REPORT

Somerset Levels and Moors Phosphate Mitigation Solutions

Assessment of mitigation solution options

Client: Combined Somerset Authorities

Reference: PC2250-RHD-ZZ-XX-RP-Z-0001

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Royal HaskoningDHV
Enhancing Society Together

HASKONINGDHV UK LTD.

Stratus House
Emperor Way
Exeter
EX1 3QS
Industry & Buildings
VAT registration number: 792428892

+44 1392 447999 **T**
+44 1392 446148 **F**
info.exeter@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

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Author(s):	Oliver Bowers
Drafted by:	Oliver Bowers
Checked by:	Ian Dennis
Date:	14/03/2022
Approved by:	Peter Thornton
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The content and recommendations of this report were based on the best available evidence and understanding at the time of writing. The nutrient neutrality problem is an emerging issue and guidance is subject to change. Similarly, the delineation of the Somerset Levels and Moors catchment map was conducted using the best available evidence and expert advice available at the time and is based on current management practise which may subject to change in the future.

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Abbreviations

Abbreviation	Description
CJEU	Courts of Justice of the European Union
Dutch-N	Dutch Nitrogen Case
EQS	Environmental Quality Standards
HRA	Habitats Regulations Assessment
NAVs	New Appointments and Variations
NFM	Natural Flood Management
P	Phosphorus
PE	Population Equivalent
PR19	Price Review 19
PTP	Package Treatment Plants
SAGIS	Source Apportionment Geographical Information System
SIMCAT	Simulated Catchment
SPA	Special Protection Area
SPD	Supplementary Planning Document
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TP	Total Phosphorus
WFD	Water Framework Directive
WwTWs	Wastewater Treatment Works

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EXECUTIVE SUMMARY

Introduction and purpose of this report

1. Following the Dutch Nitrogen Case ('Dutch-N'), which ruled that where an internationally important site (i.e. SACs, SPAs and Ramsar Sites) is failing to achieve condition due to pollution, the potential for a new development to add to the nutrient load is "necessarily limited". The Dutch-N case has informed the way in which regulation 63 of the Habitats Regulation 2017 should apply to pollution related incidents. This has resulted greater scrutiny of proposed developments that are likely to increase nutrient loads to internationally important sites where a reason for unfavourable condition is an excess of a specific pollutant.

2. The Somerset Levels and Moors are listed as a Ramsar Site under the Ramsar Convention and designated as a Special Protection Area (SPA) under the Habitat Regulations 2017, both of which broadly cover the same area. The Ramsar Site is designated for its internationally important wetland features including the floristic and invertebrate diversity and species of its ditches. This is shared as a designated feature of the underpinning Sites of Special Scientific Interest (SSSI) designated under the Wildlife & Countryside Act 1981 (as amended). The vast majority of the ditches within the Ramsar Site are classified as being in unfavourable condition due to excessive phosphorus and the resultant ecological response, or at risk from this process.

3. As a result, Local Planning Authorities in Somerset are not able to grant planning permission for new developments within the catchment of the Somerset Levels and Moors Ramsar Site unless it can be clearly demonstrated that they will not increase nutrient loading to the protected area.

4. This report sets out suitable mitigation options that could potentially be used to offset the additional phosphorus load from a new development within the catchment of the Somerset Levels and Moors Ramsar site, including potential strategic options to manage phosphorus inputs and allow further residential development to proceed.

Potential phosphate mitigation options

5. Following a detailed review of scientific literature and best practice guidance, a range of different phosphate management solutions were identified. Following an initial screening exercise, in which the potential viability of solutions were evaluated, the following types of solutions were identified as potentially viable for use in the catchment of the Somerset Levels and Moors Ramsar:

6. a) Nature-based solutions: Solutions that would be implemented within a catchment to reduce diffuse-source phosphate loadings, including: Taking land out of agricultural use; Cessation of fertiliser; Installation of riparian buffer strips; Beaver reintroduction; and wetland creation

7. b) Non-catchment based interventions: Solutions that require the implementation of specific local policies, including: Setting restrictions on water usage; Use of anaerobic digestors; Use of package treatment plants. Similarly, solutions that require interventions by third parties,

including: Water company improvements to Waste Water Treatment Works (WwTW) and reductions of their permit limits; Sustainable Drainage Systems (SuDS); Third party credit schemes; Installation of portable treatment works; Use of alternative wastewater treatment providers.

Housing projections

8. In order to understand the mitigation required to meet the upcoming housing requirements, a review of local plan documents and housing projections was undertaken. The additional phosphate loading from the projected housing was calculated using the Phosphate Budget Calculator developed to accompany this report. Worst-case scenarios were assumed to ensure the phosphate loading value is not understated.

9. This found that currently (at the time of publication) 18,234 dwellings require mitigation within the catchment, which is equivalent to 2,455kg/yr of phosphate mitigation that is required for the period 2022 – 2032. By the end of 2024 the current Water Company Asset Management Plan (AMP7) cycle will finish and increased phosphate removal will come online at many treatment works within the catchment, resulting in lower permit limits. In order to meet the housing needs per year, more mitigation is required prior to 2025 to account for the higher permit limits. This mitigation can then be reassigned once the lower permit limits are online, meaning that less mitigation is required per year post 2025.

Conclusions and next steps

10. Multiple potential phosphate management solutions that could potentially be used in the catchment of Somerset Levels and Moors Ramsar have been identified. These range from measures that could be implemented in the short term, to more complex measures that would require considerable design, monitoring and consenting and therefore require longer lead-in times.

11. The following sets out the next steps of what is required in order to develop the solutions presented within this report to functioning phosphate mitigation solutions:

    a) Identification of the preferred solutions to be delivered and the likely costs, timescales and delivery mechanisms. This will likely be undertaken by the creation of mitigation plans in order to formulate developer contributions which could be established through a supplementary planning document (SPD).

    b) A tool to track the phosphate loading for each development and through what schemes this will be mitigated. This should include details of any agreements. The tool should be able to assign credits from various mitigation schemes at various stages of the development lifetime.

    c) A tracking tool could also be expanded to track ‘credits’ achieved through mitigation schemes that can be used for biodiversity net gain, carbon offsetting and nitrogen mitigation.

d) A nutrient trading platform could be established which would provide a mechanism for developers and landowners / farmers to buy / sell credits.

e) Standardised legal agreements should be drawn up and used as a basis in future mitigation schemes.

1 Introduction

1.1 Nutrient Neutrality and the Dutch N Case

12. Following the Dutch Nitrogen Case (the 'Dutch-N'), which ruled that where an internationally important site (i.e. SACs, SPAs and Ramsar Sites) is failing to achieve condition due to pollution, the potential for a new development to add to the nutrient load is "necessarily limited". The Dutch-N has informed the way in which regulation 63 of the Habitats Regulation 2017 should apply to pollution related incidents. This has resulted greater scrutiny of proposed developments that are likely to increase nutrient loads to internationally important sites where a reason for unfavourable condition is an excess of a specific pollutant.

13. As a result, Local Planning Authorities in Somerset are not able to provide planning permission for new developments within the catchment of the Somerset Levels and Moors Ramsar Site unless it can be clearly demonstrated that they will not increase nutrient loading to the protected area. The catchment of the area of risk is presented in **Figure 1**.

