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Carmarthenshire County Council Nutrient Neutrality Action Plan

Technical Report

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Carmarthenshire County Council – Action Plan

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P1	26/01/2024	AR / JF	EBP	JL	RG	
P2	21/03/2024	JL	JL	RG	RG	Update to include Non-technical Summary

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1 Introduction

In January 2021, Natural Resources Wales (NRW) published evidence[1] following a review of tighter standards set by the Joint Nature Conservation Committee (JNCC)[2], which showed that over 60% of riverine Special Areas of Conservation (SAC) water bodies fail against revised phosphorus standards.

As a result of these failures, NRW has subsequently issued planning advice[3] to avoid further deterioration in environmental capacity where new developments have the potential to affect phosphorus sensitive riverine SACs. These actions are required to demonstrate the compliance with the Conservation of Habitats and Species Regulations 2017, as amended (Habs Regs). Therefore, this NRW 'advice' relates to all riverine SACs whose drainage catchments extend into Carmarthenshire, namely, the Afon Teifi, Afon Tywi, Afon Cleddau, River Wye and River Usk.

The Carmarthenshire County Council (CCC) administrative boundary contains several SACs, including the Afon Tywi and Afon Teifi. The addition of wastewater and changes in land-use resulting from the CCC's revised Local Development Plan (rLDP) are likely to increase phosphate export to these two SACs. A Habitats Regulation Assessment (HRA) has considered the potential significant effects on the SACs (following risk avoidance measures as a first principle) and identified the need for additional mitigating actions to achieve 'nutrient neutrality'.

CCC, as the Local Planning Authority (LPA), is required to have regard to the above advice given by NRW when making planning decisions on individual developments and Local Development Plans (LDPs). As a result, the new advice passed from NRW with respect to phosphorus within Welsh Riverine SACs effectively paused the progression of CCC's rLDP to its adoption stage.

Arcadis Consulting UK Ltd (Arcadis) have been commissioned by CCC to provide specialist support to progress the preparation of the rLDP. Specifically, Arcadis has been tasked with developing an Action Plan (AP) for the rLDP which will make clear recommendations as to the way ahead, providing an indication of how the rLDP can be brought forward to adoption in line with NRW's advice.

1.1 Purpose of this Document

This document sets out CCC's proposed AP to deliver strategic phosphate mitigation requirements within the Teifi and Tywi SACs to accommodate the growth planned within the rLDP. The document is an update to the Interim Action Plan (IAP) produced for CCC in March 2023. It is not necessary to read the IAP to understand the findings and detail of this AP. The AP is an evolution of the IAP to provide additional detail, quantum and feasibility of the mitigation required based upon updated guidance, data, modelling, stakeholder engagement and work undertaken in the wider catchment.

The AP is a key supporting document, which informed the HRA and its overall conclusions to mitigate the potential likely significant effects of the extra phosphorus discharge from the planned new development within the rLDP. Details of the HRA can be found in the Phosphate Assessment Appendix to the rLDP HRA Addendum (January 2024)[4]. The necessary information to support HRA compliance is presented in the Phosphate Assessment Appendix, the AP provides additional detail on the measures that CCC are taking towards delivering the strategic phosphate mitigation that has been calculated as required to ensure that the rLDP will be nutrient neutral where required. Furthermore, it contains more detailed, technical information with regards to the assessment of phosphate budgets and mitigation.

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[1] Natural Resources Wales (2021) Tighter phosphate targets change our view of the state of Welsh rivers
[2] Joint Nature Conservation Committee (2016) Common Standards Monitoring Guidance for Rivers.
[3] Natural Resources Wales (2023) Advice to planning authorities for planning applications affecting phosphorus sensitive river Special Areas of Conservation.
[4] Carmarthenshire County Council (February 2024) Phosphate Assessment Appendix to the rLDP HRA Addendum

The document will outline the expected phosphate budgets within the two SACs (considering CCC allocations under the rLDP and potential allocations from neighbouring councils). It will provide background and context to the current position on the phosphate issue amongst key stakeholders. It will outline the quantum of mitigation required to demonstrate nutrient neutrality. Finally, the document will discuss delivery considerations such as funding, and monitoring / maintenance.

1.2 Afon Tywi

The Afon Tywi is a river in southwest Wales with a total length of around 120km, particularly important for its migratory fish populations. Its source is located on the lower slopes of the Cambrian Mountains, Crug Gynan. The catchment is largely rural, with the majority of the upland areas dominated by sheep farming and coniferous forestry. The middle and lower reaches of the catchment mainly consist of dairy/livestock farming. The completion of the Llyn Brianne reservoir in the early 1970s resulted in 75km of the Tywi being regulated under low flows to aid in the support of public water supply. The Afon Tywi is currently passing under the Water Framework Directive (WFD) Regulations, despite some concerns over the level of phosphorus within the river.

As seen in Figure 1-1, 375.83ha of the Afon Tywi is a designated SAC. One of the primary reasons for this classification is because of the large spawning population of Twaite shad *Alosa fallax.* Spawning sites are found throughout the lower reaches of the river, with most spawning occurring downstream of Llandeilo. Currently, the water quality of the Afon Tywi is considered adequate to maintaining this vulnerable species. Another primary reason for the SAC classification is the presence of otter *Lutra lutra*. There are few known breeding sites; however, this species has been sighted numerous times along the river and the water quality is generally considered to be 'good'. Other species present in the Afon Tywi, that are qualifying factors for the SAC classification, but are not a reason for site selection, include Sea lamprey *Petromyzon marinus,* Brook lamprey *Lampetra planeri,* River lamprey *Lampetra fluviatilis,* Allis shad *Alosa alosa* and Bullhead *Cottus gobio*[5].

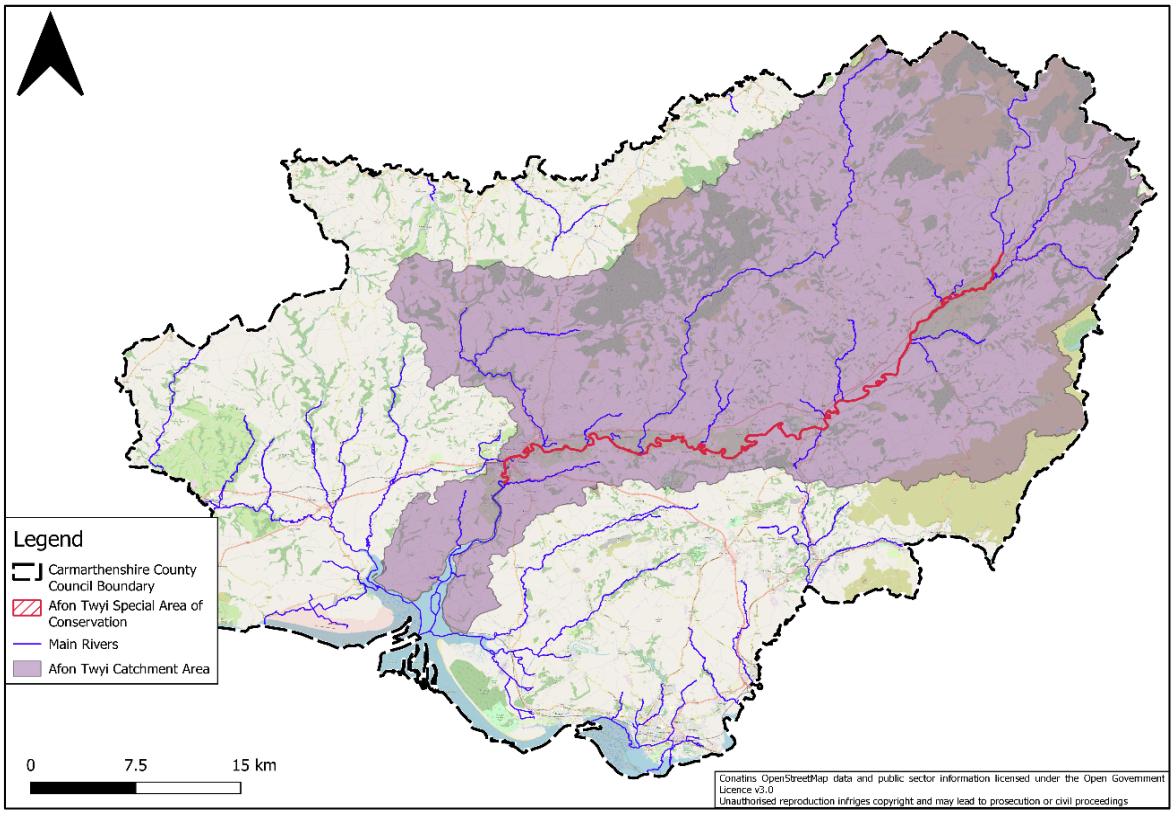


Figure 1-1: Afon Tywi Catchment

[5] JNCC. Afon Tywi/ River Tywi Designated Special Area of Conservation

1.3 Afon Teifi

The Afon Teifi is a river in southwest Wales with a catchment area estimated to be just over 1,000km^2. It is sourced from one of the several lakes known collectively as the Teifi Pools, Llyn Teifi. After meandering through upland pastures, several small tributaries join Afon Teifi in the rural lowlands, before it finally flows into Cardigan Bay. The Teifi is currently failing under the WFD Regulations due to high phosphorus levels. Under WFD Cycle 3, the overall status of the Afon Teifi is shown as “moderate”.

Within the Afon Teifi, as seen in Figure 1-2, 691.07ha is classified as a SAC. A primary reason for this is due to the unique habitats seen along the river. The Teifi is largely mesotrophic with some sections in the upper reaches being oligotrophic. It represents a great example of a sub-type 3 river with Water-crowfoot *Ranunclus* vegetation. Due to the oligo-mesotrophic base-poor rocks, the in-stream vegetation is dominated by water-crowfoot *Ranunculus penicillatus* ssp. *penicillatus,* Water-starworts *Callitriche hamulate* and *C. obtusangula* and the aquatic moss *Fontinalis squamosa.*

The Afon Teifi also flows through Cors Caron, which is a large area of 7110 Active raised bog, which is a SAC in its own right. As a result of the unique habitats and water quality found within the Teifi, the types of species found in the river are also unique. Species that give further reason for the SAC classification include brook lamprey *Lampetra planeri,* River lamprey *Lampetra fluviatilis,* salmon *Salmo salar,* bullhead *Cottus gobio,* otter *Lutra lutra* and Floating water-plantain *Luronium natans*[6]*.*

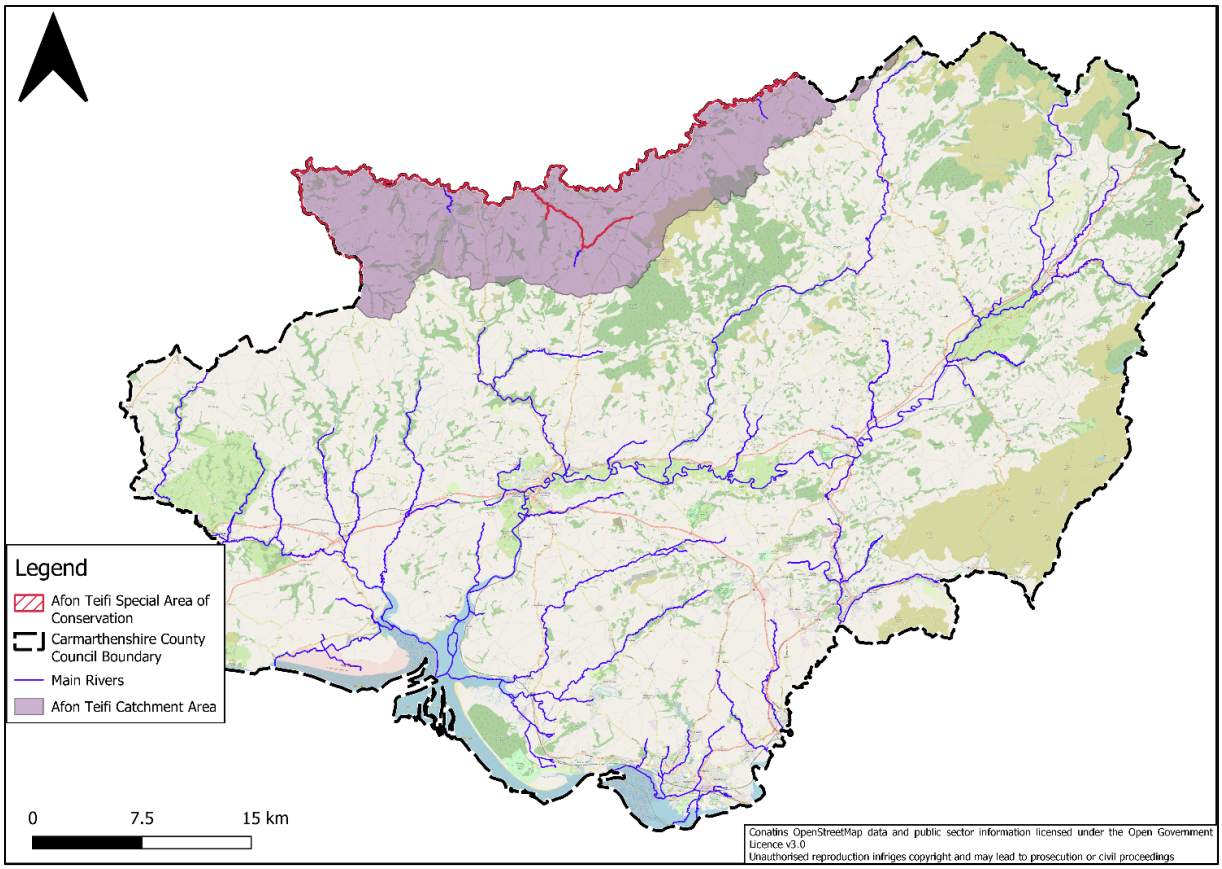


Figure 1-2: Afon Teifi Catchment

[6] JNCC Afon Teifi/ River Teifi Designated Special Area of Conservation

1.4 Afon Cleddau, Afon Wye & River Usk

The Afon Wye is located to the north of the Carmarthenshire boarder, while the Afon Cleddau is found to the southwest and the River Usk to the east within the Brecon Beacons National Park (BBNP). As per the Nutrient Budget Calculator Guidance[7], only developments which are within a catchment that drains to an affected SAC or connects to a Wastewater Treatment Works (WwTW) which discharge to a SAC need to be included in the nutrient budget calculations. As shown in Appendix A Figure A1, all proposed housing applications and associated WwTWs in the rLDP either drain to the Afon Tywi or Afon Teifi. Therefore, the Afon Cleddau, Afon Wye and River Usk are not impacted by the housing allocations in this assessment.

1.5 Nutrient Neutrality in Carmarthenshire

Over 60% of riverine SACs in Wales fail to meet their new targets for phosphorus. Of the two SACs in this assessment, only the Afon Teifi is failing to meet the new targets. 44% of the water bodies in the Afon Teifi catchment passed the targets. With the exception of the Groes water body, the upper part of the Afon Teifi is passing its phosphorus targets, with the lower water bodies generally failing as the river flows through Carmarthenshire (Figure 1-3)[8].

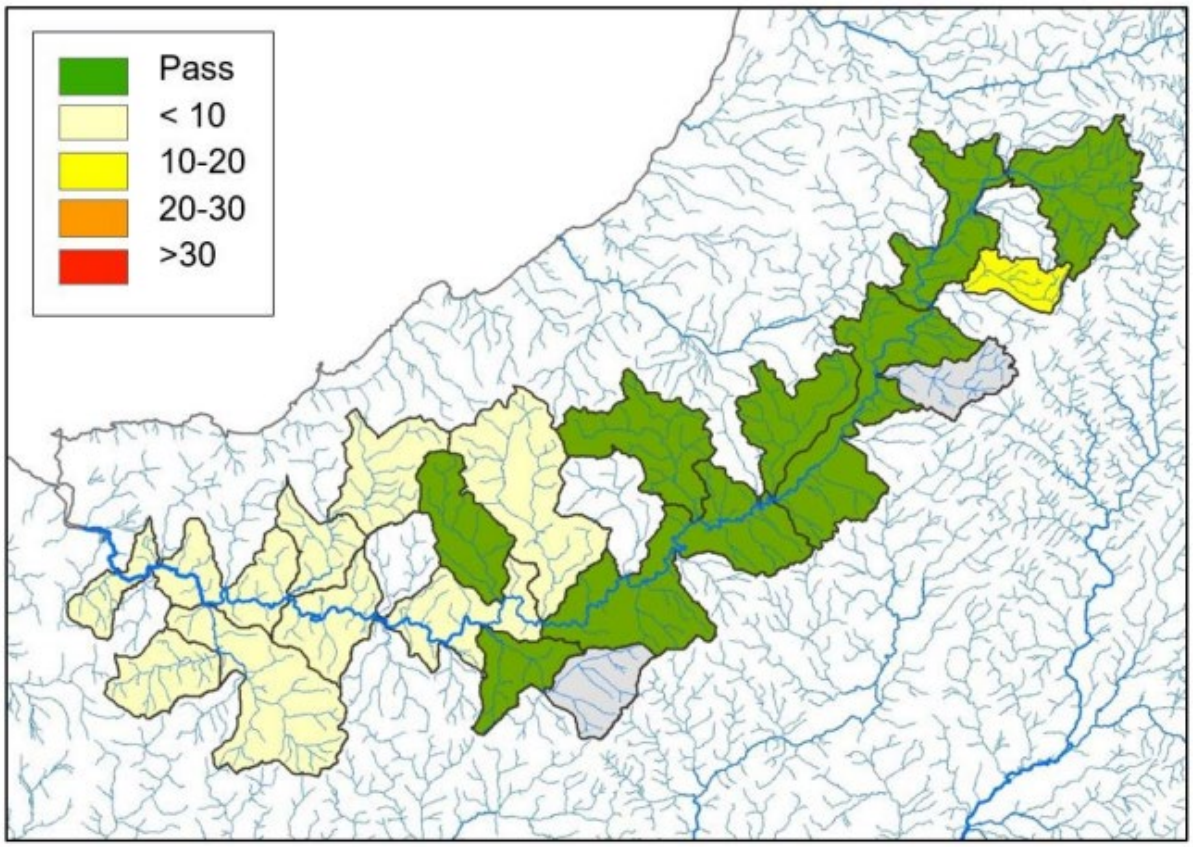


Figure 1-3 Map of phosphorus compliance for Afon Teifi SAC.

Note: *Water bodies shaded green pass their target. Other colours fail their target with different colours representing the magnitude of failures in µg l^{-1}, expressed as the larger of annual means and growing season means. Greyed out water bodies could not be assessed due to lack of data.*

[7] Nutrient Budget Calculator Guidance (2023) A guide on how to calculate a phosphorus budget for a development with the West Wales Calculator

[8] Hatton-Ellis TW, Jones TG. (2021) Compliance Assessment of Welsh River SACs against Phosphorus Targets. NRW Evidence Report No: 489, 96pp, Natural Resources Wales, Bangor.

Based on the NRW Compliance Assessment of Welsh River SACs Against Phosphorus Targets[88], the upper, middle and lower catchments in the Afon Tywi are all comfortably passing their targets with some level of environmental headroom available. In all instances the mean P concentration is below half of its target and is therefore not at a high risk of phosphorous.

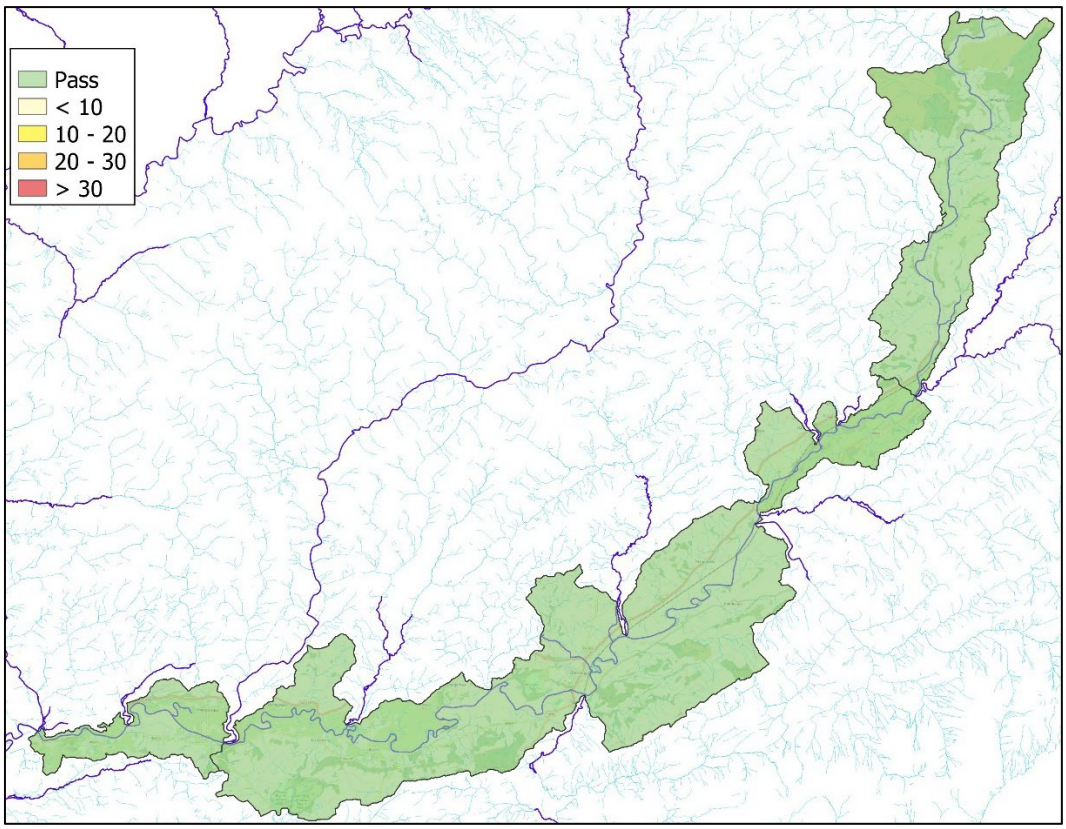


Figure 1-4 Map of phosphorus compliance for Afon Tywi SAC.
***Note:** Water bodies shaded green pass their target. Other colours fail the target with different colours representing the magnitude of failures in µg l-[1], expressed as the larger of annual means and growing season means.*

Figure 1-4 has been created using data presented in the original compliance assessment reports[8] and subsequent data provided by NRW in their consultation response to CCC on the HRA Approach for the Non-failing Tywi SAC[9].

In November 2022, NRW provided an update to phosphorus targets for water bodies in SAC rivers in Wales[10]. The update reviewed the water bodies "in scope" for SAC targets, made changes to the phosphorus targets of some water bodies, and reassessed them for compliance. The update has no new implications for the Afon Tywi and Afon Teifi SACs that will contradict the information in Figure 1-3 and Figure 1-4.

[9] NRW (2022) "Compliance requirements of non-failing riverine SACs" (2022) Letter to CCC, 8th December.
[10] NRW (2022) Update to phosphorus targets for water bodies in Special Area of Conservation (SAC) rivers in Wales

1.5.1 NRW Consultation on the approach for non-failing Tywi SAC

On 8th December 2022, NRW provided a response to CCC following their consultation dated 21st October 2022, which sought to establish a common understanding of the nutrient neutrality compliance requirements in non-failing SACs[10]. The scope of the CCC consultation and NRW response was wide ranging, but with specific reference to the application of an environmental headroom approach in non-failing SACs, the following key points are highlighted:

1. CCC and NRW were in agreement that phosphorus concentrations within the Afon Tywi catchment were significantly less than their targets, indicating that "*phosphorus is not likely to be a significant concern in these stretches*".
2. NRW reiterated their advice that "*for developments leading to increases in phosphorus discharges into catchments of non-failing riverine SACs. As set out in our planning advice, new developments can be authorised if it can be demonstrated they will not lead to an adverse effect on site integrity (i.e. will not undermine the ability for the SAC to meet its conservation objectives by causing a phosphorus target failure alone or in combination with other plans or projects).* ***There is no requirement for nutrient neutrality..."***
3. NRW recognised that developments not requiring nutrient neutrality are likely to reduce "*river headroom*", which without consideration could lead to water bodies in the Afon Tywi failing to meet their phosphorus targets.
4. NRW highlighted several considerations that may help the local planning authority to consider the requirement to apply a nutrient neutrality approach, including the rate and pace of development coming forward and the application of decision thresholds based on phosphorus export potential.
5. NRW noted their work with DCWW to review phosphorus impacts of discharges from WwTW in SAC catchments. The work will inform a Review of Permits for WwTW and will provide clarity on the capacity of WwTWs to receive connections from new development, aiding both the water company and planning authorities as part of the decision-making process for planning applications.

Based on the NRW Compliance Assessment of Welsh River SACs Against Phosphorus Targets, the upper, middle and lower catchments in the Afon Tywi are all comfortably passing their targets. In all instances the mean P concentration is below half of its target and is therefore not at a high risk of exceeding phosphorous targets. The implications of this from a HRA perspective are covered in detail in the HRA Phosphate Assessment Appendix[4], including a rationale for applying an environmental headroom approach when considering the rLDP. This is also discussed in further detail in Section 4.4.1.

However, this document still examines technically on mitigation that could be delivered and presents mitigation delivery potential in relation to the nutrient budgets calculated for each unit of the rLDP Site Allocations. As such, whilst the HRA phosphate assessment has concluded that an environmental headroom approach is applicable within the Tywi with respect to the rLDP Site Allocations, other sources of phosphate, namely agricultural, are the major contributors in this catchment. Therefore, potential mitigation options are therefore explored in this AP for maintaining the environmental headroom. This will then ensure that should headroom reduce in the future, or should the council decide that new sites (outside of the rLDP) on a case-by-case require nutrient neutrality to be demonstrated (i.e. when determining future planning applications), then such strategic mitigation options can be taken forward.

