a new asset or service	**Viable.** This option involves building additional storm storage capacity to supplement the existing.	✓

The most viable option which has been considered is:

Option 7: New additional storm tanks.

Table 11 below shows the cost breakdown and CBA for the storm tanks. All monetary values are expressed in 2022/23 prices and are prior to portfolio adjustments for corporate overheads and efficiency challenge.

Table 11: U_IMP6 costs and CBA

Site	AMP 8 Delivery Cost (£k)	Annual Opex Cost (£k)	Whole Life Cost (£k)	Whole Life Benefit (£k)	Whole Life Value (£k)	Cost Benefit Ratio (£k)
BANCYFELIN	£607	£10	£781	£9,252	£8,470	11.8
BRECON	£764	£19	£1,072	£9,118	£8,116	8.5
BUILTH WELLS	£728	£12	£944	£9,229	£8,284	9.7
COSLECH	£790	£29	£1,304	£9,022	£7,718	6.9
DYFFRYN ARDUDWY	£672	£14	£908	£9,227	£8,319	10.1
FAIRFACH*	£471	£3.8	£475	£9,294	£8,819	19.5
FIVE FORDS (WREXHAM)	£1,738	£57	£2,733	£8,722	£5,988	3.1
GLYN CEIRIOG	£601	£10	£768	£9,254	£8,486	12
GRESFORD	£1,030	£22	£1,393	£9,176	£7,782	6.5
LITTLE MILL	£595	£9	£751	£9,257	£8,506	12.3
LLANBEDR	£603	£10	£773	£9,253	£8,480	11.9
LLANFOIST WWTW	£687	£14	£935	£9,317	£8,381	9.9
LLANGOLLEN	£765	£16	£1,027	£9,222	£8,195	8.9
LLANLLYFNI	£643	£13	£869	£9,225	£8,356	10.6
LLANNON	£653	£14	£886	£9,223	£8,336	10.4
LLANWRST*	£450	£5	£471	£9,317	£8,845	19.7
LLANSANNAN	£646	£12	£850	£9,222	£8,371	10.8
LLANYSTUMDWY*	£383	£84	£379	£9,299	£8,191	24.4
LLWYNCELYN*	£357	£2	£343	£9,303	£8,960	27.1
OVERTON	£615	£11	£798	£9,249	£8,451	11.5
RHUDDLAN	£755	£16	£1,029	£9,214	£8,185	8.9
TREFNANT	£681	£14	£912	£9,234	£8,321	10
TREGARTH	£628	£11	£823	£9,246	£8,422	11.2
WICK	£612	£11	£792	£9,251	£8,458	11.6

*percentage of total cost attributed to storm tanks. Total cost is the combination of storm and U_IMP5 costs.

3.1.3 Assessment and Selection of Solution Options

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

Our approach to cost benefit appraisal and its role in decision making is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.3).

The tables below have been completed using data from our cost benefit analysis to illustrate the value generated by the proposed investment (All monetary values are expressed in 2022/23 prices and are prior to portfolio adjustments for corporate overheads and efficiency challenge. Welsh Water ref: SMF version 5). An example from W_U_IMP5 has been used to demonstrate the process, however for storm tanks there was only one option that was viable (see table 12), therefore an example of the options development decision using CBA is not detailed here.

To carry out cost benefit of scheme options we have assessed benefit using the Welsh Water multi-capitals framework.

The below table shows an example of the CBA results for U_IMP5. For the Caernarfon WwTW the best value option was S7, which had the lowest whole life cost among the various viable options.

Table 12: Caernarfon - CBA Costs (W_U_IMP5)

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S1	Increased PFF New PST, new aeration lane, reinstate flat bottom FSTs with Towbro, new RAS P/S; integrated with existing works	£3.966M	£3.168M	£10.180M	**1.651**	£4.012M
Option S2	Increased PFF New PST, new aeration lane, 2 new FSTs, new RAS P/S; integrated with existing works	£3.450M	£5.576M	£10.260M	**1.840**	£4.684M
Option S3	Increased PFF PST, HYBACS upstream of aeration lanes, new RAS P/S; integrated with existing works,	£3.460M	£5.730M	£10.116M	**1.765**	£4.386M
Option S4	Increased PFF New PST, revert to carbonaceous, new RAS P/S, additional nitrification process; integrated with existing works	£3.873M	£11.304M	£6.940M	**0.614**	-£4.365M