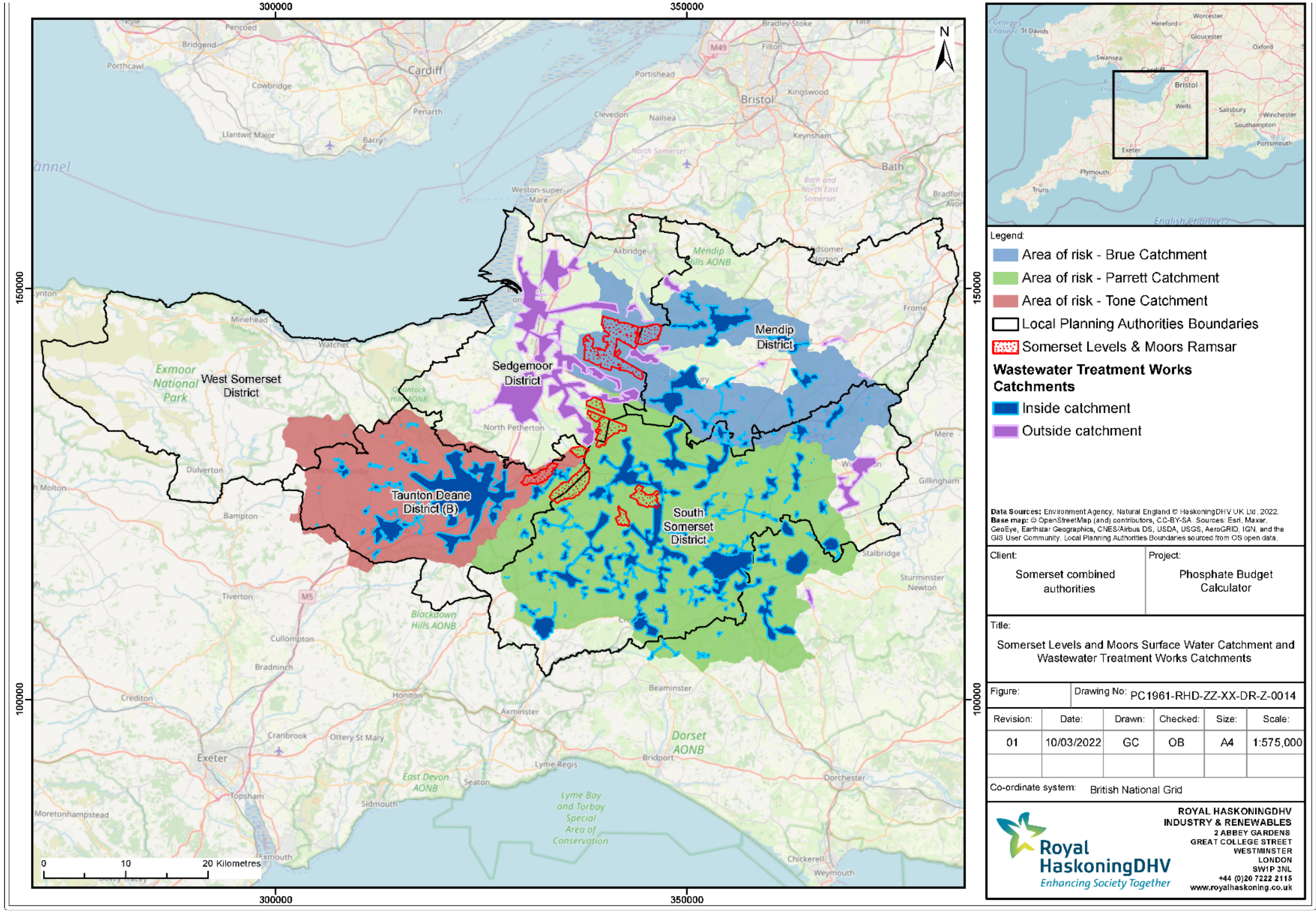

***Figure 1:** Somerset levels and Moors area of risk*

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1.2 Somerset Levels and Moors

1.2.1 Overview

14. The Somerset Levels and Moors are listed as a Ramsar Site under the Ramsar Convention and designated as a Special Protection Area (SPA) under the Habitat Regulation 2017, both of which broadly cover the same area. The Ramsar Site is designated for its internationally important wetland features including the floristic and invertebrate diversity and species of its ditches. This is shared as a designated feature of the underpinning Sites of Special Scientific Interest (SSSI) designated under the Wildlife & Countryside Act 1981 (as amended). Wetland ecosystems are important worldwide, providing numerous valuable ecological services for people and wildlife. They are biologically diverse habitats that also serve various hydrological functions (Ramsar Convention Secretariat, 2016).

15. The Somerset Levels and Moors Ramsar site consists of a series of SSSIs within the largest area of lowland wet grassland and wetland habitat in Britain. The landscape is dominated by rivers and wetlands, artificially drained, irrigated and modified to allow productive farming. The Ramsar site covers an area of approximately 35,000 ha in the flood plains of the Rivers Tone, Parrett, Brue and Axe, and their associated tributaries. The catchment of these rivers broadly relate the Local Planning Authority districts with the Tone reflecting Somerset West and Taunton, the Parrett to South Somerset and the Brue and Axe to Mendip. The Sedgemoor district is located within the catchment of the Parrett and the Brue. Parts of the Parrett catchment cross into Dorset.

1.2.2 Current condition

16. The favourable condition of the ditches of the Ramsar Site is partly reliant on the water quality. Phosphorus in freshwater habitats acts as a key limiting factor to excessive primary productivity. There are high levels of phosphorus inputs into this water environment, with evidence to suggest that phosphorus loading could be leading to eutrophication at part of these designated sites (Crocker *et al*., 2020). Eutrophication represents a significant threat to the biodiversity of surface water, as wetland ditches see an increase in the dominance of algae and duckweed, which ultimately leads to excessive shading and depletion of oxygen in the water column (Zhang *et al*., 2017). This can lead to increased fish deaths and bad odours (Padedda *et al*., 2017). Point sources (e.g. wastewater treatment works) and diffuse sources (e.g. agricultural runoff) of phosphorus pollution are principal reason for failure in the majority of surface water bodies in England to meet the required water quality standards (Crocker *et al*., 2020).

17. The vast majority of the ditches within the Ramsar Site are classified as being in unfavourable condition due to excessive phosphorus and the resultant ecological response, or at risk from this process. The water quality across a number of SSSI sites that underpin the Ramsar site already show exceedance of the Common Standards Monitoring Guidance for phosphorus (>0.1mg-P l−1 as total Phosphorus) set as part of the Natura 2000 series (Taylor *et al*., 2016; Crocker *et al.*, 2020). Monitoring and modelling work conducted by Wessex Water, and agreed with the Environment Agency, demonstrates that the annual mean concentrations of Phosphate in the river inputs into all the SLMs SSSIs, are at least 3 times the CSMG target in

numerous locations. This resulted in the SSSI condition to be downgraded to Unfavourable – declining by Natural England in June / July 2021. Similarly, the Environment Agency's assessment of water quality undertaken under the Water Framework Directive (WFD)[1] across the Somerset Levels and Moors identified that many are at poor or moderate status for phosphate, which is having a detrimental effect on the overall classification of the water bodies.

1.2.3 Condition of sub-catchments

18. As stated above, the Somerset Moors and Levels Ramsar site is located within several main river catchments, including the River Parrett, River Tone, River Brue and River Axe.

19. The Parrett catchment is located in the southern part of Somerset. Key tributaries include the Rivers Isle, Tone, Yeo and Cary. The catchment is approximately 1,700km^2 (including the Tone catchment). The catchment is predominantly rural, but does include the urban areas of Yeovil. Bridgewater is located downstream of the Somerset Levels and Moors. The tributaries of the Parrett flow in a north and westerly direction from steep upland areas into an extensive lowland floodplain. Some of the key rivers are embanked and perched above the surrounding floodplain. The Parrett is tidal for approximately 30km from the Severn Estuary. Environment Agency WFD data (as set out in the South West River Basin Management Plan (RBMP)) indicates that the catchment is split into 56 surface water bodies, of which only one is in good ecological status, with eight poor and one bad, as defined under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (the WFD Regulations). This is partly due to elevated phosphate concentrations. The reasons for not achieving good status are dominated by pollution from rural areas as well as from towns and wastewater. The area of risk map for the Parrett catchment is presented in **Figure 2**.