1.5.2 Approach for failing SACs

As per NRW advice to planning authorities' guidance[3]; for SAC catchments failing to meet phosphorus targets, it is possible that new developments can be authorised if it can be demonstrated they will not lead to further deterioration of water quality in the SAC water bodies failing to meet water quality targets and will not undermine the ability for the SAC to meet its conservation objectives or

introduces additional P within the SAC that could trigger a failure. In these instances, nutrient neutrality must be demonstrated.

1.5.3 Assessing Nutrient Neutrality

To assess nutrient neutrality, it is required to first consider whether a development will cause additional nutrient inputs to a SAC. In the context of Carmarthenshire, only Total Phosphorus (TP) is being considered. This requires calculation of the amount of extra phosphorus a new development will create, otherwise known as a TP budget (See Figure 1-5).

The nutrient budget calculations are completed as per the following four key stages:

- **Stage 1 -** Calculate the increase in TP loading that comes from a development's wastewater.
- **Stage 2 -** Calculate the pre-existing TP load from current land use at the development site.
- **Stage 3 -** Calculate the future TP load from land use at the site post-development.
- **Stage 4 -** Calculate the net change in TP loading from the development to the SAC with the addition of a 20% precautionary buffer; this is hereby referred to as the TP budget.

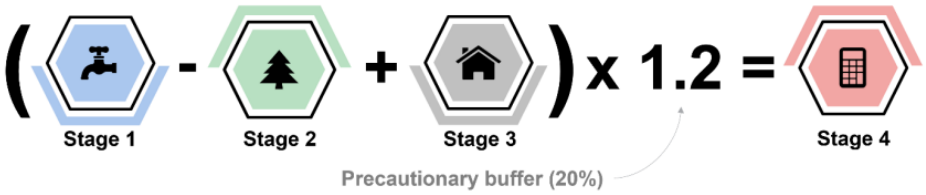


Figure 1-5 Diagram showing the overall equation used to calculate the TP budget.

1.6 Aims & Objectives

The principal aim of this report is to set out a realistic and adaptable action plan for catchment scale management of phosphorus within the Afon Teifi and Afon Tywi in support of the Carmarthenshire rLDP. The key objectives of this AP are:

- Provide TP budgets for the sites allocated in the rLDP (using best available data) for Afon Teifi and Afon Tywi SACs;
- Summarise the in-combination effects from the various LPAs within the Afon Teifi SAC Catchment
- Outline the potential mitigation solutions available to CCC to offset the TP budget;
- Indicate the scale of mitigation required for the solutions deemed most practical / effective; and
- Outline next steps to deliver solutions and promote a phased approach for delivery.

2 Revised Local Development Plan

The emerging rLDP is a land-use plan that sets out the planning requirements for achieving sustainable development in Carmarthenshire County over the period 2018-2033. The plan identifies where and how many new developments will occur, as well as which areas need to be protected due to their environmental qualities.

Arcadis have been involved in delivering the IAP and HRA addendum to support Key Stage 4 – Second Deposit rLDP for the CCC LDP (2018-2033), which was published for consultation on 17th February 2023 to the 14th April 2023. As noted in Section 1.1 this AP now supersedes the IAP. The current indicative timeline for rLDP progression is presented in Table 2-1.

The relevant Legislation and Planning context can be found in Appendix B.

Table 2-1 – Indicative timetable for Key Stages of the rLDP[11]

Stage in Plan Preparation	Regulation Number	Timescale
Definitive		
Key Stage 1 – Delivery Agreement	5-10	Initial DA – February 2018 to July 2018 First Revised DA – publication following WG approval, November 2020 Second Revised DA – publication following WG approval, August 2022
Key Stage 2 – Pre-Deposit – Preparation and Participation	14	February 2018 – February 2020
Key Stage 3 – Pre-Deposit – Public Consultation	15,16, 16A	May 2018 – May 2019
Key Stage 4 – First Deposit Revised LDP	17-21	January 2019 – January 2021
Key Stage 4 – Second Deposit Revised LDP	17-21	March 2022 – March 2024
Focused Changes on ISA & HRA, including addendums	17-21	February – March 2024
Indicative		
Key Stage 5- Submission of LDP to WG for Examination	22	March 2024
Key Stage 6 – Independent Examination	23	March 2024 – January 2025
Key Stage 7 – Publication of Inspector's Report	24	March 2025
Key Stage 8 – Adoption	25, 25A	May – June 2025
Key Stage 9 – Monitoring and Review	37	Continued following adoption

[11] Revised Delivery Agreement (January 2024) Revised Carmarthenshire Local Development Plan 2018 – 2033.

3 Total Phosphorus (TP) Budget

Section 3 summarises the TP budget for the CCC rLDP with the Afon Tywi and Afon Teifi SACs. It also summarises the TP budget for Ceredigion County Council (CeCC) and Pembrokeshire County Council (PCC) LDP site allocations, to assess in-combination impacts on the Afon Teifi SAC. Calculations were undertaken in line the West Wales Nutrient Budget Calculator[12].

Arcadis has consulted with CCC, DCWW and NRW on several matters that materially impact the TP budget, which are summarised in Section 3.2.

3.1 Final rLDP Site Allocations Review

Since the early development of the IAP, there have been several iterations of the site allocations under the rLDP. For example, council planning officers have reviewed sites with a view to "screening out" sites which were deemed unlikely to come forward under the rLDP. This reduced the total allocations brought forward under the rLDP.

Further to this initial screening, in October 2023, the Council provided a finalised list of Site Allocations, which will be taken forward as part of the rLDP. In comparison to the list of screened in/out Site Allocations in the previous iteration of this report, one site allocation (SuV43/h2) was removed from the Afon Teifi SAC and one new site allocation (SuV16/h1) for the Afon Tywi SAC was included after initially being screened out.

A revision of the site allocation units was also undertaken, for example, SuV43/h1 which previously contained 8 units, was reduced to 5 units as three homes had already been built and were not required to be included in the nutrient budget.

For the Afon Tywi (Table 3-1), there are 7 site allocations with a total of 104 units. For the Afon Teifi (Table 3-2), there are 14 site allocations with a total of 172 units.

Table 3-1 Allocated Sites in the Afon Tywi following CCC Review

Afon Tywi				
Site Reference	No. of Units	Settlement	Area (ha)	WwTW
SuV16/h1	2	Capel Dewi	0.63	No public sewerage
SuV17/h1	35	Nantgaredig	1.52	Nantgaredig (Pontargothi)
SuV51/h1	8	Cwm Ifor	0.49	Cwm Ifor
SeC16/h1	27	Llandeilo	2.19	Ffairfach
SeC15/h2	8	Llandovery	1.19	Llandovery
SeC17/h1	16	Llangadog	0.60	Llangadog
SeC17/h2	8	Llangadog	0.40	Llangadog
Total	**104**		**7.02**	

Table 3-2 Allocated Sites in the Afon Teifi following CCC Review

Afon Teifi				
Site Reference	No. of Units	Settlement	Area (ha)	WwTW
SuV38/h1	6	Cwmann	0.65	Capel Iwan
SuV37/h3	10	Newcastle Emlyn	0.50	Lampeter
SuV37/h2	20	Llangeler	0.90	Lampeter
SuV39/h1	7	Waungilwen	0.51	Llanfihangel-ar-arth

[12] Carmarthenshire County Council. West Wales Nutrient Budget Calculator

Afon Teifi				
Site Reference	No. of Units	Settlement	Area (ha)	WwTW
SuV33/h1	5	Capel Iwan	0.40	Drefach/Felindre
SuV36/h2	16	Llanllwni	0.71	No public sewerage
SuV36/h1	6	Cwmann	0.35	No public sewerage
SeC13/h1	10	Llanybydder	0.50	Llanybydder
SuV43/h1	5	Newcastle Emlyn	0.73	Llandysul
SeC12/h1	17	Pencader	0.90	Adpar
SeC12/h3	20	New Inn	1.34	Adpar
SeC14/h2	24	Pontweli	0.76	Pencader
SeC14/h1	20	Llanllwni	0.61	Pencader
SuV35/h1	6	Pencader	2.50	Drefach/Felindre
Total	**172**		**11.35**	

3.2 NRW & DCWW Permitting Position

To understand DCWW's contribution to the phosphorus load to the rivers, and to assess any improvements DCWW would need to make to their WwTW discharges, DCWW have updated and re-calibrated their water quality models using the regulator and industry standard tool known as SAGIS (Source Apportionment Geographical Information System).

SAGIS has been used to identify and quantify the main sources of phosphorus within each water body within each of the SAC catchments. DCWW have produced their indictive Phosphorus Reduction Programme, detailing WwTWs likely to require a new phosphorus permit limit, to address DCWW's regulatory compliance needs.

This work has helped inform the Review of Permits (RoP) between NRW and DCWW, which have progressed substantially. Whilst the RoP is still progressing, many permits have already been issued (Table 3-3), including for WwTWs within the Teifi and Tywi catchment.

In February 2023, DCWW published an open letter to its stakeholders outlining progress made on the issue of phosphorus in Welsh SACs. Alongside this letter, details of the Review of Permits (RoP) was published. NRWs public register for environmental permits or licenses hosts the ultimate decision documents supporting the RoP, of particularly importance is PAN-018673, a decision document supporting the RoP project, which states:

"We have decided to review and where appropriate issue variations for Environmental Permitting Regulations water discharge activity permits from an agreed list of Dŵr Cymru Welsh Water Waste Water Treatment Works...

We consider in reaching that decision we have taken into account all relevant considerations and legal requirements and that the permit will ensure that the appropriate level of environmental protection is provided"

In other words, where a permit has been reviewed and issued, taking into consideration its effective date (which can vary from immediate to March 2030), it can be assumed that the environmental impact of this new limit has been considered according to NRWs duty under Article 6(2) of the Habitats Directive. As such, so long as a site allocation is discharging to a WwTW with a reviewed permit that is effective before its planned occupation, it can be assumed that there would be no likely adverse impact on the SAC resulting from an increased discharge of phosphorus.

SAGIS modelling has been used to identify where DCWW must remove additional phosphorus in order to meet their 'fair share' of the improvements needed. DCWW's programme states that all

WwTWs discharging over 20m^3/day to a SAC or discharging to a non-designated water body draining to a SAC (i.e., where there is no TP limit currently in place), will meet a backstop phosphorus permit limit of 5 mg/l by the end of the investment programme (2032)[13].

It should be noted that all WwTWs assessed in this report qualify under these conditions i.e., all WwTWs in this assessment discharge over 20m^3/day without a P permit and will be subject to at least a backstop P limit of 5 mg/l by the end of DCWW's planned investment programme (2032).

However, there are circumstances where the actual permitted value will be lower than 5mg/l due to existing and/or proposed WwTWs enhancements. For six WwTW locations within the Afon Teifi SAC, implementation of a tighter TP limit has already been confirmed, however, most of them will not be implemented until 2030 and therefore the backstop P limit has been applied.

The TP budget load calculations have been made using a backstop permit 5mg/l TP, with the exception of those discharging to Lampeter or Llanybydder, as the improvement are due in Annual Management Plan (AMP) period 7 (AMP7) (before 2025).

DCWW have released key documents[14] relating to their SAGIS modelling and planned phosphorus reduction investment strategy under the emerging programme. This will support collaborative efforts with their key stakeholders to restore the SACs to favourable conservation status whilst supporting the economic development of Wales. The expected completion of this programme is the end of 2032, delivered over multiple 5 yearly AMP investment periods that will require prior agreement with the Water Services Regulation Authority (OFWAT).

Table 3-3 Summary of DCWW Phosphorus Reduction Scheme by WwTW for Carmarthenshire rLDP

SAC	WWTW	RoP Status	P permit mg/l	Date Implemented	Permit No.
Afon Teifi	Capel Iwan	Accepted	1.8	2030	BN0054901
	Pencader	Proposed	3.5	2032	BG0007801
	Llanybydder	Accepted	2.5	2025	BJ0091401
	Lampeter	Accepted	0.5	2025	BP0045001
	Tregaron	Accepted	2	2030	BH0057801
	Pontrhydfendigaid	Accepted	1.8	2032	BN0040202
	Drefach/Velindre	Accepted	5	Effective Dec '23	BH0060601
	Adpar	Accepted	5	Effective Dec '23	BN0112801
	Llandysul	Accepted	5	Effective Dec '23	BG0010201
	Llanfihangel-ar-arth*	Proposed	5	2032	BN0020802
Afon Tywi	Cwm Ifor	Proposed	5	2030	BN0103601
	Ffairfach	Proposed	5	2030	BH0065401
	Llandovery	Accepted	5	Effective Aug '23	BN0202701
	Llangadog	Accepted	5	Effective Jul '23	BG0040001
	Pont-ar-Gothi & Nantgaredig	Accepted	5	Effective Jul '23	BN0002601

[13] DCWW (2023) Phosphorus Programme Cover Letter.
[14] DCWW (2023) Understanding the sources of phosphorus in our rivers

** Llanfihangel-ar-arth WwTW currently does not have a confirmed date for its new permit. Therefore, the end of the DCWW investment programme has been assumed.*

3.3 Carmarthenshire Final TP Budget Estimate

As described in Section 3.2, all WwTWs in this assessment discharge over 20m^3/day without a P permit and will be at subject to at least a backstop P limit of 5 mg/l by the end of DCWW's planned investment programme (2032).

This section provides the nutrient budget calculations for each site allocation in the Afon Tywi (Table 3-4) and Afon Teifi (Table 3-5) SAC using the relevant AMP7 permits. For WwTW with no current implemented permit, a backstop of 5 mg/l P is applied.

Following the methodology set out in Figure 1-5, the results below show that Stage 1 (the TP loading that comes from wastewater discharge due to developments) is the main contributor to the overall Stage 4 Nutrient Budget, compared to the loading difference in the Stage 2 (current land use TP load) and Stage 3 (post-development TP load) calculations.

Table 3-4 Latest Nutrient Budget Summary in the Afon Tywi

Afon Tywi				
Site Ref	Stage 1 (kg TP/year)	Stage 2 (kg TP/year)	Stage 3 (kg TP/year)	Stage 4* (kg TP/year)
SuV16/h1	1.96	1.18	1.63	2.89
SuV17/h1	17.64	0.37	3.95	25.47
SuV51/h1	4.03	0.12	1.29	6.24
SeC16/h1	13.61	2.99	4.37	17.99
SeC15/h2	4.03	1.58	3.09	6.64
SeC17/h1	8.06	0.26	1.55	11.23
SeC17/h2	4.03	0.71	1.05	5.24
Total	**53.37**	**Total Nutrient Budget**		**75.69**

**Includes a 20% precautionary buffer to provide confidence that mitigation of the nutrient budget will remove the risk of adverse effects, as per West Wales Nutrient Budget Calculator[77].*

Table 3-5 Latest Nutrient Budget Summary in the Afon Teifi

Afon Teifi				
Site Ref	Stage 1 (kg TP/year)	Stage 2 (kg TP/year)	Stage 3 (kg TP/year)	Stage 4* (kg TP/year)
SuV38/h1	3.02	0.41	1.94	5.46
SuV37/h3**	0.50	0.94	1.30	1.03
SuV37/h2**	1.01	1.34	2.34	2.42
SuV39/h1	3.53	0.90	1.52	4.98
SuV33/h1	2.52	0.11	1.05	4.15
SuV36/h2	15.65	0.18	1.84	20.77
SuV36/h1	5.87	0.09	1.05	8.20
SeC13/h1**	2.52	0.01	1.31	4.58
SuV43/h1	2.52	0.07	2.18	5.55
SeC12/h1	8.57	0.16	2.07	12.57
SeC12/h3	10.08	0.28	2.82	15.15
SeC14/h2	12.10	0.19	2.28	17.02
SeC14/h1	10.08	0.50	1.82	13.68
SuV35/h1	3.02	0.46	6.50	10.88
Total	**80.99**	**Total Nutrient Budget**		**126.45**

**Includes a 20% precautionary buffer to provide confidence that mitigation of the nutrient budget will remove the risk of adverse effects, as per West Wales Nutrient Budget Calculator[7].*

*** As discussed in Section 3.2, these development discharge to Lampeter and Llanybydder WwTW. New P permits will be implemented at these WwTW locations as part of the current AMP7 programme and therefore these tighter TP limits have been used in the nutrient budget calculations.*

3.4 Cumulative TP Budget

In line with the HRA compliance assessment, there is a clear need to consider the impacts of planned new developments that discharge to the Teifi SAC from the adjacent LPAs (CeCC and PCC) to the west of Carmarthenshire.

CeCC LDP (LDP2) is currently on pause due to the phosphate issue being unaddressed and although the current adopted LDPs plan period ended in 2022, it will continue to be the Development Plan for Ceredigion until a Replacement Plan is adopted. Therefore, those currently allocated LDP sites that are yet to be fully developed have been included in the TP budgets.

Similarly for PCC, the current adopted LDP's plan end date of 2021 has been disregarded, so that it will continue to be the Development Plan for Pembrokeshire until a Replacement Plan is adopted. Therefore, those site allocations that were considered in the Deposit Plan of 2020 have been included in the TP budget.

As per the Carmarthenshire rLDP nutrient budget calculations (Section 3.3), unless otherwise stated to have an implemented tighter permit within AMP7, the 5mg TP/l backstop has been used in calculations.

As shown in Table 3-6, within both Ceredigion and Pembrokeshire, Stage 1 (the TP loading that comes from a developments wastewater) is the main contributor to the overall Stage 4 Nutrient Budget. In line with the CCC nutrient budget calculations, unless otherwise stated to have a new TP permit within AMP7, a backstop of 5mg TP/l has been used in calculations.

Table 3-6 Latest Nutrient Budget Summary in Ceredigion and Pembrokeshire using the relevant AMP7 Permits

Ceredigion				
Site Ref	Stage 1	Stage 2	Stage 3	Stage 4*
	(kg TP/year)	(kg TP/year)	(kg TP/year)	(kg TP/year)
H0401	17.72	0.61	5.67	27.33
H0501**	0.61	1.69	1.69	0.73
H0502**	1.01	0.19	1.77	3.11
H0503**	0.46	0.13	1.48	2.17
H0504**	4.56	1.04	10.26	16.53
H0505**	5.32	1.00	9.17	16.18
H0601	63.79	1.16	10.53	87.78
H0701	18.22	0.41	4.09	26.28
H0702	19.24	0.35	3.34	26.67
H1101	3.54	0.85	0.85	4.25
H1102	8.61	0.68	1.73	11.59
H1103	7.09	0.96	1.82	9.53
H2001	22.27	3.10	3.86	27.64
H2002	9.62	0.18	1.69	13.35
M0701	29.53	0.82	7.52	43.47

Ceredigion				
Site Ref	Stage 1	Stage 2	Stage 3	Stage 4*
	(kg TP/year)	(kg TP/year)	(kg TP/year)	(kg TP/year)
Subtotal	**211.57**	**Subtotal Nutrient Budget**		**316.62**
Pembrokeshire				
Site Ref	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4***
	(kg TP/year)	**(kg TP/year)**	**(kg TP/year)**	**(kg TP/year)**
HSG/001/LDP2/01	5.35	0.11	1.16	7.68
HSG/020/LDP2/1	24.33	5.00	7.72	32.45
Subtotal	**29.68**	**Subtotal Nutrient Budget**		**40.13**
Total	**241.25**	**Total Nutrient Budget**		**356.75**

**Includes a 20% precautionary buffer to provide confidence that mitigation of the nutrient budget will remove the risk of adverse effects, as per West Wales Nutrient Budget Calculator[7].*

***Sites with a current AMP7 permit of 0.5mg TP/l as opposed to the inferred 5mg TP/l. New P permits will be implemented at these WwTW locations as part of the current AMP7 programme and therefore these tighter TP limits have been used in the nutrient budget calculations.*

3.5 Summary

Based on the Nutrient Budget summaries above, the cumulative budget for CCC, CeCC and PCC to mitigate is **558.89kg TP/year**. This would allow a total of **929** residential units to come forward from the respective LDPs (**276** units from Carmarthenshire, **592** units for Ceredigion and **61** units for Pembrokeshire).

A summary of the cumulative nutrient budget requirements all three counties can be found in Table 3-7.

Table 3-7 Summary of cumulative nutrient budget.

LDP	SAC	No. of Units	Nutrient Budget (kg TP/year)
Carmarthenshire	Tywi	104	75.69
Carmarthenshire	Teifi	172	126.45
Ceredigion	Teifi	592	316.62
Pembrokeshire	Teifi	61	40.13
Total (Cumulative)		**929**	**558.89**

As discussed in Section 3.4, the CeCC LDP (LDP2) 2018 – 2033 and PCC LDP (LDP 2) have been on hold following the advice issued by NRW. In Ceredigion, the replacement LDP has been on hold since 2020. As this LDP develops in the future, there is the potential that some of the site allocations in this assessment are screened out, or new developments are screened in. This exercise would influence the nutrient budget and mitigation requirements in the Teifi SAC catchment. Similarly for PCC, the LDP review (LDP2) has developed with a return to the Deposit Stage anticipated, which is yet to be confirmed. The timetable is not yet finalised as it is dependent on the release of information and outcomes of research. As a result, specific dates for this are not yet identified[15].

[15] Pembrokeshire County Council Local Development Plan Review (LDP 2) Delay to LDP 2 Timetables and return to 2nd Deposit Plan Stage.

Therefore, the cumulative budget is based on the latest information and could be subject to change as the respective LDPs are developed for examination and adoption. Should the development of the respective LDPs impact the current TP budget and mitigation requirements along the Afon Teifi, CeCC and PCC would need to explore any additional mitigation required.

4 Outline Solutions Screening

4.1 Sources of Pollution

The increase in wastewater and/or the change in land-use due to a new development, will result in an additional nutrient load. This can create an 'impact pathway' that will exacerbate the existing nutrient loading issues already seen in Carmarthenshire's SACs. Examples of multiple impact pathways can be seen in Figure 4-1.The impact pathway for nutrients will result in a HRA finding 'Likely Significant Effects' on the SACs because of the increase in nutrient load from new developments. In this regard, the two significant nutrients that are output from new developments are nitrogen (N) and phosphorus (P). All riverine SACs within Carmarthenshire are under pressure from levels of phosphorus[7].

It is important to understand the sources of pollution, both existing sources and proposed new sources, created by the proposed site allocations in order to implement mitigation. Mitigation should, where possible, be implemented at the source. Using the TP Budget loads, which can be categorised based on each WwTW or location, combined with the results of the Source Apportionment modelling when they are available. Hotspots and key contributors can be identified across the catchment, which allows for more targeted solutions to be implemented.

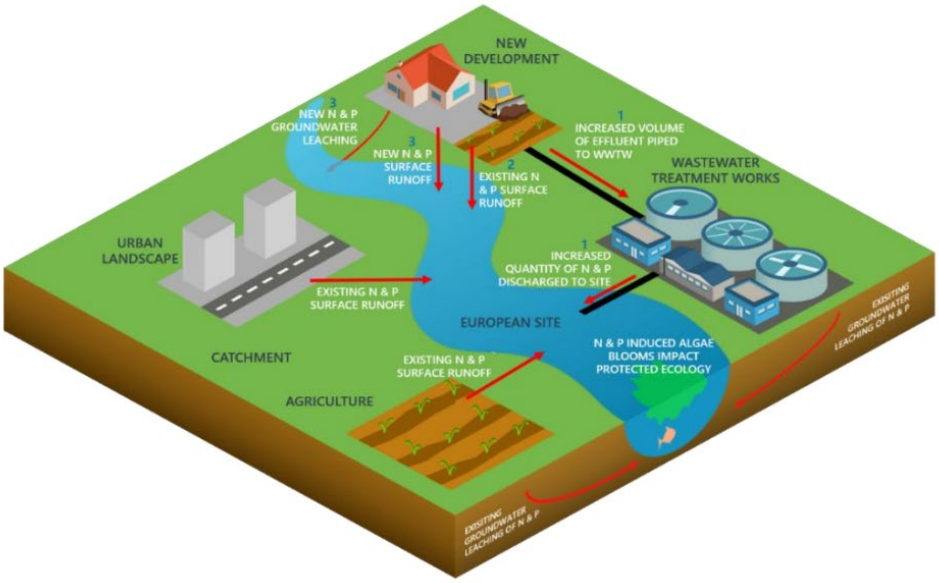


Figure 4-1 Diagram showing potential nutrient impact pathways[12]

The primary sources of excess phosphorus in water bodies are:

- **Agriculture**: phosphorus in animal manure and chemical fertilisers are necessary to grow crops. However, when these nutrients are not fully utilised by plants, they can be lost from the farm fields and negatively impact air and downstream water quality, otherwise known as eutrophication. This varies according to agriculture type, with more 'intensive' systems like dairy, potatoes, wheat being generally considered to be higher contributors, and more extensive systems like beef, sheep being less phosphorus consuming, and therefore lower contributors. The Teifi valley is mainly rural with agriculture and forestry accounting for the majority of land usage. Large dairy units predominate in the lower reaches of the Teifi, with mixed dairy and livestock rearing present in the middle reaches. In the upper area, the poorer soil conditions restrict agriculture to livestock rearing on rough grazing and improved pastures.
- **Wastewater**: Phosphorus is removed from sewage via either chemical or biological methods. Chemical precipitation occurs when phosphorus is forced to react with iron, aluminium, or calcium, to form solid precipitates that can be collected. Either the chemical precipitate (sludge) or the

phosphorus-enriched bacteria can then be scooped out of the sewage treatment plant as 'biosolids'. WwTW are responsible for treating large quantities of waste, and these systems do not always operate properly or remove enough nitrogen and phosphorus before discharging to waterways.