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S5	Increased PFF New aeration lane, reinstate flat bottom FSTs with Towbro, new RAS P/S; sidestream settlement tank for flows in excess of 98.6 l/s	£3.913M	£6.108M	£10.187M	**1.668**	£4.079M
Option S6	Increased PFF New aeration lane, 1 new FST, new RAS P/S; sidestream settlement tank for flows in excess of 98.6 l/s	£3.140M	£5.230M	£10.277M	**1.965**	£5.047M
Option S7	Increased PFF HYBACS upstream of aeration lanes, new RAS P/S; sidestream settlement tank for flows in excess of 98.6 l/s	£2.539M	£3.810M	£10.745M	**2.820**	£6.935M
Option S8	Increased PFF Revert to carbonaceous, new RAS P/S, additional nitrification process; sidestream settlement tank for flows in excess of 98.6 l/s	£3.624M	£9.188M	£8.117M	**0.883**	-£1.071
Option S9	Increased PFF Convert storm tanks to PSTs, convert old FSTs to storm tanks, new anoxic tank, convert existing anoxic zone to aeration, replacement diffusers in existing lanes	£3.476M	£5.877M	£10.007M	**1.703**	£4.130M

Solution Option	Option Name	CapEx	Present Value Whole Life Costs (WLC)	Present Value Whole Life Benefits (WLB)	Benefit/ Cost Ratio	Net Present Value (=WLB - WLC)
Option S10	Increased PFF Salsnes filters for additional primary treatment, new anoxic tank, convert existing anoxic zone to aeration, replacement diffusers in existing lanes	£3.527M	£4.875M	£10.637M	**2.182**	£5.762M

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

3.2 Quantification of Benefits

Has the company fully considered the carbon impact, natural capital and other benefits that the options can deliver?
Has the impact (incremental improvement) of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?

– Ofwat's final methodology for PR24, Appendix 9, A1.1.2c and A1.1.2d

To demonstrate how we have considered the carbon impact, natural capital and other benefits for this particular case we have included an excerpt from our Service Measures Framework (SMF) which maps benefits to Ofwat drivers for inclusion within data tables.

In the table below we have shown how the preferred option for this Enhancement Case has apportioned benefits across the appropriate headings from the SMF.

Table 13: SMF benefits

Scenario	Benefits from AMP8 Spend relative to baseline						
	Legal Compliance	Flow Compliance PFF	Storm Storage Consent Compliance	Environmental Impact	Pollution Incidents	Other*	Total
Preferred	81.3%	13.4%	3.2%	0.8%	0.7%	0.5%	100%
*** Avoidable Costs, Land-use.**							

In this case the preferred option delivers a series of benefits across the SMF with the highest proportion of this belonging to increased legal compliance which accounts for 81.3% of benefits.

Within our cost benefit process the impacts of each option on the need have been quantified. Our methodology is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.1). Our service measure framework quantifies a wide range of aspects including Carbon and impacts on performance within the cost benefit assessment.

From our analysis the proposed option will make the following impacts:

- Compliance with new FPF and storm overflow permit requirements.
- Harm reduction on receiving waterbodies.

We have not stated an improvement in our level of services against the pollution incidents performance commitment. The work set out above will maintain the current level of compliance against changing external factors and increased requirements. If the work was not delivered, performances would deteriorate.

3.3 Uncertainties relating to cost and benefit delivery.

> ***Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.2e*

Our methodology is set out in WSH50-IP00 Our Approach to Investment Planning (Section 4.10). This includes commentary on our approach to optioneering, costing and cost benefit analysis.

For this Enhancement Case, we have used our growth estimations to 2040 to forecast future flows and ensure they are in line with what is being predicted. To do this, we have undertaken desktop assessments and calculations at each site including the use of headroom assessments.

We have highlighted areas in which the calculation of costs or benefits are unusual or uncertain and how we have mitigated for this in our evaluation. Innovation and new approaches such as nature-based work is inherently more uncertain than tried and tested engineering approaches. We have proposed lagoons in some circumstances in the U_IMP5 schemes and more nature-based solutions may evolve from more detailed design. For U_IMP6 schemes green storm storage solutions are not currently supported by NRW therefore none have been proposed. We have a trial site for a green solution for storm overflows at Pontrillas. Once this trial is concluded there will be ongoing discussions with NRW on green solutions for storm storage. If green solutions get entered into the acceptable processes for storm storage within Wales, then we will look at adopting these into our plans where they are cost efficient relative to what has already been proposed.

The majority of the U_IMP5 schemes have an estimate on the amount of infiltration that has been included in the FPF calculation. We will undertake more detailed flow surveys towards the end of 2023. This could mean that the design FPF increases in some circumstances. However, we will endeavour to keep the costs within those quoted in the submission by pushing the design limits or looking at alternative modular options that could be delivered using a multi-AMP approach.

4. Costing Efficiency

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

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

4.1 Developing a cost for increasing FPF

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

The costing of the approach of this project was using the like-for-like (top down) cost modelling through our Unit Cost Database (UCD) Cost & Carbon Estimating Tool (C&CET) as described in 'Overview: How we have developed our investment plan Section 5 Costing Methodology.