[1] *England | Catchment Data Explorer*

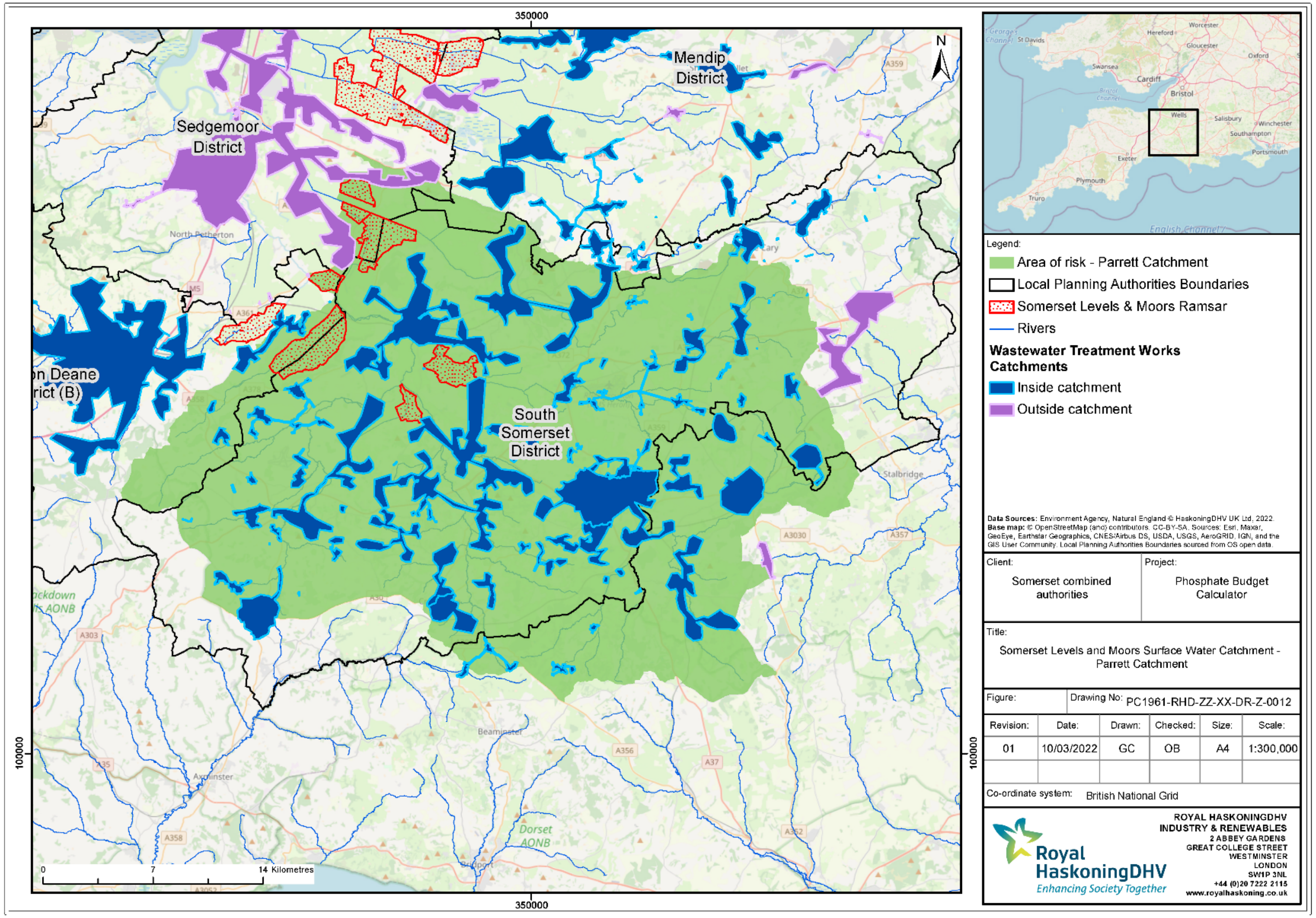

Figure 2: *River Parrett catchment area of risk*

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20. The River Tone is approximately 33km long and has a catchment area of 414km^2. The tributaries of the Tone include the Hillfarrance Brook, Halse Water, Haywards Water and Broughton Brook. The River Tone and its tributaries drain Exmoor, the Brendon, Quantock and Blackdown Hills. The Tone runs to the north of Wellington and through Taunton, the two major settlement areas within the catchment. The Tone becomes tidal at Newbridge prior to the confluence with the River Parrett at Burrowbridge. The typical land use within the catchment consists of permanent pasture, arable, sheep and cattle grazing and woodland. The catchment is divided into seventeen separate water bodies in the RBMP. The latest Environment Agency data (September 2021) indicates that only three water bodies are achieving good status under the WFD Regulations for phosphate concentrations with the majority achieving moderate status. Reasons for not achieving good status typically include pollution from rural areas and from wastewater. The area of risk map for the Tone catchment is presented in **Figure 3**.

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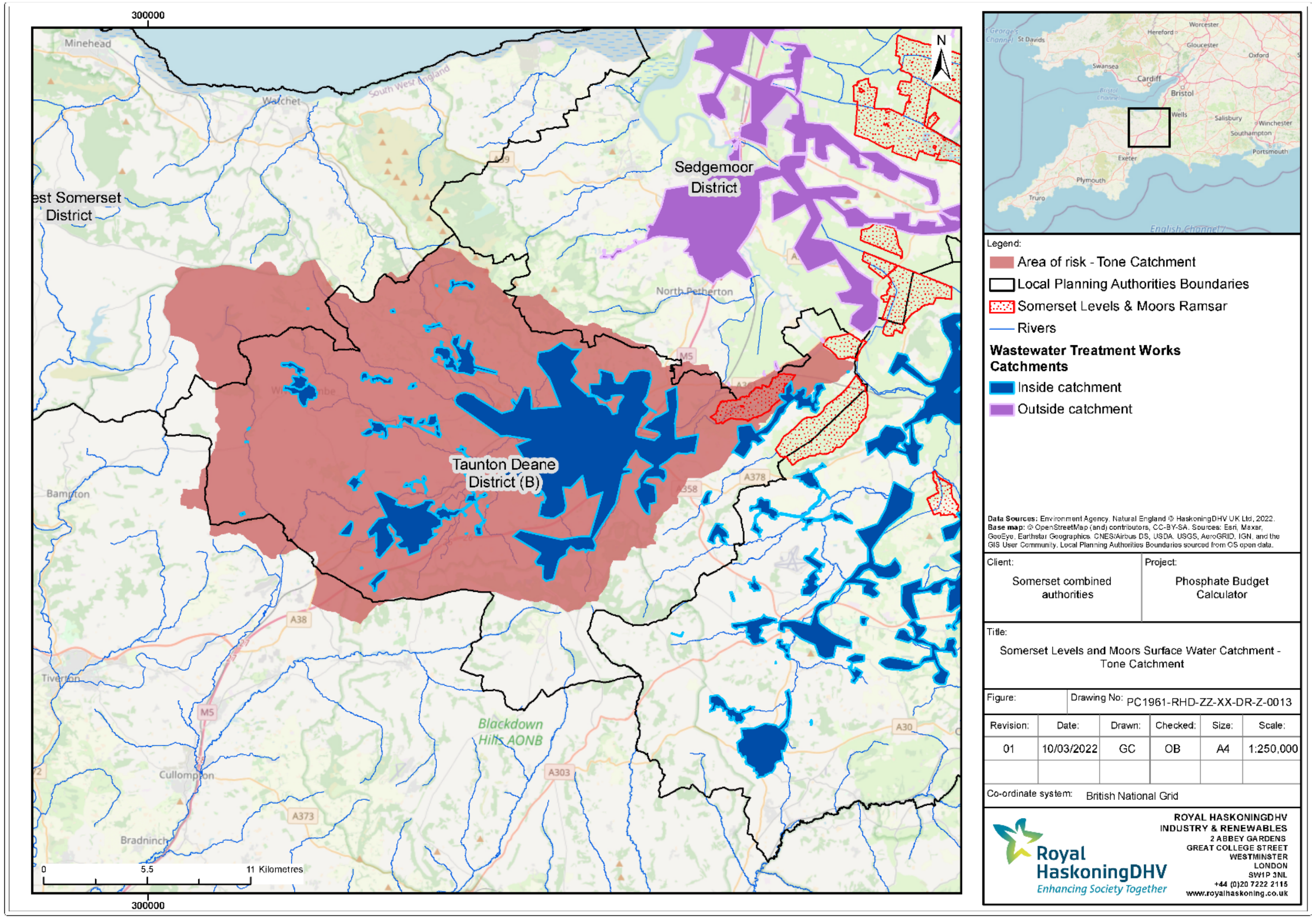