- **Stormwater**: Sources of phosphorus in urban runoff include plant and leaf litter, soil particles, pet waste, road salt, fertilizer, and atmospheric deposition of particles. Lawns and roads account for the greatest loading. Increased surface water runoff then carries phosphorus and other pollutants into local waterways.

As per the latest Phosphorus Source Apportionment Summary on the Afon Teifi, model results suggest, at the furthest downstream point in the (modelled) river, approximately 45kg of phosphorus is discharged from the catchment daily[16]. It was found that the predominant source of phosphorus in the Afon Teifi is WwTW; 66% of the average daily load (kg/d), rural land use only contributes 30% of the daily phosphorus load, storm overflows (intermittents) contribute 3% and a further 1% from other sources such as septic tanks and urban run-off. This confirms that phosphorus load in the Afon Teifi is largely driven by WwTW discharge. Figure 4-2 gives an overview of the source apportionment loads for the Afon Teifi riverine SAC catchment. The Afon Teifi Phosphorus Loading Overview, which shows a breakdown of the phosphorus load and a breakdown of the sources of pollution within each water body has been published by DCWW[17], and a copy can be found in Appendix C.

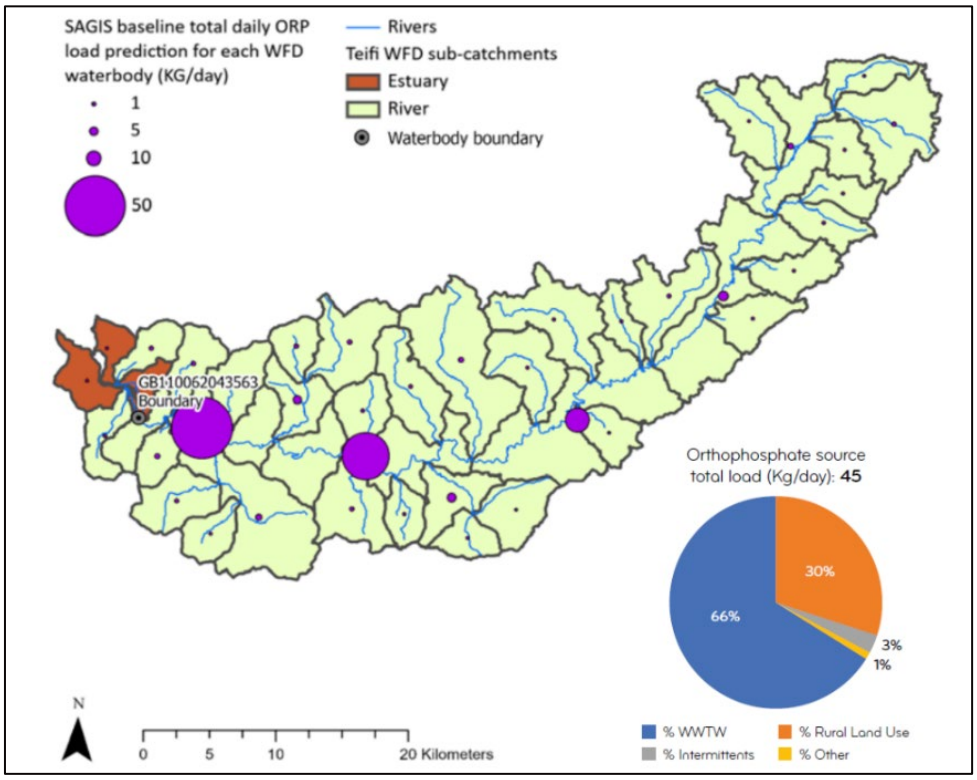


Figure 4-2 Afon Teifi Phosphorus apportionment by source[16]

Note: The source apportionment represents that of the boundary of the furthest downstream WFD water body in the Afon Teifi catchment (GB110062043563). Load prediction points are plotted at the centre of each WFD water body. The "Other" category is comprised of estimated contribution from diffuse sources of urban, industry and septic tanks.

As per the latest Phosphorus Source Apportionment Summary on the Afon Tywi, model results suggest that, at the furthest downstream point in the (modelled) river, approximately 60kg of

[16] Phosphorus Source Apportionment Summary (2022). Updating the SAGIS Afon Teifi Model. SAGIS Non-Technical Calibration Report for the Afon Teifi.
[17] Afon Teifi Phosphorus Load Overview

phosphorus is discharged from the catchment daily[18]. It was found that the predominant source of phosphorus in the Afon Tywi is land use; 86% of the average daily phosphorus load (kg/d). WwTW contribute 11% and a further 3% from other sources such as septic tanks and urban run-off. This confirms that phosphorus load in the Afon Tywi is largely driven by rural land use. *Figure 4-3* gives an overview of the source apportionment loads for the Afon Tywi riverine SAC catchment. The Afon Tywi Phosphorus Load Overview has recently been published by DCWW[19], and a copy can be found in Appendix C.

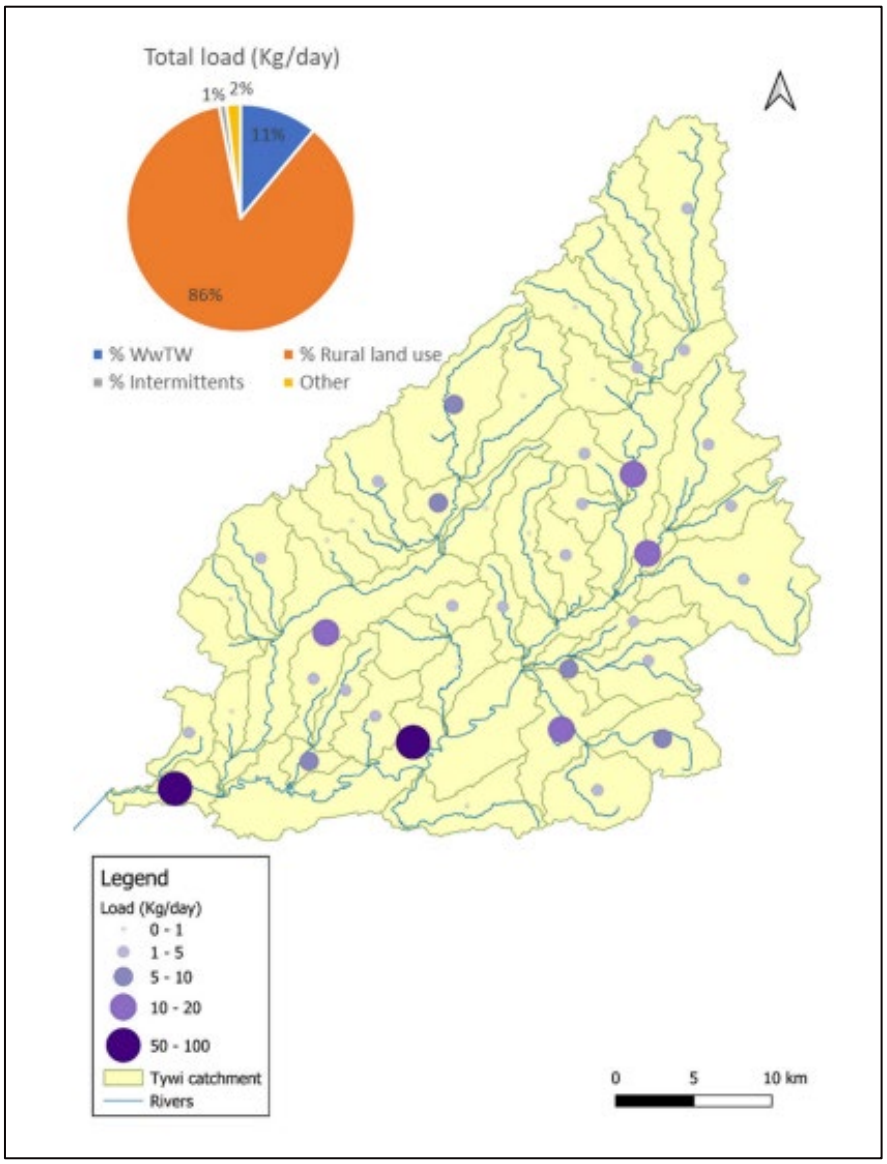


Figure 4-3 Phosphorus apportionment by source at the furthest downstream point on the River Tywi.

***Note**: that the 'Other' category is comprised of estimated contribution from diffuse sources of urban, industry and septic tanks.*

[18] Phosphorus Source Apportionment Draft Summary (2023) Updating the SAGIS River Tywi Model 2023. SAGIS Calibration Summary.
[19] Afon Tywi Phosphorus Load Overview.

4.2 Potential Solutions

DCWW[14] and NRW have both expressed their position on what intervention measures they will and will not support for phosphorus mitigation. NRW have published their final Policy on Constructed Wetlands[20] in October 2023. Additionally, NRW have recently shared their 'live' mitigation menu[21] with WG and the Nutrient Management Board (NMBs). The document outlines various nutrient mitigation measures and the evidence underpinning their ability to reduce nutrient levels in water as shown below. A full list of mitigation measures from the NRW Mitigation Measures Menu can be found Figure 4-4, with a detailed summary in Appendix C.

- Vertical Flow Wetlands
- Algae Treatment
- Reed Beds
- Private Treatment Systems
- River Restoration
- Terrestrial Sediment Traps
- Drainage Ditch Blocking
- Water Stabilisation Ponds

For DCWW, wetlands for use on their WwTW sites must meet certain criteria:

- Treatment works must have a Population Equivalent (PE) of less than 2000 to minimise wetland surface area footprint.
- Have high enough permit limit to warrant wetland construction.
- Ensuring whether the trade effluent contains damaging chemicals to wetlands.

For each of the options, consideration must be given to the practical upkeep and monitoring required for its long-term maintenance. As well as this, the various factors which may affect the efficacy of each solution must be considered when deciding on the mitigation option which will maximise potential P removal, in any given location.

Proposals for any scheme put forward should give detail on:

- Design objectives
- Feasibility assessment
- Design overview
- Detailed design of the solution
- Implementation of the solution
- Monitoring strategy
- Management and maintenance

[20] Natural Resources Wales (2023) Policy on Constructed Wetlands
[21] Natural Resource Wales (2023) Mitigation measures menu.

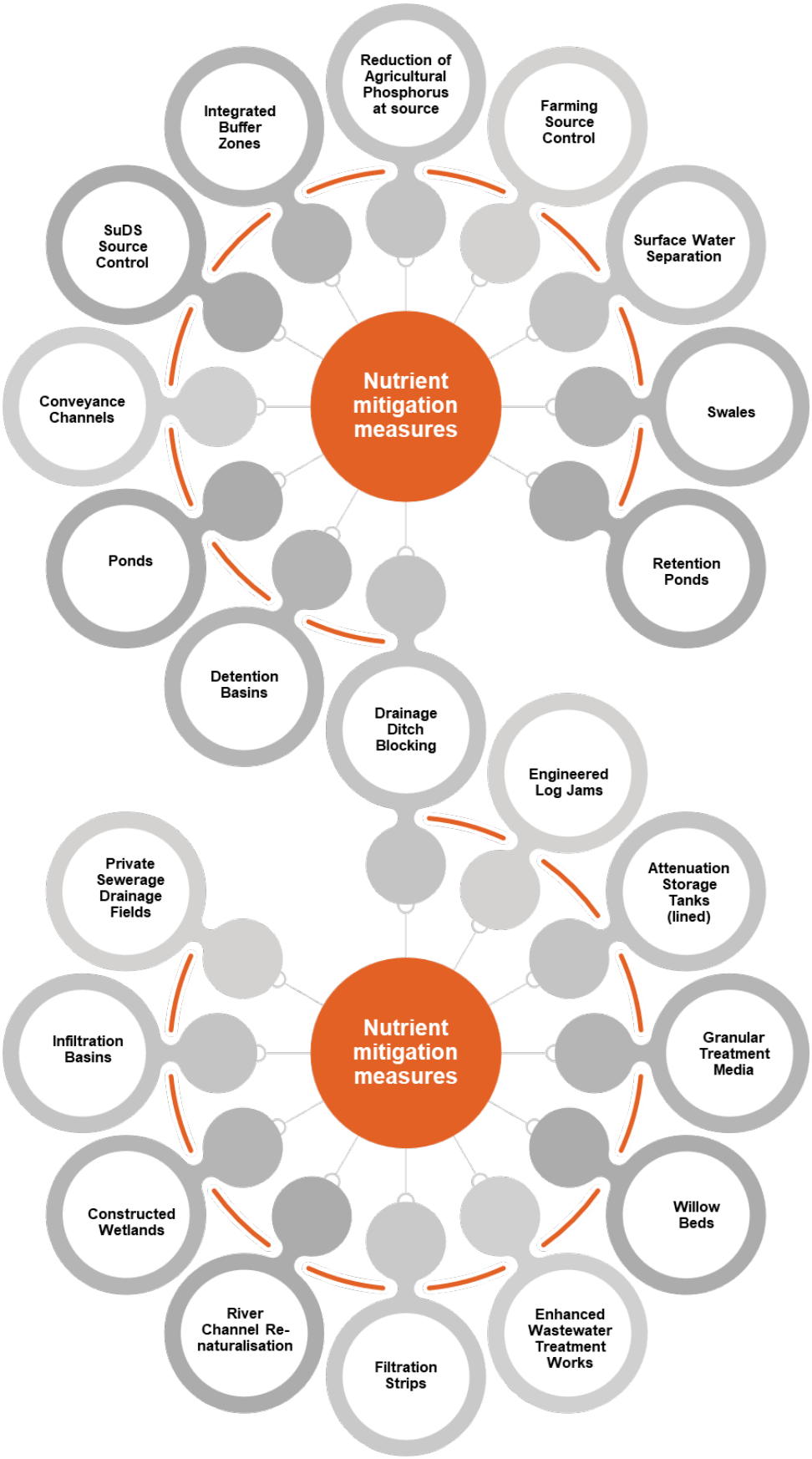


Figure 4-4 Nutrient Management Interventions

4.3 On-site / Off-site mitigation

As shown in Table 3-1 and Table 3-2, all of the sites are relatively small (<2 ha) and the area available for onsite mitigation opportunities are therefore limited.

Onsite solutions, such as Sustainable Drainage Systems (SuDS) could be designed to manage surface water runoff and provide nutrient mitigation, as discussed further in Section 7.1 and shown in Appendix D

Sections 5 and 6 outline the main offsite solutions which could be explored to demonstrate nutrient neutrality. However, alternative additional options like SuDS, tree planting and integrated buffer strips have been explored in Section 7.

4.4 Approach

The below sets out the approach taken to developing mitigation solutions in support of delivering the rLDP, whilst considering the requirements of the HRA Phosphate assessment appendix.

4.4.1 Nutrient Neutrality vs. Headroom Approach

The requirement for nutrient neutrality is defined by the compliance of the SAC against its phosphate targets. This has been presented earlier in this document (Section 1.5), which shows the Teifi SAC to have widespread failures, particularly in the lower reaches. As such, any additional phosphorus discharges in the catchment have the potential to exacerbate the issue and a nutrient neutrality approach is applicable to mitigate this risk. This means that any development brought forward must be appropriately mitigated to avoid further deterioration.

In contrast, the Tywi SAC is comfortably passing against its targets. In considering this, it's important to consider the scale of impact arising from additional development versus the broader phosphate loading in the catchment, which is dominated by the agricultural land uses. The additional TP from the rLDP Site Allocations is very low (75.69 Kg/year) compared to its current receiving values (22,150 Kg/year[18]) which equates to a yearly increase in phosphate loading of 0.35%. As such, this additional phosphate loading is highly unlikely to reduce the environmental headroom sufficiently to trigger a phosphate compliance failure in the SAC. As a result, an environmental headroom approach will be applied for the Tywi SAC, and this headroom will be monitored (working closely with the key parties of the NMB) to ensure that this is not being eroded and if required nutrient neutrality can be applied on developments on a project-by-project basis in the future. For a more detailed rationale on this, see the HRA phosphate assessment appendix.

Also, as highlighted in Section 1.5.1 , some potential strategic mitigation options have been explored in this AP for maintaining the environmental headroom. This is to ensure that should the environmental headroom reduce in the future, or should the council decide that new sites (outside of the rLDP) on a case-by-case require nutrient neutrality to be demonstrated (i.e. when determining future planning applications), then such strategic mitigation options can be taken forward.

4.4.2 Mitigation Categories

Where mitigation has been considered, a hierarchy of solutions has been considered, alongside a categorisation of measures as detailed below.

Table 4-1 shows the recommended hierarchy of solutions which should be used to mitigate the additional P loading that will be generated by new developments in Carmarthenshire within the Afon Teifi SAC drainage catchment.

Two categories of measures have been presented.

- Category 1 measures – those which allow compliance with the Habitats Regulations and avoid adverse effects from the developments arising from the rLDP allocations.
- Category 2 measures – those that will deliver wider phosphorus reductions across the catchment to increase certainty of success, increase and/or maintain headroom and that could be utilised by developers on a project basis should this be required.

Table 4-1: Hierarchy of Solutions

Mitigation Option	Category	P Removal	Costs	Scale	Feasibility
Enhanced WwTW	1	High	High	Medium	Medium
Constructed Wetlands	1	Medium – High	Low	Medium	Medium
Land Management	2	Low	Medium – High	Low	Low
SuDS	2	Medium - Low	Low	Low	Medium
Tree Planting	2	Low	Low	Medium	Medium
Integrated Buffer Zones	2	Medium – High	Low	Medium	Medium

The Interventions Measures Matrix in Appendix D also outlines further potential mitigation measures with regard to their feasibility and effectiveness as solutions for P removal. A number of interventions are highlighted as having ‘high’ effectiveness, however out of these only two options have both ‘high’ feasibility as well. These are farming source control and surface water separation. The feasibility of a solution is determined by feasibility to put in place, with consideration to likely cost as well as capacity.

5 Enhanced WwTWs

A small quantity of phosphorus is naturally removed through WwTWs with solids settlement and biological treatment processes. However, this is not enough to remove the quantities required to meet phosphorus limits. To achieve this, many techniques have been developed to remove phosphorus through the treatment process. In some cases where existing phosphorus permits are being tightened or new permits are introduced, a combination of techniques may be required. These consist of:

- **Chemical Precipitation** – where metal salts are used to precipitate the phosphate component through flocculation and settlement. The use of rare elements to remove phosphorus has also shown to be effective at P removal as rare earths form a strong crystalline ionic bond with phosphates, unlike the chemical approach of iron- and aluminium-based coagulants, which do not bind to phosphorus as efficiently[22]
- **Physical separation** – where filtration is used to remove the suspended solids phosphorus component. One example of this is electrocoagulation which destabilizes and aggregates contaminant particles, ions such as heavy metals, and colloids, using an electrical charge to hold them in solution.
- **Enhanced biological phosphorus removal** – where an anaerobic phase positioned upstream of an activated sludge process encourages growth of phosphorus accumulating microorganisms to take up phosphorus in the downstream aerated stage.
- **Algae treatment** – where algae is used to naturally consume the phosphorus as a nutrient. This is a relatively new technology. This solution is already being used by South West Water.[23]
- **Reedbeds** – where there have been developments in phosphorus adsorbing media being used as the base for the reedbed.
- **Constructed wetlands –** where high retention times encourage settlement and natural uptake of phosphorus.

As documented in Section 3.2, the RoP has identified and committed to several enhancements to existing DCWW WwTWs to establish a new lower permit for TP. Instances of this, such as Llanybydder and Lampeter (Improvements to be complete by 2025) will enable planning for developments connecting to these works, thus removing the need for nutrient neutrality.

Several other WwTWs within the Teifi catchment have been identified for improvements to reduce the TP limit. However, these improvements are not due to complete until the end of AMP8 (2030) or during AMP9 (2032). In these instances, developments scheduled to complete ahead of these dates would require nutrient neutrality to be demonstrated.

No WwTWs have been identified for major upgrades to enhance treatment in the Tywi catchment, largely due to the fact that the catchment is not failing against its phosphorus targets (see Section 1.5). Despite this, backstop limits have been proposed at many works within the catchment, which have been assessed as reasonable to prevent deterioration of the condition of the SAC. This helps support the environmental headroom approach within this catchment, as it ensures that provided the treatment works has capacity for treating additional wastewater, the final quality of effluent leaving the works will not exceed the proposed backstop limit, which has been fixed to avoid deterioration of the SAC.

[22] Neo WaterFX Superior Phosphorus Removal
[23] South West Water (2020) Use of I-Phyc's algae-based treatment

5.1 Collaboration on Phosphorus Reduction Schemes

DCWW[14] have expressed their position on what intervention measures they will and will not support for phosphorus mitigation. For DCWW, wetlands developed alongside their WwTW sites must meet certain criteria:

- Treatment works must have a Population Equivalent (PE) of less than 2000 to minimise wetland surface area footprint.
- Have high enough permit limit to warrant wetland construction.
- Ensuring whether the trade effluent contains damaging chemicals to wetlands.

These requirements are documented in DCWW's guidance document on 'Collaboration on Phosphorus Reduction Schemes'[24]. The guidance sets out 5 collaboration categories (A, B1, B2, C & D) and for each outlines the opportunity to collaborate, potential funding routes, and roles and responsibilities when co-delivering.
While categories may be subject to change, the preliminary desktop screening aims to provide a starting point for focused and well directed Constructed Treatment Wetland (CW) feasibility studies. These categories are summarised in Table 5-1.

[24] DCWW (2023)

Table 5-1 DCWW WwTW Collaboration Categories

Category	Qualifying Criteria	Impact on Collaboration
A	DCWW has an existing TP limit of ≤4mg/l. DCWW will have a TP limit of ≤4mg/l in future AMPs. The current or future flows expect to increase the population equivalent the treatment WwTW serves over the suitable flows for a wetland to accommodate. The WwTW receives trade effluent that contains certain substances that is likely to harm a wetlands habitat, or make the normal treatment process a wetland can provide, inefficient.	No further TP via CW is possible. No collaboration opportunities are available at this site for further TP reduction. No Proformas or collaboration requests can be processed for these WwTW.
B1	DCWW has an existing TP limit >4.1mg/l DCWW will have a TP limit of >4.1mg in future AMPs DCWW's future AMP TP limit will require investment*	There is potential for further TP reduction. Collaboration opportunity is available at these WwTW. This collaboration may involve a jointly owned CW (different cells owned by different organisations but part of the same interconnected wetlands). Both parties garner a reportable TP reduction from the CW. Category B WwTW are subject to change. The categorisation is based on current sample data. Sites may transition to a category D site, as our understanding of the site's performance increases during route course analysis. The impact of this change in category (from B to D) will mean the wetlands transitions from being a jointly owned and funded CW, to a 3rd party solely owned and funded CW.
B2	DCWW has a future AMP water quality investment need (within certain limits), that is non-Phosphorus related** DCWW's future AMP driver, has the potential to be addressed by a CW (based on known flows and WwTW dynamics among additional variables)	CW is anticipated to form part of/all the solution required to address DCWW's water quality driver. CW solution could also be designed to reduce TP There is a need for a multi-scope feasibility to be agreed in the inception meeting to understand if the CW can address both organisation's needs. This collaboration may involve a jointly owned CW (different cells owned by different organisations, with clear compliance demarcation, but part of the same interconnected wetlands). DCWW garners it's required water quality parameter reduction, partner organisation garners TP reduction from the same CW.
C	DCWW has AMP8 driver that is non- Phosphorus related. DCWW expects to have a conventional solution to address the water quality improvement (determined by the % reduction required or the route course analysis).	Further TP reduction is available following DCWW's future AMP investment. Though both organisations require separate solutions. The impact of this, and the difference between a Category C WwTW and a Category D WwTW, is that the future flow and water quality parameters are what the feasibility should be based upon. Not the current parameters.
D	Based on current regulation and policies, DCWW has no anticipated future investment need (now or future AMPs) due to the sites current performance, % of growth anticipated, flows and/or location of the WwTW in the catchment.	Partners can progress feasibility, using current parameters, provided by the WwTW Asset Information Pack DCWW supports with effluent transfer only, full TP reduction provided by the CW is the reportable benefit of the third party.

**As opposed to a WwTW that requires a TP limit, but the site is already meeting the new permit limit or will do so by the regulatory deadline.*

***For example, ammonia reduction target, or another water quality parameter*

Further discussion with DCWW may be needed to establish if any collaboration opportunities are still available at the Category A WwTW locations. For example, where suitable wetland sites are present, there are other stakeholder and/or DCWW drivers to promote such nature-based solutions and proposed TP permit is > 1mg/l. This is because current research shows that it is still possible to remove phosphorus when the influent concentration strength is < 4mg/l TP (the threshold currently being used by DCWW). However, this will require further modelling using *P-K-C** and *K-C** analytical methods to determine suitable wetland sizes to ensure the desired treatment performance. It is also important to recognise that wetlands can provide multiple benefits, including other water quality treatment benefits, not just phosphorus.

Table 5-2 below shows the proposed P permit and current collaboration category for those WwTWs that will receive flows from Carmarthenshire rLDP site allocations. Currently, there are four WwTWs in Collaboration Category A that receive flows from Carmarthenshire rLDP site allocations. This means that, at present, no DCWW collaboration opportunities are available at these locations. As discussed in Section 3.2, Lampeter and Llanybydder are included in DCWW's current investment programme, which are classed as Collaboration Category A based on their new proposed AMP7 P permits. Capel Iwan and Pencader are also in Collaboration Category A, with tighter P permits proposed, however, these improvements are planned in the future AMP9 cycle. It should also be noted that there are two more Collaboration Category A WwTWs (namely, Tregaron and Pontrhydfendigaid) within the Afon Teifi SAC, due to their tighter P permits under future AMP8/9 cycles, but they will only receive flows from the adjacent Ceredigion County Council area.