The costing was carried out by the Welsh Water costing team. The governance procedures, as outlined in Section 5 Costing Methodology were adhered to with the appropriate use of cost models being confirmed and all manual allowance verified prior to providing sign offs throughout the different iterations of the costings.

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

The scope is aligned to our Work breakdown Structure (WBS), which was developed to support our data capture process of historical project cost against delivered assets, into a scope input sheet. Within this, sizing of the assets based on the relevant yardstick, which is dictated by the WBS, is provided following calculation in the previous engineering stages. Our costs models are developed in line with our WBS, and this allows us to input this information into the C&CET and generate a project estimate. WBS details the inclusions and exclusions of works under each cost model and the limitations of the model, so we can ensure all project costs are captured and there is also no over costing.

The estimate identifies the assets from the scope with the relevant drivers to influence costs and the C&CET calculates the costs of each item using the cost models. For instance, pipework with the length and diameter, tanks with their volume, screens with their flow etc. With the workstream selected the C&CET applies the correct models to the direct works and site-specific costs, to cost the contractor indirect and project oncosts, associated with delivering the project.

Various assumptions have been made in the design process that have influenced the UCD costs. These include assumptions on incoming flowrates to the works for U_IMP 5 sites (which, as described above, will be verified through monitoring in AMP8) and the requirement for land purchase for additional storm tanks (U_IMP6 sites).

Along with our overall costing strategy being reviewed and assured by Jacobs, we have also employed third party consultants to review single Enhancement Cases to provide confidence that the estimates within them are robust, efficient and deliverable. Please refer to WSH50-IP00 Our

Approach to Investment Planning (Section 6) for more information regarding the review and assurance undertaken.

4.2 Benchmarking our approach

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

In order to demonstrate that our costs are efficient we employed Aqua Consultants to carry out an independent benchmark of a majority sample of projects within our WINEP/NEP Pass Forward Flow programme costing.