***Figure 3:** River Tone catchment area of risk*

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21. The Brue is the main river within the catchment of the Brue & Axe that flows through the Somerset levels and Moors. The River Brue rises in the uplands in the east of the catchment before flowing in a westerly direction. The Brue and Axe are interconnected by rhynes controlled by sluices and form a complex artificial drainage system. Key tributaries include the South drain and North drain which directly feed the Ramsar sites and the Sheppey. Land use within the catchment is predominantly agricultural. The River Brue is embanked and perched above the surrounding floodplain. The catchment is divided into 27 surface water bodies, of which one is in good ecological status, 2 in poor ecological status and the remainder in moderate ecological status. Reasons for not achieving good status are typically from pollution in rural areas and wastewater. The area of risk map for the Brue catchment is presented in **Figure 4**.

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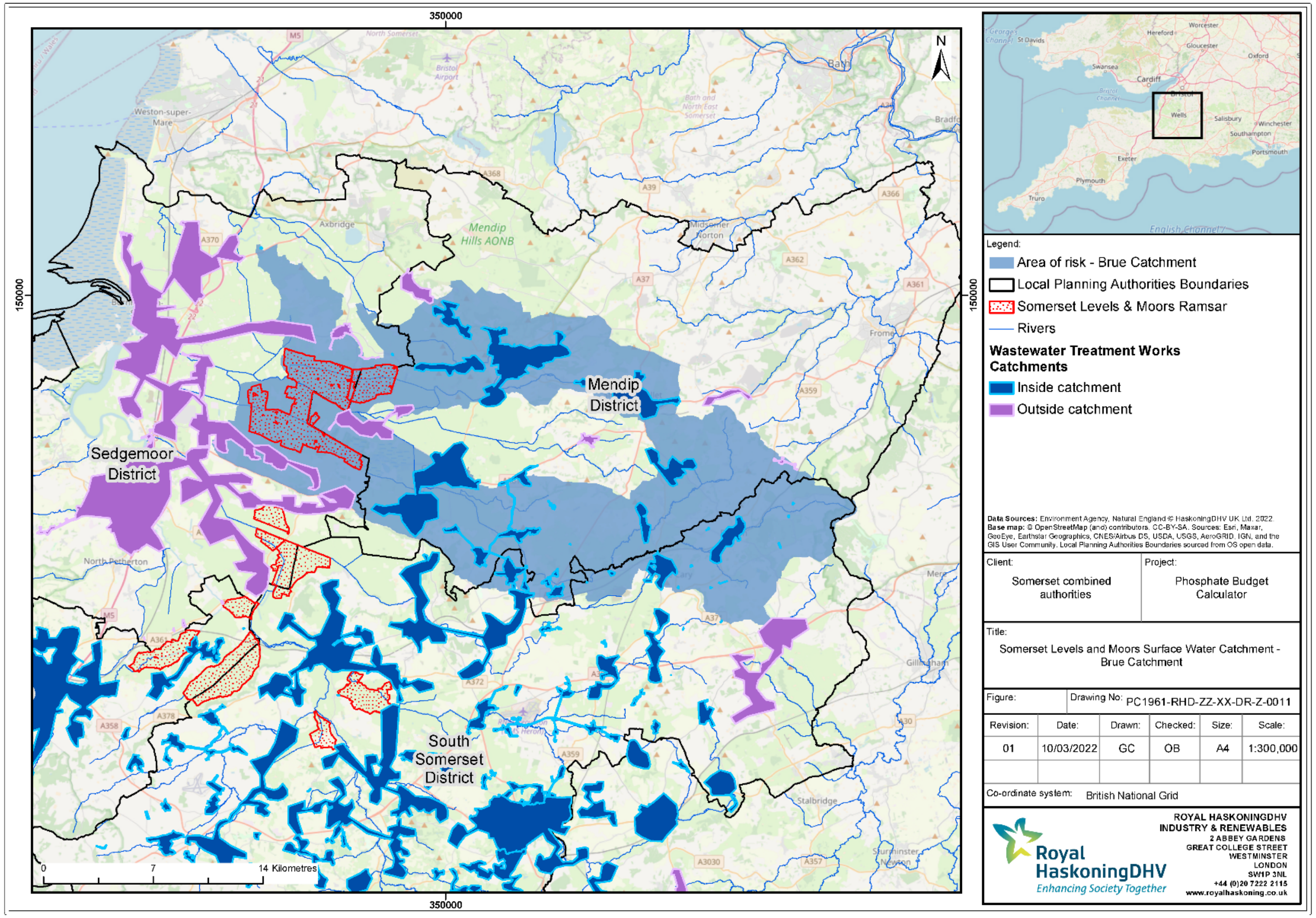


Figure 4: *River Brue catchment area of risk*

1.3 The need for mitigation

22. An assessment of phosphorus loading, and mitigation options, provides guidance to prevent developments creating additional nutrient burdens and offers greater confidence that the whole of a proposed development is compliant with the requirements of the Conservation of Habitats and Species Regulations 2017 (as amended) (the 'Habitats Regulations') and in light of relevant case law.

23. There is therefore a need to identify phosphate mitigation solutions that can be successfully applied within the Somerset Levels and Moors catchment to offset additional phosphates resulting from new developments and allow planning applications to proceed. Natural England have advised that a solution that reduces phosphate loading within a sub-catchment (e.g. Tone catchment, Parrett catchment) can only provide the mitigation to developments within the same catchment.

24. There are a variety of different pollution sources that contribute phosphates to the Somerset Levels and Moors and understanding these sources is an important process in establishing mitigation options. Source apportionment was derived using Environment Agency SAGIS (Source Apportionment GIS, a GIS-based tool developed by UKWIR to identify the sources of pollutants in a river water body) data. Wastewater treatment has a strong influence on water quality within the catchment, but land use also exerts a strong influence over phosphate concentrations and the pathway along which they travel (**Figure 5**). The land use within the Somerset Levels and Moors catchment is typically livestock grazing and combinable crops. **Figure 6** shows the source apportionment for the operational catchment of the Rivers Parrett, Tone and Axe & Brue. The Parrett is the largest catchment and mirrors what is observed at the management catchment scale. The Tone catchment shows a greater concentration from livestock and arable farming, as well as urban runoff; this is in part reflective of the phosphate stripping already in place within this catchment. The Axe and Brue catchment shows a greater concentration from wastewater treatment works.