The WwTW's and their associated collaboration opportunities are shown in Figure A2 in Appendix A.

Table 5-2 Summary of DCWW Phosphorus Reduction Scheme by WwTW for Carmarthenshire rLDP

SAC	WWTW	Permitted DWF m^3/day	Collaboration Category
Afon Teifi	Capel Iwan	82	Category A
	Pencader	439	Category A
	Llanybydder	1019	Category A
	Lampeter	1201	Category A
	Tregaron*	-	Category A
	Pontrhydfendigaid*	-	Category A
	Drefach/Velindre	943	Category B1
	Adpar	535	Category B1
	Llandysul	689	Category B1
	Llanfihangel-ar-arth	56.3	Category B1
Afon Tywi	Cwm Ifor	92.5	Category B1
	Ffairfach	847	Category B1
	Llandovery	705	Category B1
	Llangadog	427	Category B1
	Pontargothi	171	Category B1

* *Tregaron and Pontrhydfendigaid are located in the upper Teifi catchment and only receive flows from the adjacent Ceredigion County Council. However, they may provide strategic locations for mitigation to mitigate downstream development impacts and have therefore been included.*

6 Constructed Wetlands

Constructed wetlands are densely vegetated water bodies that use natural processes to provide treatment of surface water runoff and WwTW final effluent. They remove fine sediments, metals and particulates, and dissolved nutrients. They can consistently provide the largest P removal capacity of the nature-based solutions and the greatest biodiversity benefits. Constructed wetlands designed for nutrient mitigation are distinguished from other wetlands in that they receive a well-defined source of water and are managed to improve the quality of water through creating and maintaining appropriate water depths and flows.

A high-level feasibility study has been carried out across the Afon Tywi and Afon Teifi catchments to identify the most suitable locations for constructed wetlands. To meet the objectives of the Habitat Regulations, a wetland scheme must provide effective mitigation for nutrient loads to avoid any adverse effects on SACs.

Section 6.1 provides a summary of the estimated nutrient reductions and wetland area requirements along the Afon Teifi and Afon Tywi, which would achieve nutrient neutrality and satisfy the HRA. Section 6.2 and 6.3 outline the technical feasibility behind CWs and opportunities across the Carmarthenshire.

6.1 Wetland Requirements

6.1.1 Indicative Mitigation Requirements

Table 6-1 and Table 6-2 show the indicative wetland area requirements for each LPA, which includes an additional 25% buffer to account for the required earth reprofiling and bunds which would be required to deliver the effective treatment area.

There is limited information to accurately quantify the effective P reduction for the various mitigation options, particularly at a catchment scale, due to limited monitoring data that is applicable for specific site conditions. However, the median P removal rates from constructed wetlands can be considered as 1.2 g m^{-2} $year^{-1}$. Whilst this is acceptable to use for the current initial feasibility stage, it does not take into account the inlet concentration of TP within the receiving effluent and hydraulic retention time within the proposed wetland cells, which will strongly influence the load removal in most wetland treatment systems.

As further discussed in 6.1.2, more accurate design approaches have been undertaken as part of the Phosphate Reduction and Mitigation Project (PRAM Project) for the Afon Teifi SAC Catchment[25]. Part of this funding has been allocated for progressing two integrated constructed wetlands (ICWs) to planning. The overall objective of the PRAM project is to progress two planning applications for ICWs within the Teifi Catchment. Therefore, information from this detailed work has also been used to present the refined wetland areas in Section 6.1.2 below.

Table 6-1 Summary of Wetland requirements based on median removal rates for CCC for the Afon Tywi and Afon Teifi SACs

SAC	Indicative Wetland Requirement (ha)*	Phosphorus Budget (kg TP/year)
Afon Tywi	7.34	75.69
Afon Teifi	13.17	126.45
Total	**20.51**	**202.14**

[25] Welsh Government (2021) 29 new projects that will help 'Team Wales' tackle climate and nature emergencies

**Includes a 25% buffer to account for wetland bunding to deliver the effective treatment area required.*

Table 6-2 Summary of Wetland requirements based on median removal rates for Ceredigion and Pembrokeshire County Council

LPA	Indicative Wetland Requirement (ha)*	Cumulative Phosphorus Budget (kg TP/year)
CeCC	30.13	316.62
PCC	4.18	40.13
Total	**34.31**	**356.75**

**Includes a 25% buffer to account for wetland bunding to deliver the effective treatment area required.*

It is important to note that the indicative wetland requirements listed in this section are based on median rates only, and reflect conservative initial estimates of wetland requirements. Calculation of these figures has been useful in identifying an early sense of the scale of intervention needed, to aid investigation of opportunities within the catchment for ICWs. Through more detailed design, as documented below, it can be demonstrated that a much smaller wetland provision can produce the phosphate reductions required to achieve nutrient neutrality. As such, whilst these figures in Table 6-1 and Table 6-2 are a useful indicator, they should not be seen as the final requirements. These have been further refined through detailed modelling for the Teifi SAC, the results of which are presented in greater depth throughout the report.

6.1.2 Refined Wetland Requirements

NRW has published a Policy on constructed wetlands (October 2023)[26] which clarifies NRW's position on what CWs NRW will support. This policy assists in making an informed decision on the use of CWs for various purposes. The Policy covers CWs, wetlands designed and created for a specific purpose. Naturally occurring wetland habitats (including bogs, marshes, fens, ponds, lakes and rivers) are excluded from this Policy. It should also be noted that NRW endorse the use of Natural England's (NE) Framework Approach for Responding to Wetland Mitigation Proposals[27], which provides a detailed guide on undertaking feasibility studies for CW, designing and implementing the CW. Further details on the guidance with regard to wetland feasibility are discussed in Section 6.1.

When calculating the nutrient removal and associated wetland areas required, it is recommended that the design process and methodologies (*P-K-C** approach, *K-C** approach or Regression equations) described in the Natural England and Rivers Trust wetland framework guidance are used. The wetland areas discussed in Section 6.3 are strategically located along the Afon Teifi and Afon Tywi to ensure there is sufficient mitigation upstream of all the rLDP site allocations.

Appendix E provides a summary of the estimated nutrient reductions and wetland area requirements for the Cilgerran and Cenarth wetlands, which are being progressed under the PRAM project. Appendix E also provides the estimated nutrient reductions and wetland area requirements for Llandysul, Tregaron and Adpar. These technical notes show how the various Orthophosphate concentrations and other model inputs impact wetland requirements and nutrient reduction, for the different modelling approaches used.

The results from the *P-K-C** model were deemed to provide the most robust approach and demonstrate that the wetland area requirements based on the median removal rate, shown in Table 6-1 and Table 6-2 significantly overestimate the wetland area required to achieve nutrient neutrality.

[26] Natural Resources Wales (2023) Constructed wetlands for improving water quality.
[27] Natural England (2022) Framework Approach for Responding to Wetland Mitigation Proposals. The Rivers Trust and Constructed Wetland Association

The wetland areas obtained from the initial *K-C** modelling (to achieve an intended 1 mg/l effluent outlet concentration as a starting point) were then used to estimate % TP removal rates, loads and wetland area requirements to sufficiently offset the estimated TP budgets, based on *P-K-C** model. The wetland area requirements presented in Table 6-3 would be required to suitably manage the cumulative TP budget, as outlined in Section 3.5.

Table 6-3 Wetland Area Requirements

Wetland	Area Require (ha)	Wetland annual TP removal – Effective wetland performance (Kg TP/year)
Cenarth*	0.70	149.56
Cilgerran*	0.60	88.70
Llandysul	2.5	124.54
Tregaron	1.88	297.69
Adpar	1.25	114.81

** The Cenarth and Cilgerran wetlands are currently being developed as part of the PRAM Project.*

6.2 Challenges

6.2.1 Technical Feasibility

Designing, constructing, and maintaining constructed wetlands is a complex process. In addition to characterising the source, volume, quality, and variability of the inflow to a wetland, there are a myriad of other considerations to be taken into account including soil, topography, flood risk, archaeology, seasonal and long-term maintenance requirements. A high-level feasibility study has been carried out across the Afon Tywi and Afon Teifi catchments to identify the most suitable locations for constructed wetlands. As per the Constructed Wetlands Hub wetland design process[28], there are several factors which need to be considered (Table 6-4).

To meet the objectives of the Habitat Regulations, a wetland scheme must provide effective mitigation for nutrient loads to avoid any adverse effects on SACs. As the AP develops and wetland schemes are brought online to mitigate nutrient impacts, it is recommended that the design process and methodologies (*P-K-C** approach, *K-C** approach or Regression equations) described in the Natural England and Rivers Trust wetland framework guidance[27] are used to support the design.

In addition to the above guidance, NRW published guidance specific[26] for Wales in October 2023. Overall, the guidance is broadly similar to the guidance published by Natural England and Rivers Trust wetland framework guidance. However, one key difference is that constructed wetlands cannot be located in areas of high flood risk (Flood Zone 3).

One of the main challenges, is the lack of council owned land along the Afon Teifi and Afon Tywi near to the existing WwTWs, which could be used for constructing wetlands and therefore all potential mitigation is situated in non-council owned land.

[28] The Rivers Trust and the Constructed Wetland Association Constructed Wetlands Hub

Table 6-4 Wetland feasibility assessment criteria

Factor	Commentary
Land Ownership	Opportunities on council owned land have been explored first as they reduce costs and risks associated with land purchase and reduce / simplify stakeholder engagement.
Land Use	Where council owned land has been identified, the existing / proposed land use has been given consideration. On privately owned land, where generally agricultural / vacant land has been considered, the agricultural land classification (ALC) system[29] has been used with a preference to avoid grades 1 - 3a (good quality) and move towards grades 3b – 5 (Poorer quality).
Soils	It is favourable to site wetlands in impermeable soils to avoid infiltration of the nutrients absorbed into ground, providing a potential pathway to water supply. Where this is not possible, an impermeable layer (lining) may be required to prevent infiltration – this has the impact of increasing costs. Soils have been identified and characterised using Soilscapes[30].
Geology & Hydrogeology	Where an aquifer is present, this can provide upward discharge of groundwater into the wetland, compromising the treatment efficiency. There is also risk of leakage from the wetland, which could enter local groundwater and pollute watercourses/water supply. Solid and drift geological maps have been reviewed to determine potential areas for the proposed wetlands, favouring classification Secondary B, where layers of low permeability are generally found and therefore store / discharge limited amounts of groundwater.
Flood Risk	For a wetland to be effective, the volume and flow rates must be carefully controlled – if flooding is frequent, this is not possible and overall effectiveness reduces. As such, it is generally favourable to locate wetlands in Flood Zone 1 (Land having a less than 1 in 1,000 annual probability of flooding). As per NRW guidance[20] wetlands must not be constructed in areas of frequent flooding (Flood Zone 3) because of potential remobilisation risk of captured phosphates back into the river as well as increased maintenance needs due to siltation during times of river flood inundation. Therefore, creating a wetland within Flood Zone 2 (Land having a greater than 1 in 1000 annual probability of flooding) may be possible in some situations depending on the site-specific risks and benefits. If they are to be considered for nutrient mitigation then additional design, planning, safety redundancy, maintenance and monitoring will be essential to demonstrate satisfactory performance throughout the design life.
Hydrology & Drainage	Wetlands should be sited downstream of WwTWs and intensive agriculture so that the concentration of nutrients entering the wetland is high, and therefore the load removal is high. If the inlet nutrient concentrations are low, then it is unlikely that the wetlands will remove the required load of nutrient sufficiently to achieve nutrient neutrality. Furthermore, suitable 'Online' wetland locations i.e., where the wetland is connected to a 'natural' water source in and out without environmental damage, are likely to represent a more feasible and cheaper solution although they are more vulnerable to flood risk, siltation and varying flow patterns. 'Offline' wetlands, may require additional hard engineering to create diversions, which would require permitting and more complex stakeholder engagement.
Topography	Wetlands require earthworks and balancing the amount of cut and fill will minimise the cost of the design. The need for deep excavations should be avoided as these could cause health and safety issues and slope stability problems. LiDAR and topographical mapping have been reviewed to determine the potential area each of the proposed wetlands could occupy. All of

[29] Natural England (2021) Guide to assessing development proposals on agricultural land
[30] LandIS Soilscapes

Factor	Commentary
	the wetlands are sited on flat, low-lying land in or adjacent to the floodplain to minimise the need for deep excavation.
Groundwater	If a wetland is receiving a source of water that has higher contaminant levels than are generally prevalent in the surrounding environment (e.g., discharge from a WwTWs) it is important to be sure that the water from the wetland does not harm groundwater resources. All groundwater is a potential future resource for drinking water. Groundwater nitrate vulnerable zones (NVZs) identify areas where groundwater is vulnerable to nitrate pollution and should be protected from elevated levels of nitrate leaching either directly via leakage from a wetland or via leaching from the soil during the construction process. Groundwater source protection zones (SPZ) are defined around large and public potable groundwater abstraction sites. Wetlands which are located within or near a SPZ will most likely require a liner as to prevent the risk of microbial pollution of groundwater.
Protected Sites & Species	If the location is in, or near, a protected site, and could impact the conservation objectives of the site, a permit will be required from NRW. If protected species are present at or near the site and could be impacted by the project, a consent will be required from NRW.
Archaeology	Archaeological remains and landscape features may need to be protected so that they are not lost. The best way to minimise the risk that archaeological remains will delay construction and increase costs is to identify the issue early on and plan for it. Scheduled monuments have additional protection and should not be impacted by development. Peat soils will also preserve environmental records in situ and should be protected. The heritage value of the site and its landscape can be important. The feasibility of the wetland design needs to consider how to accommodate landscape and heritage issues.

6.2.2 Cost feasibility

As part of the wetland area requirements above, some preliminary costings have been prepared based on the Environment Agency (EA) Guidance document[31] and a variety of other published information sources. The capital costs are based on the wetland areas required, rather than the total wetland area potentially feasible. This is to show the minimum cost required to meet nutrient neutrality. However, this excludes upfront land purchase and detailed operation and maintenance (O & M) costs of the wetland for its design life.

The wetland capital costs are based on the £30/m^3 upper bound value for constructed wetlands, based on the EA Report –SC080039/R9 (Cost estimation for SUDS – summary of evidence, dated March 2015). However, this unit cost rate was first verified with a variety of alternative latest information sources for benchmarking to a likely precautionary level based on the constructed wetlands in the UK and overseas for stormwater and wastewater treatment wetlands.

It was then decided to use £30/m^3 as a precautionary estimate at the current feasibility stage and the capital costs shown below currently assumes an average wetland excavation depth of 1m. This currently excludes some notable cost items such as land acquisition, stakeholder engagement, permitting, lining to protect groundwater pollution, monitoring and project administration associated with delivering nutrient removal wetlands. Therefore, further work is required to confirm these costs as the detailed wetland proposals are produced.

[31] Environment Agency (2015) Cost estimation for SUDS - summary of evidence. Report –SC080039/R9

EA Report–SC080039/R9 also recommends £0.1 / m^2 of wetland surface area for estimating ongoing annual maintenance costs, and a further annual maintenance of £200-250/yr for first 5 years (declining to £80 - £100/yr after 3 years) should also be allowed. However, higher maintenance costs than this will be generally expected to account for additional maintenance, sampling and monitoring requirements associated with these nutrient mitigation wetlands. This means approximately £5k - £10k annual total maintenance costs are expected with the above wetlands depending on the WwTW TP limits being used for sizing.

A summary of the wetland capital costs and potential operational and maintenance costs for the Afon Teifi and Afon Tywi can be found in Table 6-6 and Table 6-7 respectively.

6.3 Current Opportunities

A key driver for locating potential constructed wetlands sites, is the ability to easily receive discharges from the existing or proposed WwTW plants, including the proximity to both WwTWs and receiving watercourses. However as highlighted before, availability of suitable land and dealing with landownership considerations are also key.

Based on the proximity to WwTWs, their geographical location in relation to the site allocations and the wetland feasibility criteria, three WwTWs have been identified (Adpar, Llandysul and Tregaron) on the Afon Teifi, which are suitable for creating constructed wetlands for further treatment.

6.3.1 Afon Teifi

Adpar

As shown in Table 6-3, the total wetland area required for Adpar WwTW is 1.25ha, four proposed locations totalling 3.8ha have been identified:

- Adpar CW1 has approximately 0.32ha of potentially available land,
- Adpar CW2 has approximately 0.54ha of potentially available land,
- Adpar CW3 has approximately 0.99ha of potentially available land,
- Adpar CW4 has approximately 1.98ha of potentially available land.

Since 1.25ha of wetland is required, either a combination of Adpar CW1, Adpar CW2 and Adpar CW3 could be selected, alternatively Adpar CW4 could satisfy the requirement. Of the four proposed wetland sites Adpar CW1 and Adpar CW2 are located completely within Flood Zone 2, whilst Adpar CW3 and Adpar CW4 are only partially located within Flood Zone 2. Both Adpar CW3 and Adpar CW4 have overland flow paths, which are consistent with surface water flooding risk. Based on a high level desk study, none of the proposed wetland sites are located within a SPZ, protected site, heritage, historic landfill and historic coal mines. All of the proposed wetland sites, are located on very good quality land (Grade 2) with flood plain soils and acid loamy soils (Adpar CW1 is only located on flood plain soils), whilst Adpar CW3 and Adpar CW4 are partially located on good quality land (Grade 3a).

As shown in Appendix A Figure A3, the wetlands are located just north of Adpar. Based on the topography, discharge pipes would need to be rerouted to these wetlands and pumping would likely be required.

Llandysul

The total wetland area required for Llandysul WwTW is 2.5ha. One location is proposed (Llandysul CW1) with an approximate 3.4ha of potentially available land. This proposed wetland is not located in Flood Zone 2 or Flood Zone 3 but is partially at risk of surface water flooding. Based on a high level desk study, the proposed wetland is not located within a SPZ, heritage, historic landfill or historic coal

mine. The proposed site is located on moderate quality agricultural land (Grade 3b) with parts located on poor agricultural land (Grade 4) and is underlain by freely draining and loamy soils.

As shown in Appendix A Figure A3, the wetland is located just southwest of Llandysul. Based on the topography, discharge pipes would need to be rerouted to this wetlands, however it is at a lower elevation and therefore pumping may not be required.

Tregaron

The Tregaron wetland is located in CeCC owned land and therefore could present a good opportunity to implement a NbS. As discussed in Section 3.2, Tregaron WwTW is a Category A WwTW and therefore CWs are currently not accepted by DCWW. However, the tighter permit (2mg/l) at Tregaron is not being implemented until 2030. As such, any developments brought forward ahead of this time would require mitigation. Therefore, a wetland at Tregaron offers an opportunity to mitigate phosphorus before 2030 and continue monitoring the wetland performance and wider benefits beyond that.

It is however acknowledged that proposal of a wetland at a Category A location such as Tregaron WwTW is currently an obstacle. However, there are no Category B WwTWs between Tregaron and Drefach/Velindre or Adpar WwTWs further downstream, creating a shortfall of category 1 mitigation opportunity for developments between these WwTWs (note that there would be plenty of opportunity for category 2 measures and application of SuDS on site).

Another potential route around this issue is to revisit the housing trajectory, and to liaise with planning officers in neighbouring Ceredigion, to align the delivery of development with the improvements planned at these works. If developments between Tregaron and Velindre were delayed until after 2030, the improvements at these WwTWs would be sufficient to enable development within the catchment (albeit all developments would be subject to a HRA on a case-by-case basis, which would offer further assurance that no development could take place without securing appropriate mitigation if it were assessed to be required).

Assuming no change to the current housing trajectory for Carmarthenshire, the total wetland area required for Tregaron WwTW is 1.88ha. One location is proposed (Tregaron CW01) with an approximate 2.67ha of potentially available land. This proposed wetland is not located in Flood Zone 2 or Flood Zone 3 and is not at risk of surface water flooding, with no potential overland drains. Based on a high level desk study, the proposed wetland is not located within a SPZ, protected site, heritage, historic landfill or historic coal mine. The proposed site is located on moderate quality agricultural land (Grade 3b) with parts located on poor quality agricultural land (Grade 4) and is underlain by acidy and loamy soils.

As shown in Appendix A Figure A3, the wetland is located just north of Tregaron. Based on the topography, discharge pipes would need to be rerouted to these wetlands and pumping would likely be required.

A summary of the proposed wetlands using the feasibility criteria (Table 6-4) is provided in Table 6-5 below.

Table 6-5: Wetland feasibility appraisal for proposed wetland locations.

Feasibility Criteria	Adpar CW1	Adpar CW2	Adpar CW3	Adpar CW4	Llandysul CW1	Tregaron CW1
Topography	The proposed wetland is predominately flat (23mAOD) with no discernible slope. Notably the site is located next to Flood Zone 3, which is slightly lower than 23mAOD and so runoff from Adpar_CW1 could end up in Flood Zone 3.	The proposed wetland is predominately flat (23mAOD), with no discernible slope. However, minor excavation might be required in the north east corner. Offsite to the north, the ground slopes towards the site. Notably the site is located next to Flood Zone 3, which is slightly lower than the site and so runoff from Adpar_CW2 could end up in Flood Zone 3.	The proposed wetland has a slope from southeast (25mAOD) to northwest (22mAOD). A highpoint is located in the centre of the site that would be required to be lowered. Notably, offsite the surrounding topography slopes towards Flood Zone 3.	The proposed wetland is predominately flat (23mAOD), with a slope from north to south which is away from housing but towards Flood Zone 3, which is at a lower elevation than the proposed wetland location. Minor excavations will be required to the east of the site.	The proposed wetland slopes from south (78mAOD) to north (61mAOD) towards the River Teifi, as well as from east (77mAOD) to west. A topographical low point is located within the northwest corner of the proposed wetland. Offsite to the south the elevations are steep. Minor excavations or planning will be required.	The proposed wetland is predominately flat with a slight slope from east (167mAOD) to west (162mAOD) and from north (165mAOD) to south (162mAOD). Offsite the topography slopes downward from east to west.
Soils	The proposed wetland is located in an area of freely draining flood plain soils. This will potentially require mitigation of lining.	The proposed wetland is located in an area of freely draining flood plain soils and acid loamy soils. This will potentially require mitigation of lining.	The proposed wetland is located in an area of freely draining flood plain soils and acid loamy soils. This will potentially require mitigation of lining.	The proposed wetland is located in an area of freely draining flood plain soils and acid loamy soils. This will potentially require mitigation of lining.	The proposed wetland is located in an area of freely draining, slightly acid loamy soils.	The proposed wetland is located in an area of freely draining slightly acidy loamy soils.
Geology and Hydrogeology	The proposed wetland is underlain with a permeable bedrock geology with limited storage/ discharge for groundwater. Overlain with an aquifer that can support local water supplies.	The proposed wetland is underlain with a permeable bedrock geology with limited storage/ discharge for groundwater. Overlain with an aquifer that can support local water supplies.	The proposed wetland is underlain with a permeable bedrock geology with limited storage/ discharge for groundwater. Overlain with an unproductive aquifer.	The proposed wetland is underlain with a permeable bedrock geology with limited storage/ discharge for groundwater. Overlain with an aquifer that can support local water supplies.	The proposed wetland is underlain with a permeable bedrock which can support storage and discharge of groundwater. Overlain with predominately an aquifer that can support local water supplies, whilst a small section of the site is overlain with an unproductive aquifer.	The proposed wetland is underlain with low permeably bedrock with limited storage/discharge potential for groundwater. Overlain with an aquifer that can support local water supplies.

Feasibility Criteria	Adpar CW1	Adpar CW2	Adpar CW3	Adpar CW4	Llandysul CW1	Tregaron CW1
Groundwater Protection	The proposed wetland location is not located in a SPZ. But is located within an area of medium to high groundwater vulnerability, which may require a liner.	The proposed wetland location is not located in a SPZ. But is located within an area of medium to high groundwater vulnerability, which may require a liner.	The proposed wetland location is not located in a SPZ. But is located within an area of predominately medium groundwater vulnerability with a small section classified as medium to high vulnerability, which may require a liner.	The proposed wetland location is not located in a SPZ. But is located within an area of medium to high groundwater vulnerability, which may require a liner.	The proposed wetland location is not located in a SPZ. But is located within an area of medium groundwater vulnerability, which may require a liner.	The proposed wetland location is not located in a SPZ. But is located within an area of medium to high groundwater vulnerability, which may require a liner.
Performance Potential and Hydraulic Connectivity	Adpar WwTW is classed as a category B1 treatment works. The proposed wetland could receive discharge from the WwTW with minimal new infrastructure.	Adpar WwTW is classed as a category B1 treatment works. The proposed wetland could receive discharge from the WwTW with minimal new infrastructure.	Adpar WwTW is classed as a category B1 treatment works. The proposed wetland will require a moderate amount of hard engineering to be connected to the WwTW.	Adpar WwTW is classed as a category B1 treatment works. The proposed wetland could receive discharge from the WwTW with minimal new infrastructure.	Llandysul WwTW is classified as a category B1 WwTW. The proposed wetland could receive discharge from the WwTW with minimal new infrastructure.	Tregaron WwTW is classified as a category A WwTW with a new permit of 2mg/l in 2030. Further discussion with DCWW would be required to determine if a collaboration opportunity is viable here.
Hydrology and Drainage	There is a low risk of fluvial flooding / nutrient remobilisation	There is a low risk of fluvial flooding / nutrient remobilisation	There is a small, overland flow path (from surface water mapping) present to the west of the proposed wetland. This may require additional design/ earthworks to mitigate the risk.	There is a small, overland flow path (from surface water mapping) present to the west of the proposed wetland. This may require additional design/ earthworks to mitigate the risk.	There is a low risk of fluvial flooding / nutrient remobilisation	There is a low risk of fluvial flooding / nutrient remobilisation
Flood Risk	The proposed wetland is located within Flood Zone 2. Additional design/ earthworks may be required to manage flood risk. The site is not at risk of surface water flooding.	The proposed wetland is located within Flood Zone 2. Additional design/ earthworks may be required to manage flood risk. The site is not at risk of surface water flooding.	The proposed wetland is located within Flood Zone 2. Additional design/ earthworks may be required to manage flood risk. The site is partially at risk of surface water flooding.	The proposed wetland is located within Flood Zone 2. Additional design/ earthworks may be required to manage flood risk. The site is partially at risk of surface water flooding.	The proposed wetland site is not located within Flood Zone 2 or Flood Zone 3. The site is partially at risk of surface water flooding.	The proposed wetland site is not located within Flood Zone 2 or Flood Zone 3. The site is not at risk of surface water flooding.