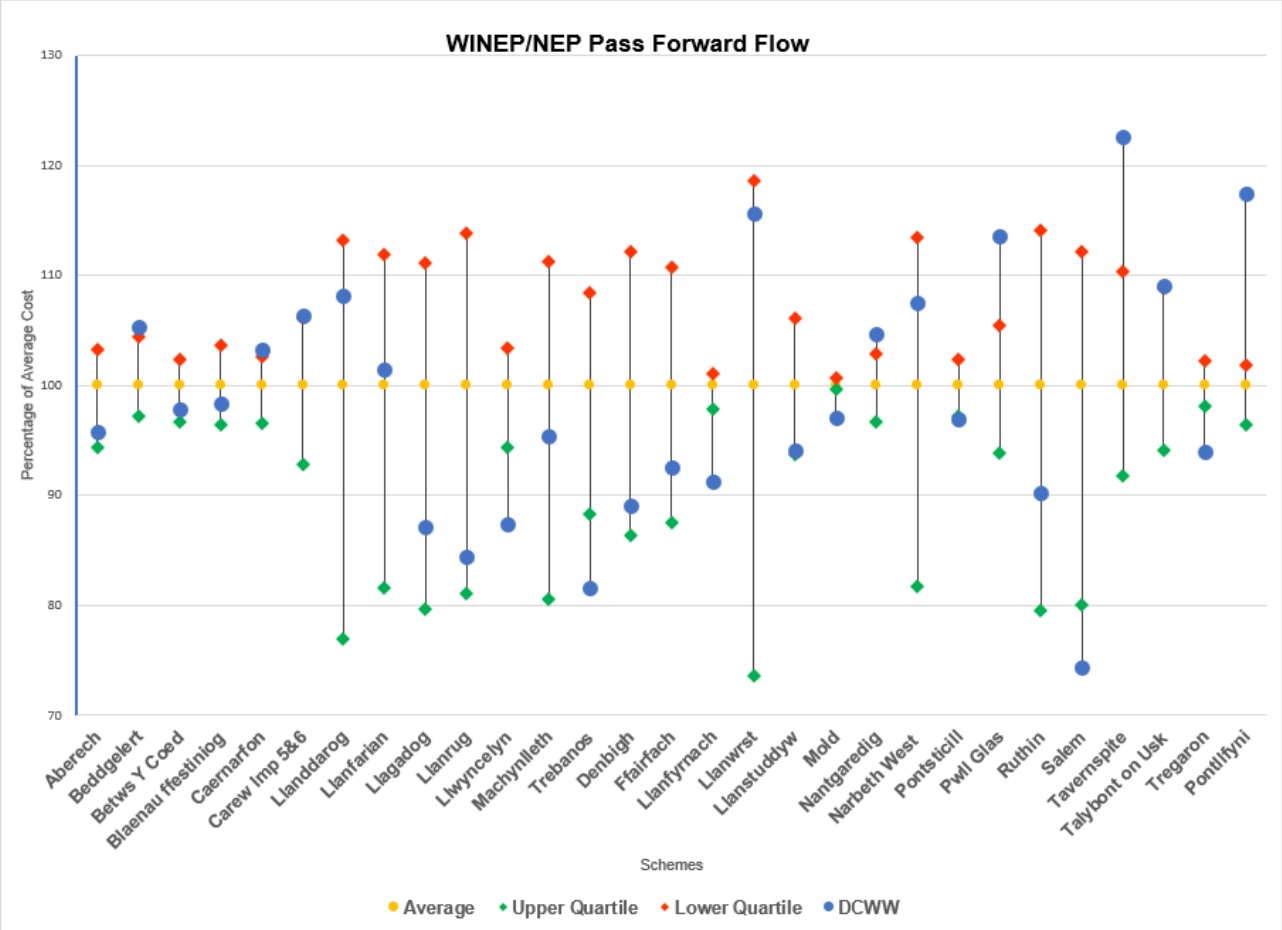


Figure 2: Cost benchmarking analysis

The Aqua Consultants benchmark showed us to be better than average on our pre-efficiency costing demonstrating our efficiency and was less than 2% from upper quartile. Applying our efficiency target of 8.7% moves us into upper quartile, as demonstrated in Table 14, below.

Table 14: Benchmarking costing efficiency

Project	Welsh Water Pre efficiency 21/22	Upper Quartile	Average	Lower Quartile
Pass Forward Flow Programme - Sample	£82M	£80M	£89M	£96M

5. Providing Customer Protection

In this section we set out the controls which are in place to protect customers. We have worked closely with the EA and NRW in building up the investment set out in this Enhancement Case, and they will provide regulatory oversight on delivery.

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

5.1 Proposed Customer Protection

Are customers protected (via a price control deliverable or performance commitment) if the investment is cancelled, delayed or reduced in scope?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.4a
Does the protection cover all the benefits proposed to be delivered and funded (e.g., primary and wider benefits)?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.4b

This enhancement investment will be covered by regulatory oversight from NRW and EA, following statutory requirements as set out by the UWWTR, and regulated through the NEP and WINEP.

Work will be delivered to increase Flow Passed Forward (FPF) and Storm Tank Capacity at WwTW's as per the W_U_IMP5 and W_U_IMP6 drivers respectively.

We have an established a mechanism for annual reporting on progress against delivery and will be challenged by NRW/EA if delivery is not on track.

We will also follow the new FPF, and storm tank permits set out by the NRW and EA, failure to achieve the permitted new requirements would lead to non-compliance with the permit and prosecution.

This scope of work is environmentally driven therefore, we are not proposing a separate PCD as significant regulatory oversight already exists.

We have not identified secondary benefits from this work.

6. Appendix A

Table 15 below shows the enhancement cost in Amp 8, The Ofwat drivers that this Enhancement Case maps to are:

- Investigations, other (WINEP/NEP) - Increase flow to full treatment wastewater CapEx. (CWW3b.013).
- Investigations, other (WINEP/NEP) - Increase flow to full treatment wastewater OpEx. (CWW3b.014).
- Investigations, other (WINEP/NEP) - Increase storm tank capacity at STWs - grey solution wastewater CapEx. (CWW3b.016).
- Investigations, other (WINEP/NEP) - Increase storm tank capacity at STWs - grey solution wastewater OpEx. (CWW3b.017).

Table 16: Cost profile

Driver Ref	Year in AMP8					
	1	2	3	4	5	Grand Total
CWW3b.13 CapEx	£26.046M	£25.459M	£12.513M	£12.645M	£8.762M	£85.425M
CWW3b.14 OpEx	£0.000M	£1.246M	£1.692M	£1.692M	£2.285M	£6.915M
CWW3b.16 CapEx	£5.455M	£5.333M	£2.622M	£2.650M	£1.836M	£17.896M
CWW3b.17 OpEx	£0.000M	£0.000M	£0.000M	£0.000M	£0.571M	£0.571M
TotEx Total	£31.501M	£32.038M	£16.827M	£16.987M	£13.454M	£110.807M

What We Will Deliver: This Enhancement Case will deliver 31 schemes to meet the FPF requirement (U_IMP 5) and 25 schemes to meet the storm tank requirement (U_IMP6). The U_IMP5 site solutions will increase the hydraulic capacity of the sites as they have a low DWF:FPF ratio by adding new process units to increase site hydraulic capacity. The U_IMP6 sites will build additional storm tank capacity.