Figure 5: *Somerset South and West Management Catchment Source Apportionment (Source: Environment Agency SAGIS)*

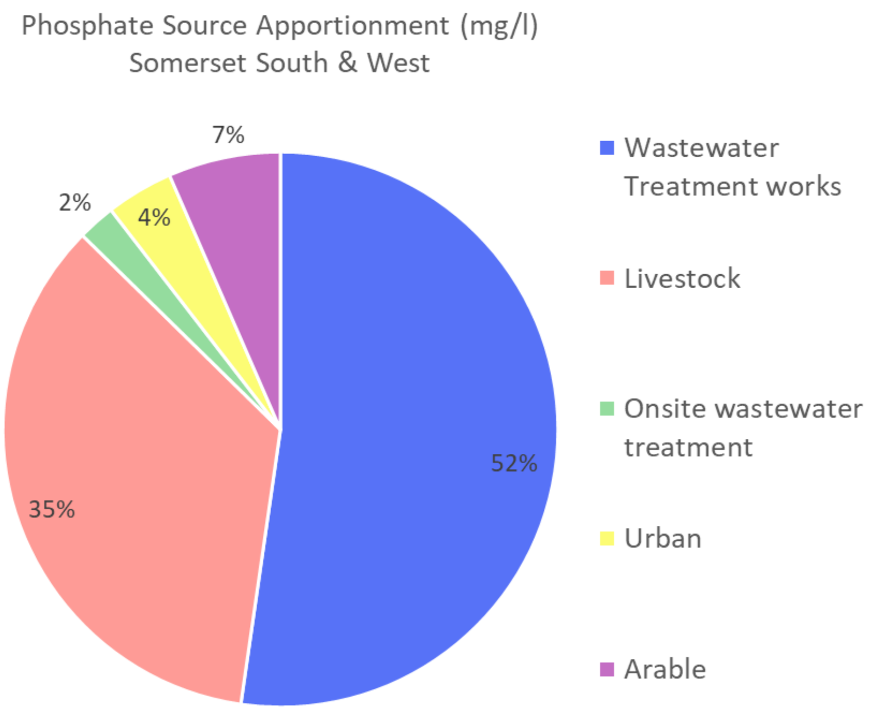
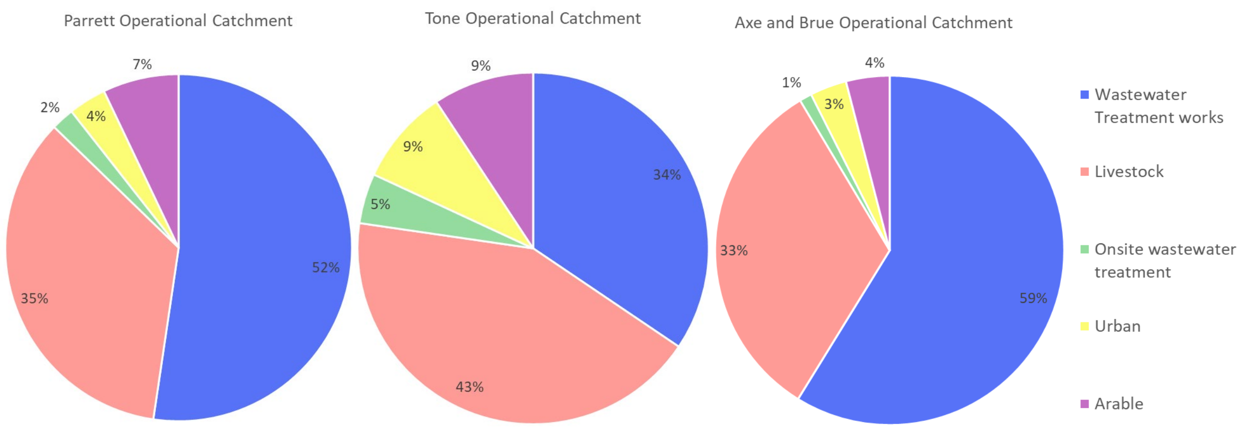


Figure 6: *Operational Catchment scale Source Apportionment (Source: SAGIS)*



1.4 Purpose of this report

25. This report is intended to set out suitable mitigation options that can be used to offset the additional phosphorus load from a new development within the catchment of the Somerset Levels and Moors. It will also assess potential strategic options to manage phosphorus inputs and allow further residential development to proceed. This report outlines the methodology used to identify potential solutions (**Section 2**) which are then evaluated in a long-list (**Section 3**) and subsequent short-list (**Section 4).** Housing projections are included in **Section 5**. A summary and conclusions are provided in **Section 6**.

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2 Methodology

26. A list of potential phosphate management solutions have been identified following a detailed review of literature and best-practice guidance. Other strategic approaches to Nutrient Management in rivers have also been consulted, including:

- River Avon Nutrient Management Plan;
- River Mease Developer Contribution Scheme;
- Advice on achieving Nutrient Neutrality for new development in the Solent Region;
- Advice on achieving Nutrient Neutrality for new development in the Stour Catchment;
- Herefordshire Council Interim Phosphate Delivery Plan Stage 2; and
- Nitrogen Reduction in Poole Harbour: Supplementary Planning Document.

27. This report outlines both short-term and long-term solutions that can be used to achieve phosphate mitigation. Typically, short term solutions cannot be achieved in perpetuity but can be used as an interim solution whilst larger, long term strategic solutions can be established. Natural England during consultation have acknowledged the importance of short-term solutions as well as long term solutions. This report outlines solutions that can be used to achieve phosphate mitigation for the purpose of allowing planning applications to proceed. Some established solutions for phosphate management at a catchment scale do not provide the certainty that is required for mitigating new developments and were not assessed here. Solutions where there is the potential to comply with the Natural England HRA tests (detailed below) were assessed further. Natural England and the Environment Agency have been fully consulted during the development of this report, and their advice has been incorporated. However, they have not formally approved the solutions presented in this report.

28. The solutions have been classified into the following two categories:

- Nature-based: solutions that would be implemented within a catchment to reduce diffuse-source phosphate loadings and includes wetland-based solutions;
- Non-catchment based interventions: solutions that require targeted interventions (excluding nature-based and wetland solutions) or specific local policies to be implemented.

29. Each solution was assessed against the following criteria:

- Timescale for implementation;
- Timescale for duration of solution;
- Phosphate removal potential;
- Regional constraints;
- Management / maintenance requirements;
- Additional benefits; and
- Indicative costs.

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30. For a solution to be accepted by Natural England, to meet the requirements of the habitats regulations, it will need to satisfy all of the following questions:

- Is the solution based on best available evidence?
- Is the solution effective beyond reasonable scientific doubt?
- Does it apply a precautionary approach?
- Can it be secured in perpetuity?

31. The solutions are given a time scale required for establishment / implementation. The time scales are defined as:

- Short term: immediate – 2/3 months;
- Medium term: months – 1 year; and
- Long term: >1 year.

32. The Solutions are also given a timescale for the duration they are likely to be in place for. These timescales are defined as:

- Short term: immediate – 3 years;
- Medium term: 3 – 10 years; and
- Long term: 10+ years.

33. A mitigation scheme may utilise a combination of solutions to provide the required phosphate offsetting and ensure the mitigation is effective over the lifetime of the development. Natural England Guidance (2019) states that in perpetuity is defined as 80 – 125 years). There may be some cases where there is uncertainty in proposed solutions, and until further investigation is carried out, suitable interim solutions may be applicable.