Feasibility Criteria	Adpar CW1	Adpar CW2	Adpar CW3	Adpar CW4	Llandysul CW1	Tregaron CW1
Protected sites and species	The proposed wetland is not located in a protected site, however, is located within 500m of a phosphorus sensitive SAC.	The proposed wetland is not located in a protected site, however, is located within 500m of a phosphorus sensitive SAC.	The proposed wetland is not located in a protected site, however, is located within 500m of a phosphorus sensitive SAC.	The proposed wetland is not located in a protected site, however, is located within 500m of a phosphorus sensitive SAC.	The proposed wetland is located within a phosphorus sensitive SAC and 300m south of a conservation area.	The proposed wetland is not located within a protected site. The nearest site is located 130m east and is a SSSI (Gwaun Ystrad Caron) and a priority habitat (Lowland Fens and Reedbanks).
Land Use	The proposed wetland is located within very good quality land (Grade 2).	The proposed wetland is located within very good quality land (Grade 2).	The proposed wetland is predominately located within very good quality land (Grade 2), whilst some is located within good quality land (Grade 3a).	The proposed wetland is located on both very good quality land (Grade 2) and good quality land (Grade 3a).	The proposed wetland is located predominately on moderate quality agricultural land (Grade 3b), whilst parts of the southeastern and east are located on poor quality agricultural land (Grade 4).	The proposed wetland is predominately located on moderately quality agricultural land (Grade 3b) whilst the eastern edges are located on poor quality agricultural land (Grade 4).
Ownership	Private	Private	Private	Private	Private	CeCC owned farmland
Archaeology and Heritage	The proposed wetland is not located on a heritage site, the nearest heritage site is located approximately 450m east and is a castle mound.	The proposed wetland is not located on a heritage site, the nearest heritage site is located approximately 550m east and is a castle mound.	The proposed wetland is not located on a heritage site, the nearest heritage site is located approximately 550m east and is a castle mound.	The proposed wetland is not located on a heritage site, the nearest heritage site is located approximately 300m east and is a castle mound.	The proposed wetland is not located on a heritage site. The nearest heritage site is located over 1km to the east (a sacred monument).	The proposed wetland is not located on a heritage site. However, is 10m away from a registered landscape of outstanding special interest.

Table 6-6: Afon Teifi Constructed Wetland Opportunities

Ref	Wetland Area Available (ha)	Wetland Area required (ha)*	Indicative Capital Costs**	Operational and Maintenance Costs***
Adpar CW1	0.32	1.25	£375,000	£1,250
Adpar CW2	0.54			
Adpar CW3	0.99			
Adpar CW4	1.98			
Llandysul CW1	3.4	2.5	£750,000	£2,550
Tregaron CW1	2.67	1.88	£564,000	£1,880
Total	**9.9**	**5.625**	**£1,687,000**	**£5,680**

**Total Area = Effective Treatment Area plus 25% of this area required earth reprofiling and bunds Total Costs*

*** The capital costs are based on the wetland areas required, rather than the total wetland area potentially feasible*

**** Based on EA Report–SC080039/R9 £0.1 / m^2 of wetland surface area for estimating ongoing annual maintenance costs*

The nutrient removal associated with each wetland solution has been calculated using detailed modelling, taking into consideration the influent quality, desired effluent quality (assumed in all cases to be 1mg/l) and the required retention time amongst other technical / design constraints and assumptions, which can be viewed in the AP. A summary of the Category 1 measures identified for the Afon Teifi catchment are included in Table 6-6.

It is worth noting that under the PRAM project CeCC identified the Cenarth and Cilgerran wetlands (refer to Table 6-3), which can address the remaining CeCC and PCC LDP growth in the lower Teifi SAC. Furthermore, the HRA has shown how the wetlands identified in Table 6-6 offer more mitigation than required to offset in combination impacts across all council in the Teifi SAC.

6.3.2 Afon Tywi

As discussed in Section 1.5, the Afon Tywi is currently passing its phosphorus targets. For detailed discussion on what this means with respect to HRA compliance, refer to the HRA Phosphate Assessment Appendix.

However, in support of this AP, the available opportunities for strategic constructed wetland solutions have still been investigated for this catchment to maintain the environmental headroom, and whilst detailed modelling has not yet been undertaken on the Afon Tywi, suitable wetland areas are available across the SAC (Appendix A Figure A4).

As a high-level assessment, Llandovery WwTW is situated in the upper Tywi catchment and therefore a wetland situated here would mitigate all the rLDP site allocations within the Afon Tywi catchment. For example, the estimated TP removal amounts shown in Table 6-3 for the Teifi SAC (based on

PRAM project detailed modelling) clearly suggest that 1.3ha wetland at Llandovery WwTW should easily be able to remove the estimated TP budget (75.69 kg/yr) for the Tywi SAC.

Table 6-7: Afon Tywi Constructed Wetland Opportunities

Ref	Wetland Area Available (ha)*	Indicative Capital Costs**	Operational and Maintenance Costs***
Llandovery CW1	1	£300,000	£1,000
Llandovery CW2	0.3	£90,000	£300
Total	**1.3**	**£390,000**	**£1,300**

**Total Area = Effective Treatment Area plus 25% of this area required earth reprofiling and bunds Total Costs*

*** The capital costs are based on the wetland areas available as wetlands are not required to meet nutrient neutrality on the Afon Tywi.*

**** Based on EA Report–SC080039/R9 £0.1 / m^2 of wetland surface area for estimating ongoing annual maintenance costs*

Therefore, it is important to note that for the Afon Tywi, there is excess of opportunity to remove phosphate from the catchment to deliver nutrient neutrality for the rLDP should this be required. This emphasises the viability of sufficient potential nutrient mitigation for the Afon Tywi SAC, to maintain and even improve upon the current headroom.

The proposed mitigation to offset the TP budgets will also be phased over many years. That is, not all of the developments will be operational at once. Therefore, there is confidence in mitigation delivery to preserve and/or enhance headroom where required, confirming the viability of the headroom approach for the rLDP and the Afon Tywi.

6.4 Nutrient Reductions

As Table 6-8 shows, Site Allocations where a constructed wetland has been proposed can be comfortably mitigated, often securing a significant contingency whereby the TP removed is in excess of the Nutrient Budget required to demonstrate nutrient neutrality.

This contingency can be expressed both as the amount of TP removed and no. of units released. The calculations show that an excess of **418.63 Kg/year** will be removed from the Teifi SAC catchment which equates to **853 units.**

As discussed in Section 3.4, the cumulative budget for CeCC and PCC LDPs have been calculated. Based on Table 6-8, the contingency of benefits achieved by the wetland opportunities identified in this AP would support a significant portion of CeCC and all of PCC LDP2 allocations. However, as discussed in Section 3.5 the CeCC LDP2 is subject to change and therefore the nutrient budget and mitigation requirements could change. Considering this, no further action has been taken to refine the mitigation requirements, noting that further work in collaboration with CeCC could provide the additional mitigation required should the full SA be expected once the LDP2 has been updated

.

Table 6-8 rLDP mitigation requirements for Category 1 measures for the Afon Teifi

Group	Site Allocation	No. units	TP Nutrient Budget (Kg/yr)	Proposed Mitigation	Wetland Area (ha)	TP Mitigation (Kg/yr removed)	No. units released
1	SuV37/h3	10	1.03	Enhanced WwTW (Lampeter)	N/A	N/A	30
	SuV37/h2	20	2.42				
	Sub-total	**30**	**3.45**		*Contingency*	**N/A**	**N/A**
2	SeC13/h1	10	4.58	Enhanced WwTW (Llanybydder)	N/A	N/A	10
	Sub-total	**10**	**4.58**		*Contingency*	**N/A**	**N/A**
3	SuV33/h1	5	4.15	Constructed Wetlands (Llandysul)	2.50	124.54	167
	SuV43/h1*	5	5.55				
	SeC14/h2	24	17.02				
	SeC14/h1	20	13.68				
	SuV35/h1	6	10.88				
	Sub-total	**60**	**51.28**		*Contingency*	**73.26**	**107**
4	SuV38/h1	6	5.46	Constructed Wetlands (Adpar)	1.25	114.81	148
	SeC12/h1	17	12.57				
	SeC12/h3	20	15.15				
	Sub-total	**43**	**33.18**		*Contingency*	**81.63**	**105**
5	SuV39/h1	7	4.98	Constructed Wetlands (Tregaron)	1.88	297.69	670
	SuV36/h2	16	20.77				
	SuV36/h1	6	8.20				
	Sub-total	**29**	**33.95**		*Contingency*	**263.74**	**641**
	Grand Total	**172**	**126.45**		**Total Contingency**	**418.63**	**853**

6.5 Summary

Across Carmarthenshire, the main source of phosphorus contribution varies, with rural land use contributing the largest proportion of Phosphorus in the Afon Tywi and WwTW contributing the largest proportion of phosphorus in the Afon Teifi.

Based on the TP Budget summary (Section 3.5) and the nutrient reductions summarised in Table 6-8, the Afon Teifi wetland opportunities and WwTW upgrades would comfortably satisfy the nutrient budget from CCC rLDP site allocations. As discussed in Section 6.4, there is also a significant amount of contingency which could support CeCC and PCC LDPs.

As discussed in Section 1.5, the Afon Tywi is currently passing its phosphorus targets. Considering the passing status of the Afon Tywi SAC, the suggested use of available headroom in combination with additional capacity to deliver nutrient neutrality, where applicable, creates confidence in this approach for the delivery of the rLDP allocations. Suitable wetland areas are available across the SAC which could be brought forward to support the headroom approach. These can be monitored to ensure that the phosphate targets are not breached and to ensure the integrity of the SAC.

The proposed wetland locations in Section 6.3 (and shown in Figure A3 and Figure A4 in Appendix A) would satisfy the nutrient budget requirements in order to deliver the residential growth in CCC rLDP (2018-2033). All of these proposed wetlands are considered feasible by criteria outlined in Table 6-4 as informed by Natural England and Rivers Trust wetland framework guidance[27]. This includes a 20% precautionary buffer when estimating the TP budget, to provide confidence that the mitigation of the nutrient budget will remove the risk of adverse effects on the SAC. A further 25% buffer is added to the estimated effective wetland treatment area to account for the required earth reprofiling and bunds.

These wetland locations would be subject to further appraisal to determine their technical feasibility, viability, deliverability, and longevity, including maintenance, ownerships, and replacement (if applicable) through further work. Section 8.1 shows the housing trajectory for the Afon Teifi site allocations and the timeframe for delivering the associated nutrient mitigation measures. Section 8.2 discusses the next steps required to ensure these solutions are suitable and operational in line with the rLDP housing trajectory.

7 Secondary Measures

The following section discuss some alternative, smaller scale solutions which CCC, DCWW and developers could invest in across the catchment to reduce the requirements on the large mitigation solutions like wetlands and WwTW improvements.

7.1 SuDS

There is a growing acceptance of the need for more sustainable approaches to managing surface water. SuDS mimic natural draining process, reducing impacts on the quality and volume of runoff from developments while providing amenity, and biodiversity and environmental benefits. IBZs, strips of habitat surrounding agricultural fields or adjacent to watercourses, can also support drainage and protect watercourses. SuDS components differentiate from traditional drainage, providing water quality improvements by reducing sediment and contaminants from runoff either through settlement or biological breakdown of pollutants. This can improve the quality of downstream water bodies such as streams, rivers, lakes, bathing, or shellfish waters.

Sustainable drainage applies a range of components and approaches to manage flows, volumes, water quality, amenity, and biodiversity benefits. This variety of SuDS often have some overlap in impacts. Components materially contributing to improvement of water quality are:

- **Source control** – A key method of source control includes permeable paving which can attenuate flow and enhance water quality. Green roofs provide interception storage, handling and treating some of the more frequent but smaller, polluting rainfall events (between about 5 – 10mm). Their purpose is to manage rainfall close to where it falls, preventing problems elsewhere.
- **Swales and conveyance channels** – Vegetated channels carry surface water runoff across the site and can be used to manage floodwater. Swales may need to be lined appropriately in certain situations to avoid pollutants entering undesired zones (e.g. contaminated land, areas with high groundwater table and source protection zones);
- **Filtration** – Filtrating and removing sediment or other particles from surface water runoff is a main treatment methods for sustainable drainage. Filter strips, including street trees and bioretention areas, support vegetation that traps silt, removing pollutants and reducing runoff downstream. Bioretention areas are shallow depressions aimed at managing and treating runoff from frequent rainfall events;
- **Infiltration** – Infiltration components are used to capture surface water runoff allowing it to infiltrate (soak) and filter through to the subsoil layer, before returning to the water table below. These include rain gardens, relatively small depressions in the ground that can act as infiltration points for roof water and other ‘clean’ surface water;
- **Retention & detention** – Provide storage, through the retention of surface water runoff, or attenuation through the detention of surface water runoff. Retention is primarily provided on the surface through ponds, however, there should be upstream components or treatment stages before surface water is conveyed to ponds. Detention is often useful in attenuating the peak flow from a rainfall event, but it also allows filtering and sedimentation to take place, which contributes to water quality improvement.

Schedule 3 of the Flood and Water Management Act 2010 for Wales[32], which came into effect 7th January 2019, outlines the mandatory SuDS standards and requirements developers need to meet before gaining approval from the SuDS Approving Body (SAB). Early consideration of the potential

[32] Schedule 3 of the Flood and Water Management Act 2010 for sustainable drainage, explanatory memorandum, incorporating the regulatory impact assessment and explanatory notes, October 2018.

multiple benefits and opportunities[33] will help deliver cost effective SuDS schemes with the best results.

7.2 Tree and Woodland Planting

Planned and managed woodland created alongside watercourses can reduce the risk of soil erosion, pollution, and nutrient run-off from neighbouring fields and in urban areas, run-off from roads and buildings. Tree roots strengthen stream banks and woodland plants trap the sources of diffuse pollution before they reach the watercourse.

As per the CCC Nutrient Budget calculator, the average phosphorus leachate rates from semi-natural native woodland planting, as well as grass set aside and neutral grass can be considered as 0.02 kg/ha/yr[34]. Hence including woodland planting and greenspaces in proposed developments or converting agricultural land to woodland would reduce the total nutrient load to mitigate while providing some mitigation of its own.

The NRW Welsh Information for Nature-based Solutions (WINS)[35] has produced a dataset showing opportunities for woodland planting across Wales. This informs discussion on the best way to realise Welsh Government's ambition for new woodland creation of 2,000 hectares of new woodland per annum from 2020, rising to 4,000 hectares per annum as rapidly as possible. The dataset showed that South West Wales could provide ~6000 ha of woodland, with over half being located within Carmarthenshire.

This target is mostly aimed at meeting climate change mitigation requirements, however the wide range of other ecosystem services provided by woodlands means other policy aims will be secured through creation of new woodland.

7.3 Integrated Buffer Zones

Integrated Buffer Zones (IBZs) are areas or strips of permanent vegetation that minimize soil erosion by reducing surface runoff. They can trap and degrade a portion of runoff adsorbed to sediments or dissolved in water and can be used alongside other best management practices to protect water quality. IBZs are an effective and cost-efficient best management practice that can improve water quality. Habitats within these IBZs, used for water control and water quality improvement, include woodland, grassland and wetlands. These can provide a physical barrier to prevent water contamination and degradation of soil, reducing soil erosion, minimising soil sediment movement and nutrient loading to surface and groundwater, moderating water temperatures. Other benefits include biodiversity benefits, in turn minimising pathogens and maximising pest predators and conditions for metabolization of pollutants.

Integrated Buffer Zones or Vegetated Filter Strips have been found to be effective in removing phosphorus from agricultural runoff. A study by Zreig et al 2003[36] found that filter length/width had the highest and most significant effect on P removal while inflow rate, vegetation type, and density of vegetative coverage had secondary influences. The P trapping efficiencies of the 2-, 5-, 10-, and 15-m-long filters were 32, 54, 67, and 79%, respectively. While short filters (5 m) are quite effective for removal of sediment, they are not very effective for P removal. For sediment trapping, increasing filter length beyond 15 m is not at all effective in increasing sediment removal but it is expected to further

[33] Benefits of SuDS (susdrain.org)
[34] DEFRA (2006) Updating the Estimate of the Sources of P in UK Waters - WT0701CSF.
[35] Natural Resource Wales. (2022) Welsh Information for Nature-based Solutions' (WINS)
[36] Abu-Zreig, M., Rudra, R.P., Whiteley, H.R., Lalonde, M.N. and Kaushik, N.K., (2003) Phosphorus removal in vegetated filter strips. *Journal of environmental quality*, 32(2), pp.613-619.

increase P removal. These findings were largely confirmed by the EA evidence base for 3D buffer strips[37] in association with the Forestry Commission. There are of course other environmental benefits such as greater passive cooling and carbon sequestration associated with woodland IBZs.

Nutrient loss risk modelling and mapping in Pembrokeshire, Ceredigion and Carmarthenshire[38] provides spatial information regarding preventative and mitigative action on nutrient loss and nutrient enrichment throughout the counties. In Carmarthenshire, opportunities for buffer strips have been identified downstream of areas with high nutrient loss rates. The buffer strip opportunities within the Afon Tywi and Afon Teifi catchments are summarised in Table 7-1, and are shown in **Appendix A Figure A5 and Figure A6,** respectively**. Box 4.1** shows an example of buffer strip opportunities within council owned farms along the Afon Tywi and similar work could be implemented to the Afon Teifi catchments.

[37] Environment Agency (2020) 3D buffer strips: designed to deliver more for the environment.
[38] Environment Systems Ltd (April 2022) Modelling and Mapping Nutrient Loss Risk in Pembrokeshire, Ceredigion and Carmarthenshire.

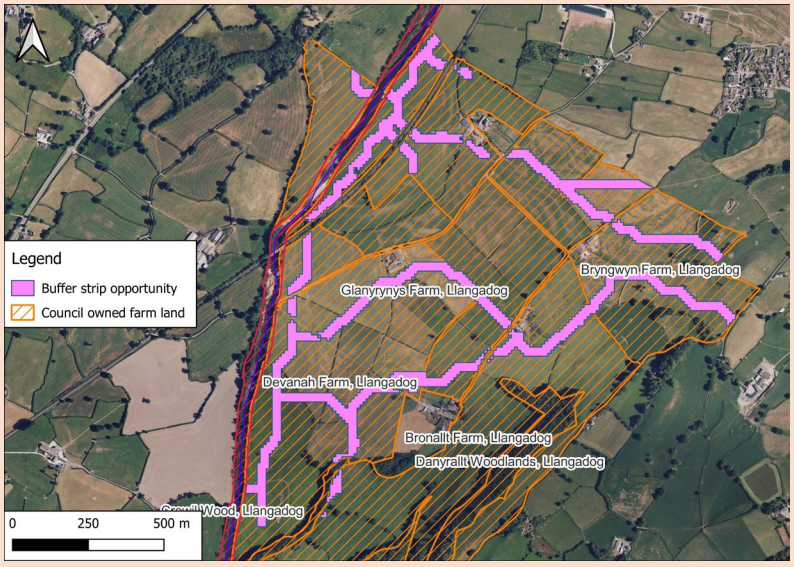
Box 7.1: Category 2 measures on Council Owned Farms – Riparian Buffer Strips.

Agriculture is the main source of nutrient enrichment within the Afon Tywi. Once mobilised from a point source, nutrients can be transported far down the catchment, leading to far-reaching downstream impacts. Pembrokeshire Coastal Forum (PCF) have undertaken modelling to analyse the risk of nutrient runoff/loss from land across Carmarthenshire, Ceredigion and Pembrokeshire as well as generate potential areas for riparian buffer strips to mitigate nutrient loss and nutrient enrichment.

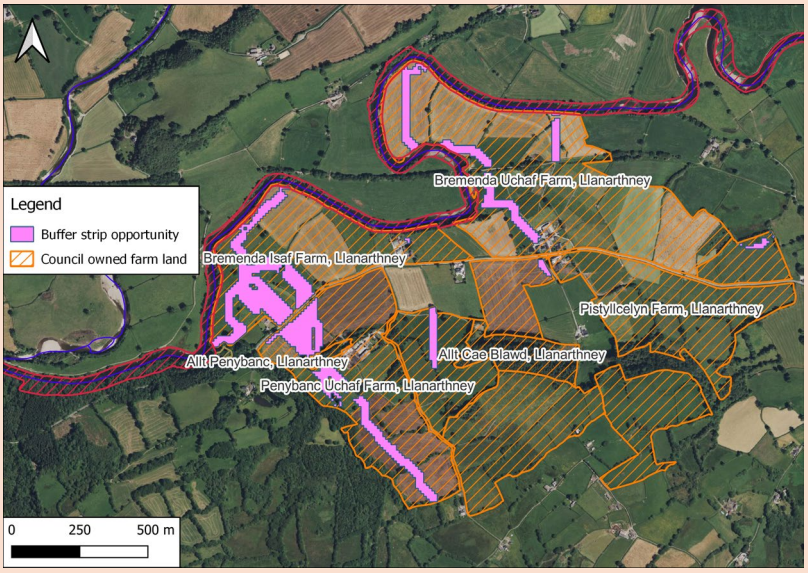
The modelling first explored the interplay between soil type and slope in determining erosion risk, which can be used as a proxy for nutrient loss. The hydrological channel network was extracted from the DTM and buffered by 10 m to identify areas where buffer strips could be located alongside channels, for effective mitigation against nutrient loss. Existing wooded areas, in addition to urban areas and water bodies, were then masked out of the buffer zones to produce the final extent of the buffer opportunities.

The figures below show the potential riparian buffer strip opportunities within council owned farms along the Afon Tywi.

Bryngwyn Farm and Devanah Farm, Llangadog = 21 ha of riparian buffer strip opportunities.



Bremenda Isaf Farm, Penybanc Uchaf Farm & Pistyllcelyn Farm, Llanarthney = 15 ha of riparian buffer strip opportunities.



7.4 Summary

There are a range of Category 2 measures that can be used to supplement Category 1 measures, provide advance mitigation prior to Category 1 implementation, if required, remove wider phosphorus from diffuse sources to increase headroom, and to provide multifunctional benefits to the overall health of the SACs. Table 7-1 presents the type and quantum of Category 2 measures available to support the rLDP.

Table 7-1 Summary of Category 2 measures available in support of CCC rLDP

Category 2 Measure	Tywi	Teifi	Potential Removal Rates (%)	Comment
Tree & Woodland Planting	Approx. 3,000ha in CCC		11-95%	Can include forestry buffers or wet woodlands each depending on design with excellent capacity for nutrient removal.
IBZs	23,000ha	5,000ha	31-99%	Can include riparian buffers with excellent potential for nutrient removal, several areas of council owned land within Tywi present opportunities
SuDS	14 site allocations	7 allocations	20-99%	Should be implemented at each site allocations meaning every application on a case-by-case basis will bring forward SuDS with some potential to remove Phosphorus.

Whilst the above provides a general summary of Category 2 opportunities available in the respective catchments, mapping showing the locations of these measures has not been undertaken as part of this AP (with the exception of IBZs). This is in part because the opportunity covers so much area, that an overview does not provide useful insight. However, the West Wales NMB (responsible for the Cleddau, Tywi and Teifi SACs) are due to produce Nutrient Management Plans which will consider these category 2 measures on a sub-catchment basis, at which point a more useful and insightful representation of the data will be available.

8 Implementation and Delivery

This section sets out an initial plan to implement and deliver the mitigation measures set out in this document such that development within the rLDP can be delivered alongside the necessary reductions in phosphorus. It is important to note that further work is required to implement these measures and several actions will be recommended within this section to set up a framework for delivery. This AP is based on current best understanding of the situation within Carmarthenshire. As further details are confirmed, this document will be updated and so too might the actions required to implement and deliver the phosphorus mitigation measures required.

8.1 Housing Trajectory

Table 8-1 presents the timeline of when the projected number of housing units per annum from the rLDP will be brought forward. The housing trajectory regularly changes and has been informed in line with possible mitigation.

Additionally, conditions may be tied to permissions to ensure habitation is concurrent with the delivery of mitigation, so planning conditions will be in place alongside mitigation. Therefore, the phasing of the creation of wetlands should be aligned with the timing of housing units brought forward. Any occupancy date will be subject to planning permission and/or Grampian Conditions (restricting other development until terms of a Section 106 are met).