34. Some solutions may only be suitable in the short term, which could be due to land take requirements or cost of delivering the solution. Whilst these solutions cannot deliver mitigation in perpetuity, where they have a short lead time, they can be used as a bridging solution until more permanent solutions can come online.

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3 Mitigation options

35. A long list of solutions has been developed and are presented in **Table 3.1**, along with a short description of the solution and an indication if the solution was shortlisted for further assessment.

Table 3.1: *Long list of solutions*

Solution	Description	Shortlisted?	Reasoning
Nature-based solutions			
Taking land out of agricultural use	Involves the cessation of fertiliser and animal waste loading from agricultural land and replacing the land use with low P runoff values such as grassland, woodland or energy crops such as Willow or Miscanthus.	Yes	Viable solution that can be utilised as a bridging solution.
Cessation of fertiliser / manure application	Farmers to cease application of fertiliser / manure as a short term solution, whilst still farming the land to a lower yield. Short-term reduction in soluble phosphate runoff and longer term reduction in particulate phosphate	Yes	Will require legal agreements and monitoring, but offers a solution where farms can stay in use whilst delivering phosphate mitigation.
Farm Audit	Conduct farm audits to encourage farmers to input less P and save money in the process. Could be conducted by FWAG, EnTrade, ADAS, Agri-tech, Farming advice service (FAS), NFU	No	Falls out of the scope of this strategy and is unlikely to be achievable in perpetuity.
Silt traps	Installation of silt traps on agricultural land to remove particulate bound phosphate.	No	Not a feasible option as it would promote something (i.e. prevention of soil erosion) that should already be in place.
Beetle Banks	Grass mounds constructed on agricultural land to control runoff. Can be planted across long or steep slopes or along natural drainage ways to minimise runoff and soil erosion.	No	Significant monitoring is likely to be required and there is a high level of uncertainty. There is also unlikely to be a high uptake amongst farmers because they need to be positioned in more productive areas in the centre of fields rather than in the margins.
Riparian Buffer Strips	Grass and woodland strips that separate an agricultural field/source from a watercourse.	Yes	Well established method for reducing pollution inputs to rivers.
Wet woodlands	Establish wet woodland areas along floodplains	Yes	Can remove significant amount of phosphate will little management / maintenance required.
Cover crops	Planting cover crops over the winter to avoid soil erosion and limit P runoff	Yes	Large uncertainty in efficacy. Monitoring would likely be required to confirm site specific removal rates.
Beaver introduction	Introducing beavers under a license to reduce phosphate loading. Beaver dams help to reduce flow of soil and nutrient from surrounding farmland into rivers.	Yes	Viable option but significant monitoring is likely to be required and phosphate reductions may not be deliverable in perpetuity.
Constructed wetland creation	Constructed wetlands to treat and filter water to remove pollutants through sediment fallout and plant uptake.	Yes	Frequently an effective solution for phosphate removal from watercourses.

Solution	Description	Shortlisted?	Reasoning
WwTW secondary treatment wetlands	Diverting WwTW effluent on to a constructed wetland for secondary treatment	Yes	Likely to achieve higher removal rates than wetlands located on rivers.
Non-catchment based interventions			
Use of bespoke housing rates	Using bespoke housing densities values instead of the national average (2.4 persons/dwelling)	No	Recent judgement suggest bespoke values would need to be used for all housing types and may not lead to a P reduction. Further guidance is needed from Natural England.
Wessex Water – Introduce P stripping to more WwTWs	Increase the number of sites with p stripping infrastructure (and a P stripping value) within the catchment, beyond that outlined in AMP7 plans.	Yes	Wessex Water are unable to accept contributions to complete any works beyond what is required and already agreed under the latest Price Review in 2019 (PR19) to be delivered under the current Asset Management Planning period (AMP7, 2020-2025). However, additional measures to address phosphate supply from WwTWs are likely to be considered in the next Price Review in 2024.
Wessex Water – Increase P stripping abilities of sites with existing infrastructure	Increase the P stripping potential (and lower the P stripping value) for WwTWs within existing infrastructure, beyond that outlined in AMP7 plans.	Yes	Wessex Water are unable to accept contributions to complete any works beyond what is required and already agreed under PR19 to be delivered within AMP7. However, additional measures to address phosphate supply from WwTWs are likely to be considered in the next Price Review in 2024. We are looking into the viability of funding upgrades.
Wessex Water – Notify if WwTW reaches permit limit prior to deadline	Implement AMP7 permit limit prior to the deadline if the value can be achieved.	No	Wessex Water are unlikely to commit to using permit limits due to the risk of potential fines for exceedance and cost of chemical dosing.
Reduce the 5mg/l value for sites without a permit limit	Use Wessex Water or Environment Agency data to set lower permit limits where possible.	Yes	May be applicable to some sites but not all. Highly dependent on data availability.
Willow buffer areas	Use willows to treat domestic and industrial wastewater	Yes	Can be used as an alternative or in combination with septic tanks / Package treatment plants
SuDS	SuDS are efficient sediment traps and reduce amount of P entering main watercourses. E.g. Basins and ponds, filter strips and swales, soakaways, infiltration basins, gravelled areas, porous paving, urban wetlands.	Yes	SuDS are likely to be an important solution.
Reduce leakage from foul sewage system	Reduce the amount of sewer leaks, which can introduce raw sewage into the environment.	No	High uncertainty with values and measuring P offsetting.
Third party credit scheme	Third party business to offer P credits as a mitigation option.	Yes	Likely to form an important solution.

Solution	Description	Shortlisted?	Reasoning
Portable Treatment Works	Treatment works that can be moved within the catchment to provide additional treatment of wastewater.	Yes	Can be used at multiple locations within the catchment and represent a short term solution
Alternative wastewater providers	Use of an alternative treatment works provider for large development sites	Yes	Viable option for larger developments
Setting restriction on water usage	Reducing Water usage per person will reduce phosphate loading to WwTWs with P stripping.	Yes	Feasible option where there is a high degree of local authority control over water usage fittings / appliances (e.g. in local authority housing or housing controlled by a Registered Provider).
Anaerobic Digestors	Anaerobic Digestors supplied with animal waste will reduce loading to rivers.	Yes	Viable option but further investigation into removal potential is needed.
Package treatment plants	Use of package treatment plants to treat wastewater and discharge to soil	Yes	Can only be used in specific circumstances. Still awaiting guidance from Natural England on how this will be changed in the Phosphate calculator.
Cesspools	Use of Cesspools to remove wastewater from the catchment	Yes	Technically feasible solution (providing conditions are met) but unsustainable and not cost effective.

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4 Shortlisted Solutions

4.1 Nature-based solutions

36. Catchment-based solutions include taking land out of agricultural use, establishing riparian buffer zones, planting cover crops and wetland creation. These solutions are typically short to medium term and can be applied to all regions. The phosphate mitigation potential is often limited compared to the other solution categories or requires a significant area of land.

4.1.1 Taking land out of agricultural use

37. Taking land out of agricultural use involves the cessation of fertiliser and animal waste loading from agricultural land and replacing the land use with low phosphate runoff values such as grassland, woodland or energy crops such as willow or miscanthus. Miscanthus is also ideally suited to marginal land that may have little value for generating income (miscanthus can be grown for biofuel). Soil erosion which can lead to phosphorus mobilisation is also likely to decrease with time as soil is stabilised by more continuous vegetation cover. Reversion of previously agricultural land to a more natural state will eventually reduce phosphorus leaching to natural background rates.

38. However, repeated applications of phosphorus fertilizers and animal waste results in the build-up of phosphorus in soil (commonly known as legacy P). Long-term field experiments have shown that a large proportion (> 70%) of the surplus phosphorus added via fertilisers remains in the soil, some in forms not readily available to crops (Pavinto *et al*., 2020). Long-term applications and accumulations of soil P is an inefficient use of dwindling P supplies and can result in nutrient runoff.

39. The time taken for soils to reduce to agronomic targets and background concentrations varies depending on soil types and the phosphate concentrations (Dodd *et al*., 2012). A study by McCollum (1991) indicated that soil concentration may not be reduced to background concentrations for up to 17 years, based on fine sandy loamy soils in arable production in the United States. Gatiboni *et al* (2021) found that the median time to reach agronomic targets was <1 year but as high as 11 years. However, the time taken to reach environmental targets purely by cessation of phosphorus fertiliser would be 26 – 55 years. This is consistent with Dodd *et al* (2012) which estimated that following cessation of phosphorus application to grassland, the time taken for surface runoff to reduce to acceptable levels is 23 – 44 years. Typically, soils with a greater initial concentration decrease at a faster rate than those with a lower initial concentration.

40. Measures can be imposed which actively uptake phosphorus and limit the impact of legacy phosphates. One method is to propose uptake by vegetation, which will also reduce the risk of soil erosion. Vegetation may include using the site for woodland, energy crops or cover crops. Other methods include blocking drains on drained land. Sharpley (2003) and Dodd *et al* (2014) suggested that ploughing to reduce phosphorus stratification and redistribute and dilute enriched topsoil can decrease concentrations by half and reduce surface runoff losses. Monitoring may also be able to demonstrate that phosphorus loading is returning to background levels.

41. Woodland planting is one mechanism of accelerating the transition to background phosphorus concentrations. Natural England advice suggests that woodland planting is a viable mitigation method that can be easily implemented. They state a requirement for at least 20% canopy cover at maturity, which is equivalent to approximately 100 trees per hectare. Maintenance of woodland is easy to verify and well established. Natural England also advice that woodland planting may be secured without land purchase (Natural England, 2020). Native tree species would also be the preferred choice. However, there is a general lack of evidence on the reduction rates achieved through woodland planting. As such, the phosphate reduction would be calculated using the Phosphate Budget Calculator (2021)and assuming a runoff coefficient of 0.02kg/ha/yr.

42. Energy crops such as *Miscanthus* (Silvergrass) are generally considered to have a higher soluble phosphorus uptake than woodland and should be considered. There is also the possibility to harvest the *Miscanthus* after 5 – 10 years. There is a general lack of research on the amount of additional phosphorus that would be retained by vegetation in semi-natural habitats. These land use types may also require land to be taken out of ownership and managed. However, this would have a lower biodiversity benefit and would be unable to retrieve as much income through potential monetised biodiversity schemes as more natural planting would.

43. Certainty regarding reductions in phosphate application in arable farming can be easily secured by limiting / stopping both organic and inorganic phosphorus fertiliser. Where grazing land is taken out of use, in order for there to be an actual reduction in phosphate loads, then it is assumed that livestock numbers would also need to be decreased and the livestock/hectare rate maintained. However, it is assumed that farms typically operate close to optimal stocking densities and livestock reductions would be needed to maintain this. Where this solution is used as a temporary measure, livestock can be temporarily located outside of the catchment of the Somerset Levels and Moors. However, changes to grazing practices and stocking densities are more difficult to monitor and enforce in comparison to arable reversion to woodland or energy crops, and therefore provide a lower degree of certainty with regards to their effectiveness. Furthermore, consideration would need to be given where potentially polluting agricultural activity is moved to another location where the land parcel is smaller and could increase the pollution risk.

44. Natural England and Environment Agency have previously stated that farms should be operating according to best practice and phosphate removal calculations would be based on the assumptions that this is the case. This is to ensure that potential pollution from agriculture is not traded to another sector, which would then discharge this load back in the catchment in the form of new housing. This will also ensure that phosphate mitigation schemes do not compromise the ability to deliver long term WFD targets for phosphorus.

45. The average agricultural phosphorus runoff rate for the Somerset Levels and Moors catchment, which typically comprises impeded drainage soils, is 0.83kg/ha/yr. Mixed livestock grazing farms, which forms a large part of the catchment, has a runoff rate of 0.50kg/ha/yr (**Table 4.1**)

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__Table 4.1:__ Somerset Runoff coefficients for agricultural land use (Derived from Farmscoper V.4)

Land use	**Runoff coefficient (kg/ha/yr)**	
	Freely draining	Impermeable
Cereals	0.12	0.58
Dairy	0.18	0.41
Cropping	0.12	0.64
Horticulture	0.09	0.46
Pig Farming	0.30	3.15
Lowland Grazing	0.12	0.22
Mixed Livestock	0.13	0.50
Poultry Farming	0.31	0.92
General Arable	0.11	0.56
Average	**0.16**	**0.83**

46. The difference between the agricultural land runoff rate and the future runoff rate is generally small which results in a large amount of land required to offset developments. However, there are some conditions where phosphate loading rates from agricultural land are higher and the land take is not as significant. Farms considered for taking land out of agricultural use should primarily be located in areas of impermeable soil in order to maximise phosphate removal and reduce land take requirements. **Table 4.2** categorises soil types derived from Soilscapes (Cranfield Soil and Agrifood Institute, 2021) into free draining and impermeable (**Figure 7**).

__Table 4.2__: Soil type classification

Free draining			**Impermeable**		
Colour	**ID**	**Name**	**Colour**	**ID**	**Name**
	3	Shallow lime-rich soils over chalk or limestone		1	Saltmarsh soils
	4	Sand dune soils		2	Shallow very acid peaty soils over rock
	5	Freely draining lime-rich loamy soils		8	Slightly acid loamy and clayey soils with impeded drainage
	6	Freely draining slightly acid loamy soils		9	Lime-rich loamy and clayey soils with impeded drainage
	7	Freely draining slightly acid but base-rich soils		15	Naturally wet very acid sandy and loamy soils
	10	Freely draining slightly acid sandy soils		16	Very acid loamy upland soils with a wet peaty surface
	11	Freely draining sandy Breckland soils		17	Slowly permeable seasonally wet acid loamy and clayey soils
	12	Freely draining floodplain soils		18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils
	13	Freely draining acid loamy soils over rock		19	Slowly permeable wet very acid upland soils with a peaty surface
	14	Freely draining very acid sandy and loamy soils		20	Loamy and clayey floodplain soils with naturally high groundwater
				21	Loamy and clayey soils of coastal flats with naturally high groundwater
				22	Loamy soils with naturally high groundwater

	23	Loamy and sandy soils with naturally high groundwater and a peaty surface
	24	Restored soils mostly from quarry and opencast spoil
	25	Blanket bog peat soils
	26	Raised bog peat soils
	27	Fen peat soils