It is important to recognise the importance of the housing trajectory in relation to the both the planned improvements to WwTWs considering the NRW / DCWW RoP process, and in relation to the phasing of delivery of category 1 mitigation. Whilst at the time of writing, the RoP process is nearly complete, several proposals are yet to be confirmed (for example at Pencader). As a result, this action plan, based on current housing trajectory and uncertainty in final determination of this process, has had to allow for mitigation based on a precautionary principle i.e., assuming that development will come through against the current timetable and that the timing of the improvements to WwTWs proposed cannot yet be relied upon. Both of these variables are liable to change (RoP is reviewed regularly with new permits being determined every two weeks, and the housing trajectory is likely to be reviewed in summer 2024).

By the time the rLDP housing trajectory is next due to be reviewed, the RoP process should have been completed. This provides an opportunity for the council to re-address the timing of development within Carmarthenshire to better align with planned improvements at WwTWs. This could substantially reduce the nutrient budgets required to be offset, limiting site allocations that would require mitigation to those discharging to Category B WwTW where a backstop limit only has been agreed.

Until this is agreed, Table 8-1 presents the case for strategic mitigation to meet the current housing trajectory.

Table 8-1: Timeline of projected housing units from the rLDP to be constructed annually on the Afon Teifi.

Group	Site Allocation	Name	No. units	TP Nutrient Budget (Kg/yr)	Proposed Mitigation	Comment	TP Mitigation (Kg/yr removed)	Housing Trajectory (units delivered per year)										
								2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1	SuV37/h3	Land adjacent to Lleinau	10	1.03	Enhanced WwTW	Lampeter WwTW RoP Accepted new P limit of 0.5mg/l by 2025	N/A				5	5						
	SuV37/h2	Land south of Cae Coedmor	20	2.42							5	5	5	5				
		Sub-total	**30**	**3.45**		*Contingency*	**N/A**											
2	SeC13/h1	Adjacent Y Neuadd	10	4.58	Enhanced WwTW	Llanybydder WwTW RoP accepted new P limit of 2.5mg/l by 2025	N/A				2	2	2	2	2			
		Sub-total	**10**	**4.58**		*Contingency*	**N/A**											
3	SuV33/h1	Land opposite Brogeler	5	4.15	Constructed Wetlands (Llandysul)	2.50ha Constructed Wetland @ Llandysul WwTW (Collaboration Category B1) proposed	124.54					2	2	1				
	SuV43/h1*	Blossom Inn	5	5.55							2	3						
	SeC14/h2	Land adjacent Maescader	24	17.02								6	6	6	6			
	SeC14/h1	Blossom Garage	20	13.68								5	5	5	5			
	SuV35/h1	Land adjacent Arwynfa	6	10.88							5	1						
		Sub-total	**60**	**51.28**		*Contingency*	**73.26**											
4	SuV38/h1	Maes y Bryn	6	5.46	Constructed Wetlands (Adpar)	1.25ha Constructed Wetland @ Adpar WwTW (Collaboration Category B1) proposed	114.81				2	2	2					
	SeC12/h1	Trem Y Ddol	17	12.57								3	4	4	4	2		
	SeC12/h3	Land rear of Dolcoed	20	15.15							4	4	4	4	4			
		Sub-total	**43**	**33.18**		*Contingency*	**81.63**											
5	SuV39/h1	Adjacent Yr Hendre	7	4.98	Constructed Wetlands (Tregaron)	1.88ha Constructed Wetland @ Tregaron WwTW (Collaboration Category A) proposed	297.69					2	2	2	1			
	SuV36/h2	Land at Bryndulais	16	20.77							5	5	6					
	SuV36/h1	Cae Pensarn Helen	6	8.20							2	2	2					
		Sub-total	**29**	**33.95**		*Contingency*	**263.74**											
		Grand Total	**172**	**126.45**		**Total Contingency**	**418.63**											

Mitigation measure committed to by third party.

Strategic Nature Based Solution, delivered by CCC (in collaboration with CeCC).

8.2 Strategic Solutions Next Steps

Section 6 discusses the potential wetland locations that would support the rLDP. Table 8-1 shows the timeline of when these wetland solutions would need to be operational in line with the rLDP housing trajectory. Therefore, in order to ensure the mitigation is operational intime for occupation of the first rLDP houses, the following tasks need to be undertaken:

- Landowner engagement to explore land purchase / leasing and access arrangements.
- Stakeholder engagement (DCWW, NRW, etc.).
- Follow the planning strategy developed as part of PRAM.
- Undertake surveys in support of design / planning works.
- Progress outline design and planning of works.

8.3 Developer Contribution Scheme

8.3.1 What is a DCS?

A potential mechanism that could help to deliver the mitigation required to facilitate the rLDP is a Developer Contribution Scheme (DCS). A DCS would be applicable to all residential development predicted to lead to a net increase in phosphorus load discharged to either the Afon Teifi or Afon Tywi SACs where nutrient neutrality is required.

A developer contribution is made by a landowner or developer to ensure that, where planning permission is granted for new development, any impact on the environment is in accordance with appropriate regulatory obligation and the infrastructure necessary to support the development is provided. By securing these contributions, planning authorities can help to improve the quality and sustainability of individual development schemes and their acceptability to local communities.

A DCS would provide a strategic approach to mitigation that facilitates the delivery of new development within the catchments. Under a DCS, phosphorus mitigation costs are matched proportionally to each development based on the additional phosphorus generated. A DCS would need to be developed alongside rLDP adoption with supplementary guidance if appropriate.

It is recommended that a DCS is prepared with key stakeholders, as one of the measures within the Afon Teifi SAC, with this approach to be confirmed on the Afon Tywi should nutrient neutrality be required.

It should be delivered alongside other wider measures within the remit of the recently appointed NMB. It is recommended that any DCS is prepared as a “living” document, i.e., one that evolves iteratively as the evidence base changes or if the costs associated with mitigation measures changes.

Further to the above, it is important to recognise that a DCS is not the only means of securing funding for mitigation. As set out in the Intervention Measures Matrix in Appendix C, there are multiple funding streams available for phosphorus mitigation within the catchments, particularly when considering the multiple benefits afforded by certain nature-based solutions, such as constructed wetlands. Here, the DCS must again be flexible to ensure that as funding is secured by other means, the costs apportioned to development are appropriately adjusted.

Finally, the DCS should be not seen as the only option available to developers when bringing sites forward through the rLDP. When making an application, a developer could ask the authority to assess their application separately from the DCS. The council would therefore remain open to considering any bespoke mitigation proposals brought forward on a case-by-case basis. Consequently, the DCS

would not be publicly consulted on, instead it would represent an agreed way forward, but not the only option available to developers in securing the phosphorus mitigation required for their development.

An alternative option to enable developers to make a financial contribution to P reduction is through setting up a phosphate credit scheme. Where a separate offsite council led P mitigation scheme is constructed, developers can make a financial contribution by purchasing credits from the associated council scheme to offset any additional P loading from their development. Such phosphate credit schemes have been utilised in Somerset and also in Herefordshire where the Council priced credits at £14,000 (+VAT) per kilogram of offset required per year to meet neutrality in the River Lugg SAC[39].

8.3.2 Roles and Responsibilities

The responsibility for the DCS would lie with the LPA. NRW would be consulted in preparing the DCS in their role as an appropriate nature conservation body advising on Habitats regulations. Advice from NRW should be sought on specific technical aspects of the DCS e.g., developing guidance around calculating phosphorus savings from mitigation measures.

8.3.3 Policy Drivers

The 2nd Deposit rLDP (2018-2033) went to public consultation in February 2023. Strategic policy "SP9: Infrastructure" will be a key policy driver. This overarching strategic policy supports the principals of planning obligations in considering the need for development proposals to demonstrate that there is sufficient capacity in the existing infrastructure to deliver and support the proposed development. Where this cannot be achieved, the proposals will need to demonstrate that suitable arrangements are in place to provide the infrastructure capacity considered necessary to deliver and support the development.

Within this policy, utility services are given specific mention, as well as biodiversity and environmental protection. Under these elements, phosphorus mitigation could be considered and a DCS could provide the mechanism for developers to assess their level of contribution needed towards specific mitigation measures.

Strategic Policy "SP12: Placemaking, Sustainability Places" also offers a useful mechanism to ensure developments contribute positively to nutrient management within the Teifi and Tywi SACs. Within this policy, protection of or enhancement of biodiversity is required. This would necessitate developments to consider the additional phosphorus generated by their development and deliver measures to mitigate accordingly. Furthermore, this would ensure developers consider on-site mitigation measures such as SuDS as standard.

On SuDS, further understanding is required as to their likely contribution to phosphorus reduction. This should be considered in line with new guidance (see Section 7.1) and in the event that more certainty is placed on the potential for SuDS to remove phosphorus and this is accepted by NRW, a developer could put forward plans for on-site mitigation that reduces their requirement for off-site mitigation. As discussed previously, any DCS put forward must be flexible to these proposals such that costs are proportional and offer developers options to bring forward their own mitigation to safeguard the natural environment.

Strategic Policy "CCH4: Water Quality and Protection of Water Resources" also places requirement on developments that are in line with the AP for phosphorus mitigation.

In this regard, the policy mechanisms to ensure delivery of the appropriate phosphorus mitigation required already exist and are clear in their remit. This HRA confirms this and planning obligations will then be actionable. A DCS would then act as a mechanism by which developers would bring forward their sites whilst contributing towards the necessary mitigation.

[39] Herefordshire Council (2023) Phosphate Credit FAQs (herefordshire.gov.uk)

8.3.4 Planning Obligations

Developer contributions are normally secured through a “planning obligation”. This is a legal commitment by the developer to secure a contribution (in cash or in kind) to address community, infrastructure or environmental improvement needs associated with development. It may be a bilateral agreement between the LPA and the developer, or simply a unilateral undertaking by the developer to provide the same. These are a proper and recognised part of the planning system and are normally entered into under Section 106 of the Town and Country Planning Act 1990 (as amended).

Planning obligations can be used to secure benefits on the development site itself or on other suitable sites close to the proposed development (as long as they are directly related to the development). Developers may be requested to make a payment of money to the relevant LPA, to be spent on agreed benefits or for the maintenance of them.

Historically, planning obligations have tended to be used to secure infrastructure improvements only from a limited number of sites. However, in respect of the impacts on the Afon Tywi and Afon Teifi, the DCS provides a strategic approach to offsetting the negative effects of development and includes a mechanism for gaining contributions from all new development which connects to mains drainage, and non-mains development where it is considered to be appropriate.

Developer contributions can reasonably be secured in respect of:

- Actual implementation of measures (i.e., costs to actually do the work);
- Staff resource to oversee and co-ordinate implementation;
- Compensation to landowners where measures involve a change of use;
- The long-term (in perpetuity) maintenance and management of mitigation; and
- Monitoring the effectiveness of mitigation measures.

In principle, planning obligations could be used to fund improvements of WwTWs, particularly if development came forward before planned upgrades to WwTWs. Further discussions are needed with the statutory water undertaker, DCWW and NRW as regulator before any commitment was made to this effect.

Regulation 123 of the Community Infrastructure Levy (CIL) Regulation prevents the imposition of planning obligations for “infrastructure”, if five or more separate planning obligations which provide for the funding or provision of that type of infrastructure have been entered into on or after 6th April 2010. However, the measures to be funded through the DCS are “environmental protection measures” and fall outside the definition of infrastructure (S 216 (1) Planning Act 2008) so are not subject to pooling restrictions.

8.3.5 DCS Monitoring

It will be necessary to manage and monitor phosphorus budgets during the course of the adopted LDP to confirm that there is sufficient mitigation. For many reasons additional phosphorus budgeting could be required e.g., where permissions are allocated a budget, but permissions are not commenced/completed, or housing delivery exceeds LDP delivery schedule. Monitoring will give advance notice if there is a need to release additional mitigation measures. It might be appropriate to manage mitigation in development ‘windows’ matching the LDP delivery schedule, this is a matter to be determined in preparing a DCS.

No new developments will be granted permission unless the required mitigation measures have been demonstrated via a project level HRA undertaken to the appropriate level.

There are a range of options in addition to NbS that could provide short term mitigation in advance of longer-term solutions, if required see the Intervention Measures Matrix in Appendix D.

Planning obligation funding will be pooled to deliver any of the mitigations within the DCS range of measures. The LPA will allocate funding to the measures in order to ensure sites can be delivered in phase with the occupation of the proposals.

8.3.6 Grampian Condition

Grampian Conditions provide a means by which mitigation can be secured. A Grampian Condition prohibits development authorised by the planning permission or other aspects linked to the planning permission (in the case of residential use, occupation of the development) until a specified action has been taken (in this case the provision of an avoidance and mitigation package). Such conditions should not be used where there are no prospects at all of the action in question being performed within the time-limit imposed by the permission, which is not envisaged in this case.

8.3.7 Development Affected

In theory any development adding phosphorus load to the Afon Tywi and Afon Teifi SAC could require mitigation e.g., tourism, agricultural development and overnight accommodation, however it would not be appropriate for the DCS to provide for every circumstance. Furthermore, the application of a headroom approach in the Afon Tywi, as documented and rationalised in the HRA Phosphate Assessment Appendix, should be referred to, as in these instances application of a DCS would not be necessary.

In the context of the AP, the DCS will initially focus on the strategic issue for the rLDP examination, enabling residential development (where required). In time it may be appropriate to expand the DCS to cover other types of non-strategic development responding to local circumstances and pressures. In the meantime, non-residential development will be treated on a case-by-case basis at the planning application stage, and the DCS may provide a solution to such development depending on the specific circumstances of each case.

Consequently, the DCS will provide mitigation for development that would lead to an increase in phosphorus entering the SAC river environment. This is likely to consist mainly of residential development connecting to public or private sewers discharging into the catchment of the Afon Tywi and Afon Teifi SAC where treatment works currently do not have the facility to remove additional phosphorus and/or planned investment to upgrade treatment works to remove phosphorus from effluent are not aligned with timing of development need.

Development where connection to the mains network is not a viable option will continue to be addressed on a case by case basis and follow NRW guidance on such matters; the DCS may provide a solution to such development depending on the specific circumstances of each case.

8.3.8 Developer Contributions

It should be noted that developer contributions in line with the rLDP for the Afon Tywi are not required with consideration to the headroom approach documented throughout this AP and the HRA Phosphate Assessment Appendix. However, if in the future a nutrient neutrality approach was required, then details of how developer contributions could be calculated and sought are pertinent still and detailed below. The below will apply automatically to the Teifi catchment, where nutrient neutrality is required.

How could planning obligations be calculated?

Step 1: Phosphorus Budget

Carmarthenshire's Nutrient Neutrality AP will inform developers of the budget allocations for individual developments along the Afon Tywi (Table 3-4) and Afon Teifi (Table 3-5), within the rLDP.

Step 2: Identify Mitigation

Based on the budget from Step 1, this AP also sets out potential mitigation measures available that can be delivered in the plan period. The Council can draw from these options to provide a package of detailed mitigation measures for delivery via a DCS.

The package of selection mitigation measures will provide the level of phosphorus reduction required to facilitate the development brought forward. The measures in the DCS will be fully costed to include all reasonable costs associated with the works as per the discussion in this section. It will be for the DCS to expand on the range of cost associated with the mitigation measures.

The DCS would determine the total cost of delivery of the mitigation as £/kg phosphorus mitigated or similar.

Step 3: Apportion Mitigation Costs to Developer

The DCS will need to determine a suitable mechanism of apportioning the total cost of the mitigation works to the developer. Several examples in England are available, and an appropriate review of the potential options should be undertaken in development of the DCS to find a suitable arrangement for Carmarthenshire.

Simply put, the costs will be apportioned to the developer in an equitable way such that the costs are proportional to the phosphorus generated from the development.

Monitoring

It will be necessary to manage and monitor phosphorus budgets during the course of the LDP to ensure sufficient mitigation is still available. For many reasons additional phosphorus budgeting could be required e.g., permissions are allocated a budget, but permissions are not commenced/completed, housing delivery exceeds LDP delivery schedule or more information is known about the effectiveness of mitigation measures. Monitoring will give advance notice if there is a need to release additional mitigation measures in an updated DCS. It might be appropriate to manage mitigation in development 'windows' matching the LDP delivery schedule, this is a matter to be determined in preparing a DCS.

For the DCS to mitigate the negative effects of development, it is important that the reduction measures are implemented in a timely manner which reflects the rate at which development comes forward. In the case of larger scale development, phased payment can be negotiated with the LPA on a case-by-case basis as appropriate.

Note, the delivery of mitigation could constrain the timely delivery of development, however, there are short term options. While these may not be sustainable solutions, they could provide a stopgap solution subject to ensuring the longer-term solutions are delivered and are effective.

Planning obligation funding will be pooled to deliver any of the mitigations within the DCS range of measures. The LPA will allocate funding to the measures in order to ensure sites can be delivered in phase with the occupation of the proposals.

8.4 Additional Sources of Funding

When dealing with wider diffuse phosphate inputs, there are a number of other funding mechanisms available. The Intervention Measures Matrix in Appendix D identifies potential sources of funding available for each intervention. The key funding streams that should be considered are set out below:

8.4.1 Welsh Government

- WG are providing funding to support the work of NMBs, with up to £415k being made available in 2022-23 and additional provision in 2023-24 and 2024-25; in addition to £40m of funding over the next three years to address water quality problems across Wales.
- WG provide small grants for landscape and pollinators supporting the rural economy and transition to the Sustainable Farming Scheme
- WG continues to provide multi million pounds of funding to farmers in Wales to deliver positive environmental outcomes, including reducing nutrients entering watercourses. Funding is also

provided to Farming Connect who provide advice and guidance to farmers on reducing nutrient run-off.

- WG fund the NRW Dairy Project across Wales which employs officers to visits dairy farms to give advice and guidance on ways of minimising agricultural pollution.
- WG provide funding for a Nature Network Fund and this has provided NRW resource in other SAC catchments to carry out investigations and visits to reduce nutrient inputs into the watercourses

8.4.2 NRW and the Welsh Government

- Welsh Government Grant In Aid; this funding is available to deliver measures in SSSI and SAC in order to move the designated species and habitats closer to 'favourable' status. In 2021, this funding was an annual Biodiversity & Ecosystem Fund and from 2022 will become a 'multiyear' fund.
- NRW offer grants for planting trees and woodland[40]
- Welsh Government Strategic Allocated Funding; provides funding for a five-year plan for the improvement of fish and fish habitat in Wales. This fund is known to be being used in other Welsh catchments to undertake catchment measures which reduce nutrient input to watercourses.
- European Sustainable Fisheries Funding; this is available for annual ad-hoc bids for specific projects and includes catchment measures to reduce nutrient input to watercourses.
- Welsh Government Water Quality Capital Fund; this is used to fund improvements in water quality such as reducing nutrients for WFD targets and in 2021, £1.8m was available for such work.

8.4.3 Dwr Cymru / Welsh Water

- In July 2022, DCWW announced plans to improve their WwTWs across Wales in line with their Phosphorus Permitting Programming, declaring a spend of £100m on improving river water quality, £60m of which will be for removing phosphorus from WwTW on SAC rivers such as the Teifi (Lampeter and Llanybydder).
- DCWW receive funding via their customer bills through a five-year program called an Asset Management Plan (AMP). This multi-million-pound funding includes improvements to sewage treatment works and storm overflows resulting in a reduced amount of phosphorus entering the watercourses. The drivers for this can include WFD and Habitats Directive (SAC) targets.
- DCWW have made available the Environment Fund which aims to provide financial support to projects that will benefit and enhance biodiversity at or near DCWW sites. DCWW are also enabling third party funded wetlands whereby effluent at DCWW sewage treatment works is directed to a wetland to garner additional polishing for P removal. Note – this is currently in England only.

8.4.4 Ofwat PR24

- The 2024 Price Review (PR24) is in the process of being created by Ofwat, with their final decisions being announced in December 2024[41]. This will set the levels of service and bills from water and sewerage companies for 2025 to 2030.
- Some of the key themes that Ofwat aims to address in the PR24 include both an increased focus on the long-term impacts and to deliver greater environmental and social value. Ofwat emphasised the use of NbS in accounting for these aims in addition to how they can help the Welsh and UK governments to achieve net zero emissions by 2050.

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[40] Natural Resources Wales (2023) Natural Resources Wales / Grants for planting trees and creating woodlands
[41] Ofwat (2021) PR24 and beyond: Creating tomorrow, Together

- For instance, they highlight funding services that are the ‘best whole life’ solution that considers the long-term beyond the 2020-2025 period, rather than funding the cheapest option.
- Ofwat also highlighted the opportunity to gain funding outside of the Price Review where reputational pressures are strong and where improvements do not require funding beyond that provided by DCWW base cost allowance.
- Ofwat are keen to develop the previous PR19 approach for funding capital maintenance and maintaining asset health at PR24. For the PR19, Resilience was a key theme and £13 billion of funding was provided by Ofwat in this area for companies to maintain base services and for enhancements where they were well evidenced. Considering the NbS approaches proposed in the AP and their potential long-term benefits, the PR24 provides the opportunity to gain significant additional funding for the Category 2 measures to further support P reduction in the wider catchment.

It is recommended that the NMB explores these additional sources of funding at an early stage and looks to begin applications for funding as more detailed plans emerge for the mitigation opportunities outlined in this report.

8.5 Key Actions & Recommendations

There are various mechanisms for implementing the identified phosphorus reduction opportunities ranging from:

- Securing funding through DCS and other opportunities as discussed within this report and the AP;
- Providing advice on funding sources, best practice, and effective solutions which is provided within the Carmarthenshire Nutrient Management Strategy[42];
- Promoting co-delivery mechanisms to maximise wider opportunities and benefits through collaboration and building stakeholder trust and confidence which will be achieved via the NMBs;
- Exercising regulatory tools that are within the power of OFWAT, NRW, the LPAs and the WG; and
- Managing and monitoring phasing and success

Phasing of the rLDP, delivery of the developments within it and other factors outside of the council’s remit will play a pivotal role in implementing the actions outlined in this report. To ensure that developments are brought forward in sync with the phosphorus mitigation required to release them, strategic milestones are required. These milestones will be of central importance to the rLDP strategic policies outlined in Appendix B, offering certainty that developments are only brought forward when the infrastructure required to mitigate their environmental impacts is in place.

One way to manage this process is to agree ‘Development Windows’. Development Windows would be defined on the basis of a timetable for delivering specified mitigation measures and the phosphorus reductions which will be secured. These will be mapped against the delivery of specific sites as per the rLDP to ensure that occupation of development occurs in-sync with the delivery of necessary mitigation measures.

As the funding for DCWW’s planned phosphorus reduction programme has been approved by Ofwat in 2024 there will be more certainty on the locations, scale and timing of the additional phosphorus reduction measures that should also be implemented by CCC and stakeholders to protect and improve the impacted SACs. However, this AP has identified a range of potential Category 1 and Category 2 measures to achieve this, based on the best practice guidance on achieving nutrient neutrality (where applicable). They also provide redundancy contingency buffer and flexibility to

[42] Carmarthenshire Nutrient Management Strategy (April 2024)

ensure that sufficient mitigation is provided, and the AP details mitigation requirements using DCWW's 5 mg/l backstop TP limit or AMP7 upgrades.

Section 5.1 indicated that except at four WwTW locations (namely Lampeter, Llanybydder, Capel Iwan and Pencader), which are currently termed as Collaboration Category A by DCWW, there is opportunity for CCC to implement wetlands at all other nine WwTW locations assessed by this AP subject to availability of suitable land.

As highlighted before, if suitable land can be found at Lampeter, Llanybydder, Capel Iwan and Pencader WwTWs, further discussion with DCWW is recommended because current research shows that wetlands can still efficiently remove phosphorus when the influent concentration strength is < 4mg/l, which is the precautionary TP threshold currently used by DCWW when defining Collaboration Category A wetlands amongst other factors such as existing trade flows.

Table 8-2 below outlines indicative milestones to ensure delivery of the rLDP in the Afon Teifi.

Actions on the Afon Tywi have not been included here as the HRA Phosphate Assessment Appendix concluded that there was no potential for the rLDP to have an adverse effect on the integrity of the Afon Tywi either alone or in-combination with other plans or projects (as none of the neighbouring LDPs, CeCC and Pembrokeshire, drain into the Tywi.

This is due to the SAC not currently failing against its phosphate compliance targets and the additional amount of TP entering the SAC from the additional developments failing to exceed the current target. In fact, only a 0.35% increase in TP is estimated to be contributed by new rLDP developments. Therefore, a headroom approach to development can be undertaken.

However, as the greatest source of P in the Tywi is from agricultural sources, it is recommended the council monitor headroom in collaboration with DCWW and NRW and apply a nutrient neutrality approach only if/where needed. It has also been demonstrated that there is sufficient suitable land available to deliver mitigation that would implement nutrient neutrality or increase headroom in the Tywi if required. It should also be mentioned that the West Wales NMB is due to produce Nutrient Management Plans in 2024 which will provide further actions to reduce phosphate in the Afon Tywi and Teifi SACs, complimenting and building on the work carried out in this AP.

Table 8-2: Key Actions and Indicative milestones (based on current housing trajectory)

Milestone	Commentary	Owner	Completion Date
Action Plan Publication	Publish the AP allowing stakeholders to understand strategic mitigation planned in line with the rLDP. The AP will provide detailed information around delivery, costs, monitoring & maintenance allowing the council to progress strategic measures.	CCC	Mar 2024
Review housing trajectory	The next review of the housing trajectory for CCC's rLDP is estimated to be in June 2024. This may move delivery of development further into the future, which could shift the required dates for mitigation. This should be reviewed and accounted for in the AP to ensure delivery of mitigation focusses on releasing developments due soonest.	CCC	Est. Jun 2024

Milestone	Commentary	Owner	Completion Date
Consider DCS impacts	Once housing trajectory is confirmed, it will be possible to assign a cost to each mitigation measure per Kg / year of TP removed, allowing CCC to estimate the value of nutrient credits should this be the chosen funding approach.	CCC	Jul 2024
Lampeter and Llanybydder upgrades	Upgrades to Lampeter and Llanybydder WwTW will be effective from 31st December 2025, allowing development for site allocations connecting to these works.	DCWW	Dec 2025
1st development window	Upgrades at Lampeter and Llanybydder will allow the development/occupation of 40 units associated with 3 site allocations within the rLDP.	CCC	Jan 2026 - 2030
Delivery of strategic wetlands	Based on the current housing trajectory (TBC in June 2024), strategic wetlands at three locations will need to be delivered by end of 2026 to allow for remaining development in the CCC rLDP.	CCC & Collaborators (DCWW)	Dec 2026
2nd Development Window	The remaining 132 units associated with 11 SA within the rLDP can be developed / occupied.	CCC	Dec 2026 - 2031

8.6 Managing & Monitoring

Effective mitigation and compliance with the Habs Regs can be ensured in the following ways:

- Relevant experts and officers ensuring that there is implementation of sufficient mitigation to deliver the reductions required for the LDP;
- Ongoing monitoring of measures to best assess the actual reductions achieved upon implementation; and
- Monitoring of the SACs to ensure that in-combination effects from other LDPs and/or diffuse pollution sources are not exceeding targets.

This can be driven by the actions laid in this Action Plan including implementation of a DCS, with support from the Nutrient Management Plans developed between the relevant stakeholders by the West Wales NMB to ensure the long-term health of the riverine SACs in Carmarthenshire.

9 Non-Technical Summary

Arcadis has been commissioned by CCC to provide specialist support to progress the preparation of its rLDP. This report has been prepared to outline an Action Plan to deliver additional phosphorus mitigation associated with Carmarthenshire's two impacted riverine SACs, such that new development within the rLDP can be brought forward without damaging the receiving downstream sensitive water environment.

A review of phosphate compliance information for the two SACs has been undertaken, confirming that the Afon Teifi SAC has multiple failures. In contrast, the Afon Tywi comfortably passes its phosphate targets.

NRW guidance on the requirement to deliver nutrient neutrality in phosphate sensitive SACs has been reviewed, and consultation has been undertaken by CCC to establish further information on the application of nutrient neutrality in non-failing SACs (with respect to phosphate).

This has confirmed that in the Afon Teifi SAC, where failures against phosphate compliance targets exist, a nutrient neutrality approach must be taken, whereby a nutrient budget for the site allocations under the rLDP must be calculated, and a means of mitigating for this is demonstrated to achieve neutrality i.e., ensuring no net increase in phosphate to the SAC. This concluded that the total TP budget from all 14 site allocations (172 units) within the Afon Teifi SAC catchment is **126.45 TP Kg/year.**

In the Afon Tywi SAC, where there are no known failures against phosphate compliance targets, and in fact the mean concentrations are well below targets (approximately 50%), nutrient neutrality is not currently required.

"… new developments can be authorised if it can be demonstrated they will not lead to an adverse effect on site integrity (i.e. will not undermine the ability for the SAC to meet its conservation objectives by causing a phosphorus target failure alone or in combination with other plans or projects). ***There is no requirement for nutrient neutrality…"***[9]

However, Nutrient Budget calculations were still undertaken for all 7 site allocations (104 units) within the Afon Tywi SAC catchment, which concluded that the final TP budget for the Afon Tywi is **75.69 TP Kg/year.**

Afon Tywi

In the Tywi SAC, the additional TP from the rLDP allocations is very low (**75.69 Kg/year**) compared to its current yearly export (**22,150 Kg/year** taken from source apportionment modelling). This equates to a yearly increase in phosphate loading of just 0.35%. As such, this additional phosphate is highly unlikely to reduce the environmental headroom sufficiently to trigger a phosphate compliance failure in the SAC.

For this reason, the 7 new developments under the rLDP can be brought forward without a need for mitigation to achieve neutrality. Confidence in this decision can be derived from the fact that:

a) An NRW review of permits (taking into consideration environmental impact) has proposed or confirmed TP 5mg/l backstop limits at all WwTWs in the Tywi SAC with a dry weather flow above 20m^3/day.

b) There remains an ongoing commitment within the Tywi SAC catchment to deliver strategic mitigation via the NMBs, which may include category 2 measures such as riparian buffer strips (see Box 7.1) to maintain / enhance the current environmental headroom.

c) New developments will be subject to their own project level HRA, which will need to consider phosphate impacts on a case-by-case basis. In such cases, if it were determined that no impact could not be guaranteed, options remain for developers to explore category 1 and

category 2 measures (such as SuDS) as part of their development proposals. Additional Category 1 measures like strategic wetlands where collaboration opportunities exist with Dŵr Cymru (For example, a wetland opportunity at Llandovery would offer significant nutrient mitigation if determined to be a requirement for future development).

Therefore, despite there being no current requirement to assess mitigation to achieve nutrient neutrality, potential opportunities for category 1 and 2 measures have been identified across the Tywi SAC catchment. These could be considered and implemented by the Nutrient Management Board as part of the Nutrient Management Plan that are currently being developed, alongside a response to the more pressing source of phosphate in the catchment from agriculture activities. Measures outlined in this document could help to maintain or improve upon existing environmental headroom, ensuring that sustainable development in the catchment can be secured long-term.

Afon Teifi

In the Afon Teifi Catchment, the additional TP from the rLDP allocations (**126.45 TP Kg/year**) needs to be mitigated for to achieve nutrient neutrality. Furthermore, in consideration of in-combination impacts, proposed development within the neighbouring councils (Ceredigion and Pembrokeshire) has been taken into consideration. The additional TP from neighbouring council developments is **316.62 kg TP/year** from Ceredigion and **40.13 kg TP/year** from Pembrokeshire.

It should be noted that there is some uncertainty in the planned developments within these councils as their LDPs are not as far progressed as Carmarthenshire. It is possible that these development proposals will reduce or increase, and close liaison with these councils as their plans develop will be required to ensure that mitigation to deliver nutrient neutrality is delivered. The role of the NMB herein is important, given that each council has representation.

In considering mitigation for the additional phosphorus introduced by allocations in the Teifi SAC catchment, an appraisal of mitigation options has been carried out. This has proposed a hierarchy of solutions, as well as categorising the mitigation as either a category 1 or category 2 solution, defined as:

- Category 1 measures – those which allow compliance with the Habitats Regulations and avoid adverse effects from the developments arising from the rLDP allocations.
- Category 2 measures – those that will deliver wider phosphorus reductions across the catchment to increase certainty of success, increase and/or maintain headroom and that could be utilised by developers on a project basis should this be required.

Category 1 measures offer the greatest assurance of phosphate reductions and are therefore highest in the hierarchy of solutions.

Table 9-1: Summary of Solutions Hierarchy

Mitigation Option	Category
1 - Enhanced WwTW	1 or 2
2 - Constructed Wetlands	1 or 2
3 - SuDS	1 or 2
3 - Land Management	2
3 - Tree Planting	2
3 - Integrated Buffer Zones	2

When considering that new developments will connect to a WwTW before discharging to the riverine SAC, enhanced WwTWs offer an opportunity to remove phosphate at source. Dŵr Cymru have

already recognised their need to play an important role in the delivery of phosphate reductions, due to the fact that in the Teifi SAC catchment, WwTWs account for the largest source of phosphate. As a result, and in line with the NRW Review of Permits, planned improvements to several works have already been proposed or accepted. Notable improvements include those at Llanybydder and Lampeter (due to complete in 2025). However, improvements have also been accepted at Capel Iwan, Tregaron and Pontrhydfendigaid and proposed at Pencader. All will be implanted post 2025.

As discussed in relation to the Tywi catchment, the Review of Permits and planned improvements has taken into consideration the condition of the SAC and the need to reduce phosphate export. As such, new developments proposed to connect to these WwTWs, can proceed without a need to provide additional mitigation (i.e. once the required WwTW upgrades are in place to achieve the new permit conditions). This is because any additional phosphorus resulting from the development, will eventually be treated by the WwTWs, which will remove sufficient phosphorus to remain compliant with its new permit and ensure the SAC is protected from adverse impacts.

In such instances, the timing of housing delivery is key. According to the latest housing trajectory, delivery of most site allocations is due to start in 2026 or 2027. Based on this, only improvements at Llanybydder and Lampeter could be relied upon to mitigate developments connecting to these works. In Table 8-1, three site allocation are shown as being released by these improvements. Considering Carmarthenshire's nutrient budget alone, this reduces the additional phosphorus to mitigate by 8.03kg/year, leaving 118.42kg/year to mitigate for.

For the remaining sites, where an enhanced WwTW is not due to be delivered before the proposed houses are being connected in line with the current housing trajectory, constructed wetlands have been considered as the next Category 1 measure to achieve nutrient neutrality.

Constructed wetlands locations were considered based on a high-level feasibility study, NRW policy / guidance, Dŵr Cymru collaboration opportunities and the location of site allocations relative to the proposed wetland. The land take requirements for wetlands were initially sized based on the nutrient budgets calculated for site allocations under the rLDP and a median removal rate based on a literature review. This helped to identify five potential wetland areas: Llandysul, Adpar, Tregaron, Cenarth and Cilgerran. The wetlands at Cenarth and Cilgerran are also being investigated as part of the Phosphate Reduction and Mitigation Project (PRAM Project). These wetlands would be used to address the associated LDP developments from CeCC and PCC downstream of Llandysul. These two wetlands will supplement the proposed Category 1 solutions within the AP to address the in-combination impacts from their respective LDPs.

Once identified, more detailed modelling was undertaken for each wetland using an industry standard *P-K-C* modelling approach. This takes into account design constraints like the concentration of phosphorus entering the wetland, its retention time through the wetland and the proposed flows in/out. This resulted in a much more detailed understanding of the required wetland sizing to achieve nutrient reductions in line with the proposed site allocations. In each instance, it was found that a much smaller wetland could achieve nutrient reductions well in excess of that expected when using the median rates.

At Llandysul, a 2.5ha wetland has been proposed, which will remove 124.54 kg/year of phosphorus. In studying the locations of the remaining proposed site allocations, five were selected to be mitigated for by the Llandysul wetland. These five sites have a combined nutrient budget of 51.28kg/year, meaning that Llandysul would suitably mitigate for these developments and provide a potential contingency of 73.26kg/year of phosphate removal.

At Adpar, a 1.25ha wetland has been provided which will remove 114.81 kg/year of phosphorus. Here, three site allocations could be mitigation for, with a combined nutrient budget of 33.18kg/year.

This means that the Adpar wetland could comfortably mitigate for these three developments and provide a potential contingency of 81.63kg/year.

At Tregaron, based on the current performance of the works, a 1.88ha wetland could remove 297.69kg/year of phosphorus. The final three sites within the rLDP would be mitigated for by this wetland, which have a combined nutrient budget of 33.95kg/year, meaning that they would be suitably mitigated for whilst providing a potential contingency of 263.69kg/year.

In short, the delivery of these three wetlands provides more than enough nutrient removal to demonstrate nutrient neutrality whilst removing an extra 418.63kg/year of TP from the Teifi catchment.

As mentioned previously, Cenarth and Cilgerran are being progressed a part of the PRAM project. Based on the current outline design at Cenarth (0.70ha) and Cilgerran (0.6ha), the wetland could remove 149.56kg/year and 88.70kg/year of phosphorus, respectively. This would suitably mitigate an additional 238.26kg/year of phosphorus downstream of Llandysul.

In addition, secondary measures such as SuDS, tree planting and riparian buffer strips have been identified throughout the catchment, offering widespread opportunity for further mitigation to be developed. SuDS will be a necessity for all developments coming through the planning system, and so some reductions can be guaranteed from this and should be assessed on a case by case basis as developments are brought forward. SuDS can also be considered as a Category 1 measure if designed and maintained accordingly.

It is important to recognise that the wetlands proposed have been developed based on the best understanding of current housing trajectory supplied by CCC. Several site allocations are due to connect to a WwTW with planned improvements in/after 2030. In such instances, were housing delivery or occupancy delayed until after these dates, then the nutrient budget to mitigate would be reduced, and the wetlands proposed would provide even greater contingency than currently calculated.

Furthermore, at Tregaron, the requirement for a wetland could be entirely removed. This is critical, as the initial guidance[24] published by Dŵr Cyrmu suggests that collaboration for a wetland solution at this location is not possible due to planned improvements in 2030 and the associated collaboration category assigned to this WwTW. However, there are no suitable collaboration opportunities at any WwTW adjacent to sites that discharge downstream (i.e., prior to the wetland solution currently proposed at Adpar WwTW), making alternative strategic category 1 wetland measures very difficult to find for any new development proposed upstream of Adpar from CCC or Ceredigion Council.

It is recommended that the housing trajectory, when reviewed in 2024, is updated to reflect the timing of proposed WwTW improvements to remove the need for a Category 1 measure at the Tregaron Wetland. Failing this, negotiation between NRW, Dŵr Cymru and the planning authority will be needed to explore further options. This may include the possibility of delivering the current Tregaron Wetland (whether as an interim or permanent solution despite the current Collaboration Category given by Dŵr Cymru). This is because the land proposed for this wetland is already owned by Ceredigion Council and the new permit is 2mg/l, which should sufficient amount of phosphorus to operate the wetland as a polishing treatment measure even after 2030.

Table 8-1 provides a summary of the mitigation proposed and how it relates to individual site allocations and the timing of housing delivery. This should be referred to for a full understanding of how the Carmarthenshire rLDP can be sufficiently mitigated to achieve nutrient neutrality.

In Combination Impacts

In line with a HRA, combination impacts must be considered taking into concern other plans and their potential to impact the SAC. The additional TP from neighbouring council developments is 316.62 kg TP/year from Ceredigion and 40.13 kg TP/year from Pembrokeshire. This is based on current understanding of their LDPs, noting that Ceredigion is on hold and Pembrokeshire is under development i.e., these could change and are uncertain.

Despite this, the contingency afforded by the wetlands proposed within this action plan is 418.63kg/year, in excess of the 356.75 kg/year from the neighbouring councils combined. Whilst Ceredigion and Pembrokeshire will have responsibility to mitigate for their own developments, this should give confidence that Carmarthenshire is easily demonstrating nutrient neutrality whilst providing sufficient contingency to be confident that in-combination impacts will not be realised.

Conclusion

In summary, there is a clear means of delivering the rLDP in both the Tywi and Teifi SAC catchments based on the principles of an environmental headroom or nutrient neutrality approach respectively. Category 1 mitigation measures in the Teifi SAC catchment have been identified, demonstrating that the additional phosphate to be introduced by new developments can be mitigated for with significant contingency provided.

Next Steps

1. Review rLDP housing trajectory to adjust timing in line with proposed enhancements at WwTWs to ensure phasing requirements as well as to reduce pressure for delivering nutrient neutrality mitigation.
2. Confirm mitigation requirements using the outputs from this action plan and the outcome of the housing trajectory review; identify the mitigation measures to be progressed (e.g., Llandysul or Adpar).
3. Begin more detailed feasibility studies, landowner engagements and preparation of planning documents to support delivery of wetland solutions.
4. Assign costs and nutrient credits for the proposed wetland solutions under a Developer Contribution Scheme.
5. Construct wetlands (allowing for funding via the developer contribution scheme, adoption, maintenance, and monitoring) such that development can be occupied following successful delivery of mitigation.

In addition to the steps outlined above, it will be important to work closely with the NMB to understand wider mitigation measures delivered within the Tywi and Teifi SACs. This may include category 2 measures like riparian buffers, which could improve baseline conditions in the SAC catchments as works progress.

Appendix A

Report Figures

Appendix B

Legislative and Planning Context

Legislative Context

The following are the key pieces of national legislation that may affect the implementation of phosphate mitigation measures:

- Environment (Wales) Act 2016
- Well-being of Future Generations (Wales) Act 2015
- The Flood and Water Management Act 2010
- The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
- Agriculture (Wales) Bill

Environment (Wales) Act 2016[43]:

The duty for public authorities in the exercise of functions in relation to sustainable management of natural resources – enables Wales' resources to be managed in a more proactive, sustainable and joined-up way. This included the provision for Sustainable management of natural resources (SMNR) and is defined in the Environment Act as: *"using natural resources in a way and at a rate that maintains and enhances the resilience of ecosystems and the benefits they provide. In doing so, meeting the needs of present generations of people without compromising the ability of future generations to meet their needs, and contributing to the achievement of the well-being goals in the Well-being of Future Generations Act."* Innovative Nature based Solutions comply with their Natural Resources Policy under Section 9 of the Environment (Wales) Act 2016.

Well-being of Future Generations (Wales) Act 2015[44]:

In this Act "sustainable development" means the process of improving the economic, social, environmental and cultural well-being of Wales by taking action, in accordance with the sustainable development principle, aimed at achieving the well-being goals. The seven well-being goals ('the goals') show the kind of Wales we want to see. Together they provide a shared vision for the public bodies listed in the Act to work towards. The most relevant to this context are A resilient Wales:

- biodiversity and soil - Maintain and enhance the natural environment through managing land appropriately to create healthy functioning ecosystems
- natural green space – support a social resilience and community well-being
- Knowledge of Nature – increased awareness of the importance of a biodiverse natural environment with healthy functioning ecosystems
- Water quality and air quality – support ecological resilience making the environment healthier for wildlife and people
- Using natural resources – be adaptive to a changing environment where there is a need to use resources efficiently

The Flood and Water Management Act 2010[45]:

Amendments to the Flood and Water Management Act 2010 (Schedule 3), came into effect in Wales on 7 January 2019. A UK Act of Parliament relating to the management of the risk concerning flooding and coastal erosion. The Act aims to reduce the flood risk associated with extreme weather, compounded by climate change. It created the role of Lead Local Flood Authority, which is the local government authority responsible for managing flood risk in the local government area. The Act gave new powers to local authorities, the Welsh

[43] https://www.legislation.gov.uk/anaw/2016/3/contents/enacted
[44] https://www.legislation.gov.uk/anaw/2015/2/contents/enacted
[45] https://www.legislation.gov.uk/ukpga/2010/29/contents

Ministers and water companies. It requires new developments to include SuDS features that comply with Welsh national standards[46], which state that:

'Developers should demonstrate compliance with these standards in submitting planning applications. For major developments, where a drainage strategy document may be required as part of a local validation requirement, this should demonstrate how these standards have been met in the site design. It should be noted that a number of planning authorities in Wales have adopted guidance on sustainable drainage which should be taken into account in any development proposal'.

The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021[47]:

This Guidance describes the requirements that farmers and land managers in Wales must follow to comply with the Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 – (SI 2021/77, W.20) which came into force on 1 April 2021.

NRW is responsible for enforcing the Regulations. Advice on general nutrient storage and management can be obtained from NRW and the Welsh Government.

The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 have been introduced to reduce losses of pollutants from agriculture to the environment by setting rules for certain farming practices. The Regulations also set standards for silage making, storage of silage effluent and for slurry storage.

The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[48]:

This regulation imposes duties on the Secretary of State, Welsh Ministers, the EA and NRW to carry out certain functions so as to ensure compliance with the EU directives, in particular when deciding whether to grant, vary or revoke certain permits and licences which affect water quality.

Part 2 of the regulations requires the identification of river basin districts, and a number of other assessments to be carried out by the EA and NRW to characterise and classify the status of water bodies in those districts and assess the economic aspects of water use. River basin management plans must be established for each river basin district. In Part 3, which makes provision for certain protected areas, the identification of bodies of water from which drinking water is abstracted is required, and specific measures are specified that must be included in a programme of measures to protect the quality of the water.

Agriculture (Wales) Bill[49]:

The Agricultural Bill would be strategic in scope, setting a support framework which can accommodate the development of agriculture and forestry within Wales for the next fifteen to twenty years.

The Bill's policy framework is a response to the legislative framework established by the Well-being of Future Generations (Wales) Act 2015 and the Environment (Wales) Act 2016. It will create a new system of farm payments that "rewards farmers for their response to the climate and nature emergencies" and supports them to produce food sustainably. This is in the form of a proposed Sustainable Farming Scheme that reward farmers appropriately for the production of additional non-market goods (improved soils, clean air, clean water, improved habitat condition, actions to reduce global warming) at levels above those set by regulation through the management of land in a sustainable way. It will also provide advice and support for farmers and farm businesses. As described in the Agriculture Wales Bill White Paper.

Key organisations and parties relevant to the delivery of phosphate mitigation measures:

Local Planning Authority:

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[46] Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems
[47] The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021
[48] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
[49] Agriculture Wales Bill

LPAs are 'competent authorities' under the Habitats Regulations[50] and must 'have regard' to the requirements of the Birds and Habitats Directives in exercising any of their functions. LPAs are responsible for ensuring that their decision making is compliant with the requirements of the Habitats Regulations. Part 7 of the Town and Country Planning Act 1990 gives LPAs a range of enforcement powers to address breaches of planning control. A breach of planning control is defined in section 171A of the Town and Country Planning Act 1990 as[51]:

- the carrying out of development without the required planning permission; or
- failing to comply with any condition or limitation subject to which planning permission has been granted.

Any contravention of the limitations on, or conditions belonging to, permitted development rights, under the Town and Country Planning (General Permitted Development) (Wales) Order 2014[52], constitutes a breach of planning control against which enforcement action may be taken.

There are a number of responsibilities which LPA's could use to support the delivery of phosphate mitigation:

- The Town and Country Planning Process and Building Control functions help deliver the requirements of the WFD through careful considerations and consultation around developments, and by avoiding or minimising the adverse effects of any environmental risks on present or future land use[53].

Following the implementation of the Flood and Water Management Act 2010 (FWMA), councils in Wales, as the Lead Local Flood Authorities (LLFAs) are responsible for the management of flood risk from surface water, groundwater and ordinary watercourse. Under the Land Drainage Act, LLFAs also lead on ordinary watercourse consenting and enforcement. LPA's should follow the advice note on the WFD to minimise the impacts on the water environment[54].

Local Authorities have a major role to play in promoting water environment benefits through environmental health and pollution control functions.

As significant land and property owners, local authorities play an important role in protecting and improving the water environment. Local Authority and NRW operational teams should work together to discuss and identify potential opportunities to design and maintain drainage schemes on Local Authority sites and land to provide valuable flood management, water quality, ecological and amenity benefits.

Local Planning Authorities statutory function as the Sustainable Drainage Approving Body (SAB)[55] should ensure that drainage proposals for all new developments are designed and built in accordance with the national standards for sustainable drainage, as published by Welsh Ministers.

NRW[56]:

NRW is the Appropriate Nature Conservation Body (ANCB) for Wales and their functions include the management of Wales's forests and woodlands, pollution control, waste regulation, the management of water resources, flood and coastal risk management, fisheries, navigation and safeguarding of protected sites and species. NRW are the "competent authority" responsible for the implementation of the Water Framework Directive. In relation to the Habitats Regulations the "competent authority" is the decision maker under the HRA requirements and can include local authorities, harbour authorities, and other public bodies. They determine whether or not an appropriate assessment is required, whether proposals would have an adverse effect and, if necessary, whether or not derogation tests are met. It is the competent authority's responsibility to carry out the appropriate assessment and the ANBC (NRW) must be consulted by the competent authority during an appropriate assessment to provide advice and assistance on some decisions. Habitats Regulation

[50] Habitats regulations assessments: protecting a European site - GOV.UK (www.gov.uk)
[51] Town and Country Planning Act 1990 (legislation.gov.uk)
[52] https://www.legislation.gov.uk/wsi/2014/592/contents/made
[53] https://naturalresources.wales/media/684784/20171122-final-signed-revised-wfd-advice-note-for-local-authorities.pdf
[54] https://naturalresources.wales/media/2627/wfd-docs-eng.pdf
[55] https://gov.wales/sites/default/files/publications/2019-06/statutory-guidance.pdf
[56] Natural Resources Wales / What we do

63(4) provides for public consultation at the discretion of the competent authority (it is not a statutory requirement). The “appropriate authority” in Wales under the Habitats Regulations are the Welsh Ministers. Under the HRA requirements, the competent authority must inform the appropriate authority before it consents to a plan or project.

Afonydd Cymru[57]:

Afonydd Cymru (AC) is the umbrella body that represents the six Rivers Trusts in Wales. They advocate for the Rivers Trust on relevant Welsh Government and NRW working groups championing Wales’ thirty-three rivers, and the many lakes and smaller watercourses. Their environment, fish and fisheries and the wide range of diverse species depend on clean water and unspoilt habitats.

Water Utility Companies:

Water utility companies are a competent authority for their activities under the Habitats Regulations[58] and ‘public bodies’ under the Regulations which implement the Water Framework Directive. As such they also have a statutory duty to ‘have regard’ to the requirements of the Birds and Habitats Directives and to the River Basin Management Plan. Under Ofwat’s strategy, Ofwat have made it clear that they will take action if a company fails to comply with its obligations and if there is non-compliance[59]. They use a risk-based approach to regulation which enable them to use enforcement tools to deliver outcomes. The action that Ofwat take will depend on the nature, seriousness and impact of any contravention.

DCWW’s performance is tightly monitored and regulated by a number of regulators. The roles and responsibilities of DCWW regulators are outlined below:

- The Welsh Government sets the legislative and regulatory framework within which DCWW operate by making regulations and issuing statutory guidance. Welsh Government also publishes statutory guidance setting out the strategic priorities that it expects Ofwat to pursue in its regulation of the water industry in Wales.
- NRW brings together the work of the Countryside Council for Wales, EA, Wales and Forestry Commission Wales, as well as some functions of Welsh Government.
- The EA monitors and enforces compliance with environmental water quality standards. It also ensures the proper use and management of water resources.

National Farmers Union (NFU):

NFU Cymru is the leading agricultural organisation for farmers in Wales[60]. NFU represents the farming community with over 47000 members and are the UK’s largest representative body for agriculture and horticulture with has local representatives across the country, including water pollution specialists, to communicate messages between the farming industry, and the regulators. Alongside population growth, the agricultural sector will change in the future and the NFU vision is to achieve this development together with environmental improvement.

Farmers (including fish farms and cress farms) and land managers:

The role of farmers (including those involved in fish farms and cress farm) and land managers in the delivery of the ambition target reductions and the overall achievement of the conservation objectives should not be underestimated. The willingness of farmers and land managers to sign up to the various delivery mechanisms will be crucial to the extent to which reductions can be achieved without the need for further regulatory control.

Planning Context

Planning and Key Legislation[61]

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[57] About Afonydd Cymru | Afonydd Cymru
[58] The Conservation of Habitats and Species Regulations 2017 (legislation.gov.uk)
[59] https://www.ofwat.gov.uk/wp-content/uploads/2015/11/Approach-to-enforcement.pdf
[60] About Us – NFU Cymru (nfu-cymru.org.uk)
[61] Section 38(6) of the Planning and Compulsory Purchase Act 2004

The Planning and Compulsory Purchase Act 2004 introduced the LDP system to Wales. Local Planning Authorities have a duty to produce an LDP for their area. Any statutory body carrying out a planning function must exercise those functions in accordance with the principles of sustainable development for the purpose of ensuring that the development and use of land contribute to improving the economic, social, environmental and cultural well-being of Wales.

Future Wales – The National Plan 2040[62]

It is a spatial plan, setting a direction for where Welsh Government and key stakeholders should be investing in infrastructure and development for Wales. Firstly, from an environmental perspective, natural resources should be sustainably managed, and pollution reduced. Secondly, for economic outcomes, development plans should be forward thinking, with a positive attitude towards enabling economic development, investment and innovation. Nature based solutions are one of the potential mitigation measures for water quality, in addressing phosphorus pollution, they could also help deliver this national policy. The policy sees nature-based solutions as part of shaping urban growth and securing biodiversity enhancements.

Planning Policy Wales (PPW)[63]

PPW contains a framework of National Sustainable Placemaking Outcomes considered to be optimal for development plans and individual developments. The 2 key outcomes are;

Growing our Economy in a Sustainable Manner and Making best Use of Resources; Growth needs to be facilitated without compromising the integrity of the Afon Teifi and Afon Tywi and to do so in a long term sustainable, effective, efficient and least onerous manner;

Maximising Environmental Protection and Limiting Environmental Impact; Promote resilient biodiversity, reducing environmental risks, helping to ensure the Afon Teifi and Afon Tywi is resilient to the effects of climate change, promoting biodiversity, managing water resources sustainably and reducing overall pollution.

PPW contains national policy for a range of planning topics, the most pertinent now follow:

Infrastructure - Development should be located so that it can be well serviced by existing or planned infrastructure. This will involve maximising the use of existing infrastructure or considering how the provision of infrastructure can be effectively co-ordinated to support development plans. These issues were addressed in the preparation of the rLDP, working collaboratively with NRW and DCWW, the spatial strategy focusses development to areas served with WwTW that have phosphorus limits on the Permits and capacity for growth.

Housing - Planning authorities are required to identify the housing needs for its communities, identify land to meet the requirement and demonstrate delivery. Iteratively through the rLDP, it must demonstrate that the housing requirement and any associated mitigation can be delivered.

Environment – Natural assets must be protected, promoted, conserved and enhanced. Negative environmental impacts should be avoided for the wider public interest. This means acting in the long term to respect environmental limits and operating in an integrated way so that resources and/or assets are not irreversibly damaged or depleted. The polluter pays principle applies where pollution cannot be prevented and applying the precautionary principle ensures cost effective measures to prevent environmental damage.

[62] https://gov.wales/future-wales-national-plan-2040
[63] https://gov.wales/planning-policy-wales

Appendix C

Afon Teifi & Afon Tywi Phosphorus Loading Overview

Appendix D

Interventions Measures Matrix

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
Reduction of Agricultural Phosphorus at source	Category 2	This solution focusses on changing farming practices. **Advantages:** Removes P at source, thus reducing pressure on traditional WwTW and nature-based solutions. Increases sustainability of soil. Associated pre-treated sludge biosolid spreading by DCWW as a single accredited stakeholder. **Disadvantages:** Multiple stakeholders required to change long standing practices. Difficult to manage / monitor. Legacy P requires consideration i.e., 20years of continued P export needs to be considered in the land use change. **Delivery Partners:** Landowners, WG, The Council, NRW, NFU Cymru, DCWW, Env. NGOs	Increased biodiversity from a reduction in nutrient enrichment and in soil Aesthetic value Carbon sequestration	Low	Medium	High	Dairy Project Wales Land Management Forum Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Farming Source Control	Category 2	Farm improvement works to prevent Phosphorus from entering watercourses, which can include fencing. **Advantages:** A simple scheme that increases farm value and there is already an existing grant scheme, which can last a long time (50+ years) **Disadvantages:** Multiple stakeholders which may create long term management difficulties and requires seasonal vegetation management. **Delivery Partners:** DCWW, NRW, NFU Cymru, Landowners/land managers, The Council, WG: WG Spending Commitments, Basic Payment Scheme, SFS, Glastir Advanced, Commons and Organic contracts scheme, National Forest for Wales, Food accreditation scheme, Farm Business Grant Scheme post 2024	Increased biodiversity in watercourse habitats from a reduction in nutrient enrichment and in soil Aesthetic value	High	Medium	High	Dairy Project Wales Land Management Forum Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Surface Water Separation	Category 1 & Category 2	This solution focuses on separating wastewater flows from new and existing developments to capture stormwater. **Advantages:** Already normal practice for new developments, leads to reduced CSO discharges into the watercourse and reduced sewage treatment costs. Similar compensatory surface water removal approach already in place for Carmarthen Bay and Estuaries European Marine site. **Disadvantages:** Costly to retrofit in urban areas, limited reduction in Phosphorus unless effective SuDS are incorporated, long term effectiveness depends on operating practices at WwTWs. **Delivery Partners:** Developers, The Council, DCWW, Wales Green Infrastructure Forum	Increased Capacity and efficiencies at WwTW	High	Low	Low	Wales Land Management Forum Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Enhanced Wastewater Treatment Works	Category 1	Increasing the ability of WwTWs to remove Phosphate. **Advantages:** Increase headroom for new development, clear delivery mechanisms within DCWW. Opportunity to explore developer contributions. **Disadvantages**: Requires long term investment and long lead times. May transfer issues to biosolid spreading which would require extra controls. **Delivery Partners:** DCWW: Existing and new WWTW funding, Spending commitments. Developers, NRW, Ofwat, NFU Cymru, WG Spending Commitments.	Improved Water Efficiency and water quality	Medium	High	High	Wales Land Management Forum Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
SuDS Source Control	Category 1	**Permeable paving** **Advantages:** Reduces peak flows and enhance water quality treatment. Dual use of the landscape, prevents ponding, can be used in high density developments **Disadvantages:** Not compatible with large sediment loads, only suitable for low traffic volume areas, maintenance to minimise silt clogging. **Delivery Partners:** Developers, The Council.	Natural Flood mitigations Temperature Regulation	Medium	Low	High	Rainscape National Surface Water Management and SuDS Group Members Teifi SAC Catchment Phosphate Reduction and Mitigation Project Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
	Category 1	**Green roofs** **Advantages:** Reduced peak waste water flows and enhanced water quality treatment along with reduced storm water overloading and CSO discharges, Mimics predevelopment state of water flows, can be retrofitted (site dependant), no additional land, can provide a return on investment from energy savings. **Disadvantages:** High cost compared to conventional roof, not appropriate for all sites and limited retrofitting abilities, requires high maintenance as any damage to roof membrane is more critical as water is encouraged to remain on the roof, limited impact of phosphate removal. **Delivery Partners:** Developers, The Council, DCWW, Business Improvements Districts for retrofits.	Increased Biodiversity Aesthetic value Thermal attenuation Climate resilience Water efficiency Noise Attenuation Air Quality improvements Health and wellbeing if accessible Increased longevity of roofs	Medium	Medium	Medium	Rainscape National Surface Water Management and SuDS Group Members Teifi SAC Catchment Phosphate Reduction and Mitigation Project Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
Swales	Category 1	Shallow broad and vegetated channels designs to store and convey runoff to remove pollutants. **Advantages:** Easy to incorporate into landscaping, good removal of urban pollutants, reduces runoff rates and volumes and low capital cost. Maintenance can be incorporated into general landscape management, pollution and blockages are visible and easily dealt with. **Disadvantages:** Not suitable for steep areas with roadside parking, limits the opportunities to use trees for landscaping, risks of blockages in existing pipework. **Delivery Partners:** Developers, The Council, Local Highways Agencies, WG, National Surface Water Management and SuDS Group, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge, NRW, Four Rivers for Life, Sustainable Drainage Feasibility Grant, DCWW: Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, Wales Green Infrastructure Forum, Living Streets Cymru, Active Travel and Safe Routes in Communities (SRiC) schemes, Heritage Lottery Fund, Esmee Fairburn Foundation	Biodiversity Amenity Aesthetic value Passive cooling	Medium	Low	Medium	Rainscape National Surface Water Management and SuDS Group Members Teifi SAC Catchment Phosphate Reduction and Mitigation Project Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Conveyance Chanels	Category 1	Channels and rills are open surface water channels with hard edges that can be planted with vegetation. **Advantages:** Effective water and pollution treatment can act as pre-treatment to remove silt before water is conveyed into further SuDS features, easy to construct. **Disadvantages:** Incorrect planting can cause silt build up, Need to give careful consideration to crossings, routine maintenance to remove litter/debris, large maintenance required every 5 years. **Delivery Partners**: Same as Swales	Biodiversity Increase Amenity Aesthetic value Passive cooling	Medium	Medium	Medium	Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Filtration Strips	Category 1	Filter strips of gently sloping grass and street trees **Advantages**: Well suited to implementation in areas with heavy traffic, encourages evaporation, infiltration and interception. Easy to construct and low construction cost, effective pre-treatment option **Disadvantages:** Not suitable for all locations. No significant attenuation or reduction of extreme flows. **Delivery Partners**: Same as Swales	Biodiversity Amenity Aesthetic value Health and wellbeing Can encourage active transport	Medium	Medium	Medium	Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
	Category 1	Filter drains are stone filled trenched with underdrains alongside roads, paths or rail lines. **Advantages:** They can capture specific pollutants if there is a layer of treatment media included (the amount removed will depend on the treatment media used). Large ability for treatment since they are often created to be in parallel to the length of roads and paths. **Disadvantages:** It does not capture pollutants directly if treatment media is not added, No vegetation, Depending on the soil conditions and/or pollutant loads, there is risk of filter drains enabling phosphate pollution migration into the underlying ground water, Flow exceedance could lead to temporary flooding. **Delivery Partners**: Same as Swales	Biodiversity (microorganisms, insects and amphibians) Amenity Can filter out fine sediments, metals and hydrocarbons (depending on filter media used) Encourage adsorption and biodegradation process	Medium	Low	Medium	Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
	Category 1	Shallow landscaped areas with engineered soils, enhanced vegetation and filtration, which can also include trees. **Advantages:** Very effective in removing urban pollutants which can also reduce volume and runoff rates. Flexible layout to fit into landscape. Well-suited for installation in highly impervious areas, Good retrofit capability and when lined, can be used to manage surface water runoff from areas with high groundwater pollution risks. **Disadvantages:** Requires landscaping and management. Susceptible to clogging if surrounding landscape is not managed. Not suitable for areas with steep slope. Should be used in conjunction with other SuDS components **Delivery Partners**: Same as Swales	Biodiversity Amenity / Aesthetic value	Medium	Low	High	Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Infiltration Basins	Category 1	A solution based around, rain gardens, infiltration trenches and basins, soakaways, tree pits. **Advantages:** Rain gardens – Small and easy to retrofit, minimal land take, easy to maintain, flexible layout to fit into landscape and can be installed in impervious areas if designed correctly. Soakaways – Particulate P removal through sedimentation of solids upstream of soakaway and infiltration in the soakaway. Can reduce rate of run off and some volume reduction Tree pits – Can enhance the performance of other green infrastructure technologies. **Disadvantages:** Rain gardens – As they are often small, their impact can be limited, requires landscaping and management, susceptible to clogging if surrounding landscape is not managed. Not suitable for areas with steep slopes or impermeable soils. Soakaways – Phosphorus removal highly dependent on infiltration rate and if there is an overflow. Tree pits – Nutrients can be cascaded downstream in extreme events. **Delivery Partners**: Same as Swales	Biodiversity Amenity / Aesthetic value Natural flood mitigation Can reduce the risk of waterborne diseases	Medium	Medium	Medium	Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Retention Ponds	Category 1	Building of ponds to retain water (retention ponds) **Advantages:** Can cater for all storms and has good removal capability of urban pollutants. Can be used where groundwater is vulnerable, if lined. **Disadvantages:** No reduction in runoff volume. Anaerobic conditions can occur without regular inflow. Land take may limit use in high density sites. May not be suitable for steep sites, due to requirement for high embankments. Colonisation by invasive species could increase maintenance. Perceived health & safety risks may result in fencing and isolation of the pond. **Delivery Partners**: Same as Swales	Biodiversity Thermal attenuation Climate resilience Amenity Aesthetic value Recreation Natural flood mitigation	Medum	Medium	High	Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Intervention	Mitigation Category	Discussion	Benefits		Feasibility	Maintenance	Effectiveness	Case Studies
Detention Basins	Category 1	Detention basins are shallow vegetated areas which retain water at times. **Advantages:** Can cater for a wide range of rainfall events and can be used where groundwater is vulnerable, if lined. Simple to design and construct with a potential for dual land use. Easy to maintain. Safe and visible capture of accidental spillages. **Disadvantages:** Little reduction in runoff volume. Detention depths may be constrained by system inlet and outlet levels **Delivery Partners**: Same as Swales		Biodiversity Amenity Aesthetic value Health and wellbeing can double up as play and recreation areas Natural flood mitigation	High	Low	Medium	Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Ponds	Category 1	Larger bodies of standing water. Water is moved in out of the pond through runoff and flow. Can be surrounded by vegetation, grass, hard landscapes, and other surroundings **Advantages:** Uptake of phosphate by plants and aquatic flora. Phosphate can also sediment out onto the base of the pond **Disadvantages:** Good practice for construction must be followed as badly designed ponds can act as exporters of dissolved phosphate. Minimal direct infiltration potential. Cannot manage large inputs of water or exceedance flows **Development Partners:** Developers, The Council, Local Highways Agencies, WG, WG Spending Commitments, Besic Payment Scheme, SFS, National Surface Water Management and SuDS Group, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, Wales Green Infrastructure Forum		Biodiversity Amenity Aesthetic value Recreation Thermal attenuation	Medium	Medium	Medium	Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
Constructed Wetlands	Category 1	Wetland creation designed and maintained specifically for maximising P reduction from both storm and foul water discharges. Plant roots can absorb nutrients and incorporate them into the plant structure. Can provide for tertiary treatment after effective primary and secondary foul treatment processes. **Advantages:** Good removal capability for pollutants and can trap large volumes of sediments. If lined, can be used where groundwater is vulnerable. Large wider environmental benefits and high longevity for functioning effectively (50+ years), Reed bed systems can be incorporated into wetlands which can further enhance biodiversity. **Disadvantages:** Land take is high. Requires maintaining sufficient baseflows in dry periods and there is limited depth range for flow attenuation. May release nutrients during non-growing season, which must be mitigated by good design and maintenance. Little reduction in runoff volume and less effective for steep sites and will require significant earthworks. Colonisation by invasive species could increase maintenance. Performance vulnerable to high sediment inflows. P will be bound in sludge which may require disposal and will require extra pre-treatment with solar drying and well managed biosolid spreading to satisfy crop need. Desludging could be every 10 years but depends on the wetland design. May need to replace bed material if it is saturated with nutrients if artificial bed material is used. Seasonal vegetation removal and management. Potential mosquito habitat. **Development Partners:** Developers, The Council, Welsh Rivers Trust, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, NFU Cymru, Local Nature Partnership for North East Wales, United Utilities, DCWW, WG, WG Spending Commitments, Besic Payment Scheme, SFS, Heritage Lottery Fund, Esmee Fairburn Foundation Ofwat Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge.	Biodiversity Amenity Aesthetic value Recreation Thermal attenuation/temperature regulation Climate resilience Carbon sequestration Natural flood mitigation Potential for water reuse	Medium	Medium	High	Upper Tywi Restoration Project The Wetlands Project The Pontbren Project Four Rivers for LIFE National Surface Water Management and SuDS Group Members Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative Teifi SAC Catchment Phosphate Reduction and Mitigation Project
Integrated Buffer Zones	Category 2	A solution involving increasing grassland, floodplain grassland, beetle banks, woodland and hedgerows. **Advantages:** Good capability for capture of pollutants and wider environmental benefits. **Disadvantages:** Reduced productive area under agriculture may release nutrients during non-growing season. Risk of increasing emissions of nitrous oxide and methane (greenhouse gases) **Development Partners:** Developers, The Council, Welsh Rivers Trust, DCWW, Rivers in Wales Environmental Investment, DCWW Community Fund, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, NFU Cymru, Cities for Trees, Local Nature Partnership Carmarthenshire , United Utilities, Salmon and Trout Conservation', WG, WG Spending Commitments, Besic Payment Scheme, SFS, Glastir Small Grant Scheme, Heritage Lottery Fund, Woodlands for Wales	Biodiversity Climate resilience Air quality Health and Wellbeing Educational Pest control Noise attenuation Amenity Aesthetic value	Medium	Medium	High	The Pontbren Project Four Rivers for LIFE National Surface Water Management and SuDS Group Members Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative Teifi SAC Catchment Phosphate Reduction and Mitigation Project

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
Private Sewerage Drainage Fields	Category 2	Network of discharge pipes from septic tank or Package Treatment Plant (PTP) laid in trenches under the ground surface so that effluent can be discharged to the ground. Effluent percolates through soil. Sediment bound P is immobilised and soluble P is bound to soils and sediments. **Advantages:** Likely to be less costly than a wetland system with less maintenance for same P removal performance. Can be delivered up to medium spatial scale (<100 units / <2.0 ha) **Disadvantages:** Longevity of scheme anticipated to be low (10-20 years). Increased usage of the drainage field with time can result in the soils or filter materials sorption capacity being reached. Fields where ground water flood risk is high or water table is within 2.0 m of ground surface are unsuitable. Provides no additional environmental benefits. **Development Partners:** Developers, DCWW Spending Commitments, NFU Cymru, The Council.	Efficiency and increased capacity at WwTW	Medium	Low	High	National Surface Water Management and SuDS Group Members Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
River Channel Re-naturalisation	Category 2	Works to return rivers to a more 'natural state' including: re-meandering, creating berms, pool-riffle systems, riparian planting and reconnecting channel to floodplain. **Advantages:** Good capability for capture of pollutants and wider environmental benefits. Can have high longevity for functioning effectively (50+ years). Minimal maintenance required during the establishment phase of the river channel. **Disadvantages:** Currently no industry standard regarding the design of larger scale river and floodplain re-naturalisation schemes to support the achievement of nutrient removal. Baseline and longer-term monitoring will be required prior to and following the implementation of a scheme in order to determine how much P the scheme is removing. P absorption to sediments is primary process of nutrient removal, however, the process is reversible with desorption occurring if P concentration of water drops below a threshold. Threshold is dynamic as the sorption capacity of sediments changes over time. Management regime may depend on the local context and degree of re-naturalisation. Potentially will be over a year until additional benefits are realised. **Development Partners:** The Council, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, Welsh Rivers Trust , Salmon and Trout Conservation', Land owners / land managers, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, WG, WG Spending Commitments, Besic Payment Scheme, SFS, Heritage Lottery Fund, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge	Natural flood mitigation Biodiversity Amenity Aesthetic value Carbon sequestration Additional pollutant removal Health and well being Air quality Climate resilience	High	Low	Medium	Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
Drainage Ditch Blocking	Category 2	Placing of barriers across ditches to slow the flow, increase residence times and prevent downstream transport of sediments. **Advantages:** Easy to construct, low construction cost and low maintenance (mainly visual inspections needed). **Disadvantages:** Low predictability / certainty of success, and low removal performance. Lack of UK based evidence for effectiveness; baseline and long-term monitoring is recommended pre-and post-implementation and may result in localised flooding during heavy rainfall events. Dam failure would have implications for P removal efficiency. Limited research currently available on the effectiveness of this method for nutrient removal. **Development Partners:** Land owners / land managers, DCWW, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, The Council, NFU Cymru, Environmental NGOs, NRW, Sustainable Drainage Feasibility Grant, WG.	Natural flood mitigation Biodiversity Additional pollutant removal Carbon sequestration	Medium	Low	Low	Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Engineered log Jams	Category 2	Leaky dams made of woody debris constructed to mimic beaver dams and slow flows and re-naturalise river reaches. **Advantages:** P removal achieved through sedimentation, chemicals sorption and biomass assimilation. Well-designed schemes will require little maintenance and could serve up to 100 units. **Disadvantages:** Risk being washed away in flood events – best suited to small watercourses < 2m wide. Lack of research for engineered log jams / beaver dams to confirm potential nutrient removal estimates; monitoring will be required pre/post scheme introduction to determine effectiveness. Potential for increased localised flooding. Adaptive management needed in case repairs are needed. Possibility that P removal may be short-term and that nutrients could be remobilised during floods. **Development Partners:** The Council, NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, DCWW, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, Welsh Rivers Trust , Salmon and Trout Conservation', Landowners / land managers, WG, WG Spending Commitments, Besic Payment Scheme, SFS, Heritage Lottery Fund, Esmee Fairburn Foundation, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge	Natural flood mitigation Biodiversity Carbon sequestration Additional pollutant removal	Medium	Low	Low	Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Granular Treatment Media	Category 2	Granular treatment media that has been designed to treat various pollutants. There are phosphorus specific granular treatment media. **Advantages:** Up to 100% TP removal (if infiltration possible and depending on the manufacturer) **Disadvantaged:** P removal highly dependent on manufacturer and how well assets are maintained. Filter media will need to be changed periodically. **Development Partners:** Landowners / land managers, The Council, NRW, Sustainable Drainage Feasibility Grant, Developers, Local Highways Agencies, National Surface Water Management and SuDS Group, Living Streets Cymru.	Potential for grey water recycling May reduce unpleasant odours	Medium	Medium	Medium	Wales Water Management Forum National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative.

Intervention	Mitigation Category	Discussion	Benefits	Feasibility	Maintenance	Effectiveness	Case Studies
Willow Beds	Category 2	Willow beds can be designed to treat stormwater from low/medium risk surfaces of small catchments. They allow capturing, attenuation, and evapotranspiration of captured flows. **Advantages:** Capture, attenuation and evapotranspiration of all flows so no discharge occurs. Uptake of P by the willow. Harvesting willow can be a valuable resource. If built as part of a closed systems, it is effective immediately. **Disadvantages:** Not commonly used in the UK, and where they are, they tend to be for private sewage treatment installations. To have optimal TP removal performance harvesting of willow will be required. Harvesting of willow is a valuable resource but the process is of harvesting it is onerous. Some sediment removal is required at the inlet and any suspended sediment may have to be removed periodically. Little information available currently regarding regulations on their implementation of water treatment. Effective only during the willow growing season. **Development Partners:** Landowners / land managers, The Council , NRW, Sustainable Drainage Feasibility Grant, Four Rivers for Life, DCWW, DCWW Spending Commitments, Rivers in Wales Environmental Investment, DCWW Community Fund, Developers: Could help to deliver Net Benefit for Biodiversity, DCWW, WG, WG Spending Commitments, Besic Payment Scheme, SFS, Heritage Lottery Fund, Ofwat, Innovation Fund, Water Breakthrough Challenge, Water Discovery Challenge.	Biodiversity Natural flood mitigation Aesthetic value Amenity value Carbon sequestration Can harvest the willow which could then be sold (offsets some of the maintenance costs)	Medium	Low	High	The Pontbren Project Natural Flood management plus in the Cadoxton catchment Four Rivers for LIFE National Surface Water Management and SuDS Group Members Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative
Attenuation storage tanks (lined)	Category 2	Lined cellular/crated or other storage below ground (no infiltration). **Advantages:** Particulate P removal through sedimentation of solids upstream of attenuation tank. **Disadvantages:** Attenuation tank is not designed to provide any P removal on its own. P removal highly dependent on upstream features and how well assets are maintained. Filters need changing every few years. **Development Partners:** Landowners / land managers, The Council, NRW, DCWW, DCWW Spending Commitments, Developers: Could help to deliver Net Benefit for Biodiversity, DCWW, WG, WG Spending Commitments, Besic Payment Scheme	Natural flood mitigation	Medium	High	High	Natural Flood management plus in the Cadoxton catchment Wales Water Management Forum Rivers Trust of Wales (Welsh Rivers Trust) Afonydd Cymru The West Wales Rivers Trust Taclo'r Tywi Initiative

Appendix E

Wetland Calculations Technical Notes

30192602-ARC-XX-XX-CA-CE-0001-P1 – Cenarth and Cilgerran
30192602-ARC-XX-XX-CA-CE-0002-P1 – Llandysul, Tregaron and Adpar