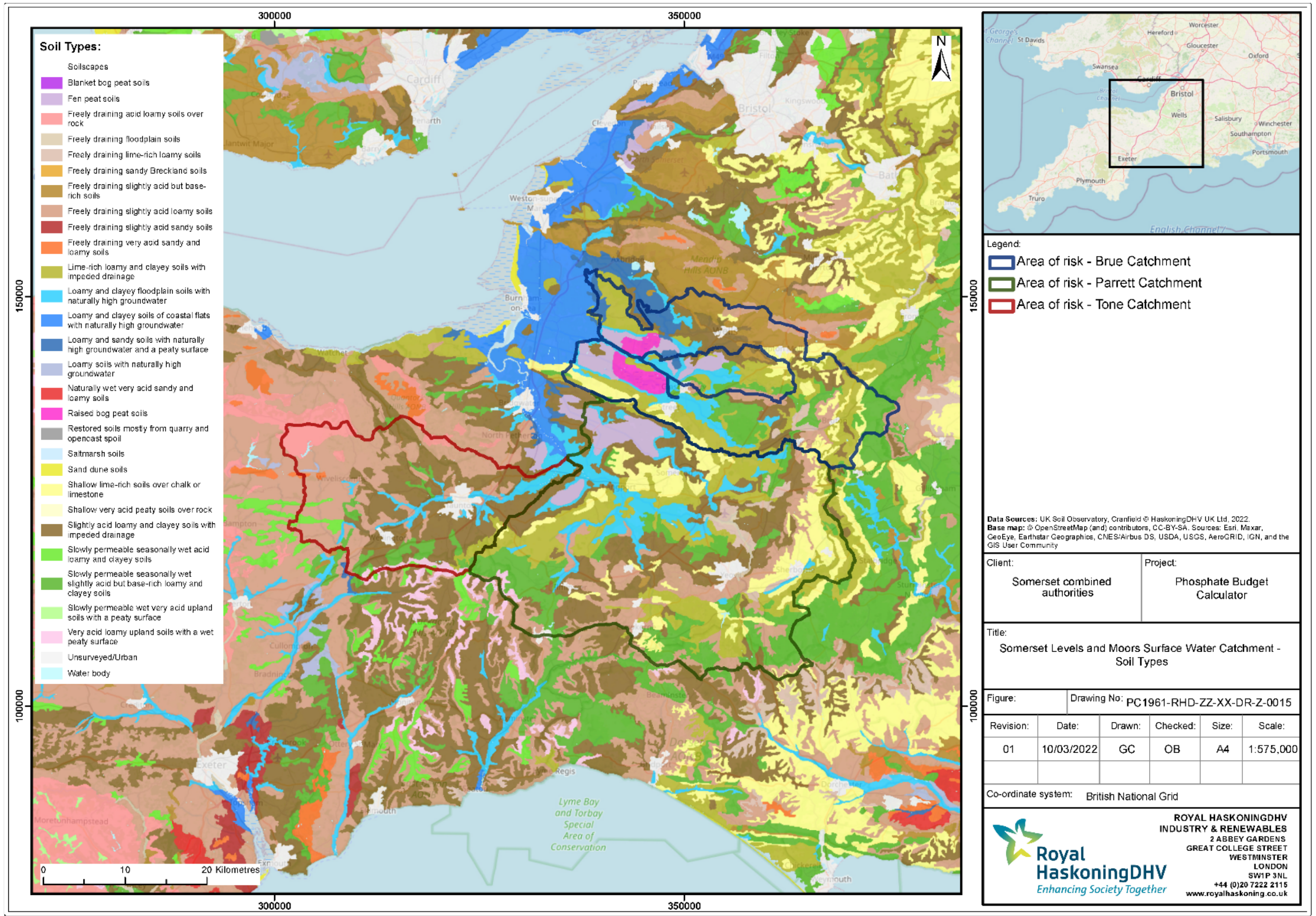

Figure 7: *Soil types within the area of risk*

47. Farming types such as pig farming (3.15kg/ha/yr), poultry (0.92kg/ha/yr) or cropping (0.64kg/ha/yr) generally have higher phosphorus loading rates than other farming types. These farm types, on impeded drainage soil, represent the most favourable for taking land out of agricultural use. Added benefits occur when land is taken out of production on certain soils types. Clay particles retain or fix phosphorus in soils. Consequently, fine-textured soils such as clay loam soils (e.g. Soilscapes 8, 9, 18) have a greater phosphorus-fixing capacity than sandy, coarse-textured soils.

48. In terms of changing land use on the farm, the phosphate budget calculator (2021) can be used to determine the phosphate mitigation achieved. Alternatively, Defra's Farmscoper Tool[2] can be used to calculate phosphate reductions and the associated cost. Farmscoper was developed by ADAS (Agricultural Development and Advisory Service) for Defra to enable the assessment of the cost and effect of one or more diffuse pollution mitigation methods at the farm scale. The tool estimates baseline emissions of a suite of different pollutants and predicts the mitigation potential against these pollutants and quantifies potential benefits for biodiversity. The tool can be set up to model most basic farm types by changing livestock numbers, crop areas, fertiliser rates, soil type and climate. In this way the effects of taking land out of production or changing land use can be assessed.

49. The amount of land take that would be required to provide the levels of offsetting needed to unlock current residential applications held up by the phosphates issue and ensure that future planned delivery of housing is nutrient neutral would likely have implications for long-term food production in Somerset. Therefore, it is unlikely that this would provide anything more than a short-term / medium-term solution to bridge the gap until more efficient and effective longer-term solutions can be developed. There is the potential for land to be leased on short term solutions without the need for purchase. Management agreements are likely to be needed to ensure the land remains out of agricultural use.

50. This is a well-established method to implement and there is therefore the potential for over-reliance as a short / medium-term solution. This is also a solution that could be implemented by local authorities, third parties and private developers. Therefore, it is important that other short-term solutions are identified, and clear guidance is given so that they can easily implemented in order to minimise short-term inflation of land prices. Consideration of in-combination effects need to be given by all parties who would be implementing offsetting schemes. Furthermore, there is the potential for long term inflated agricultural land prices if this solution requires land to be out of agricultural practise for more than 3 years (i.e. it is used as a medium / long-term solution). This could be further exacerbated when coupled with the predicted impact of mandatory biodiversity net gain which is likely to increase agricultural land values when it becomes mandatory under the Environmental Act 2021.

51. Change of agricultural land to renewable energy options such as Solar or Wind farms represents a cessation in agricultural practises which will also reduce phosphate loads. This

[2] *Developing the Farmscoper Decision support tool - SCF0104 (http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18702)*

solution would be easy to enforce and verify through aerial imagery / site visits. However, Natural England's current advice is that mitigation schemes must be developed where the main purpose is phosphate mitigation, rather than being delivered as a consequence of another action. As such, it is Natural England's stance that renewable energy schemes could not be used to deliver phosphate mitigation.

4.1.1.1 Rental costs

52. There are two main types of agricultural tenancies:

- Full agricultural tenancies, which are subject to the Agricultural Holdings Act 1986.
- Farm business tenancies, which are subject to the Agricultural Tenancies Act 1995.

53. Most tenancy agreements made after 1 September 1995 are subject to the Agricultural Tenancies Act 1995 and are commonly known as Farm Business Tenancies. **Table 4.3** presents the rental rates for farming types across England for 2018 and 2019 (the latest data available at the time of writing). Note that there is a degree of fluctuation in prices between the different years.

Table 4.3: *FBT rental rates (£/ha) for farming types in England Source: Defra, 2021*

Farm Type	Rental price (£/ha)	
	2018	2019
Cereal	279	263
General cropping	329	298
Dairy	255	271
Grazing livestock	71	79
Lowland grazing	190	128
All Farms	231	222

54. The average rental price in the South West during 2019 is £231/ha. The average removal potential is approximately 0.5kg/ha/yr. It is expected that a short-term price inflation of agricultural land will increase the rental price above the baseline figures presented in **Table 4.4**.

Table 4.4: *FBT rental rates (£/ha) for FBT farms in the South West Source: Defra, 2021*

Farm Type	Rental price (£/ha)	
	2018	2019
South West FBT	257	231

4.1.1.2 Purchase costs

55. The England average value of land for all farm types is estimated to be £18.3k/ha in 2020 (Savills, 2021).

4.1.1.3 Capital and maintenance costs

56. Other capital costs associated with woodland planting, grass conversion and planting cover crops may result in a short-term negative cash flow. Maintenance costs (e.g. harvesting, cutting) are expected to be minimal and offset by sales of products.

4.1.1.4 Taking agricultural land out of use

57. **Table 4.5** presents a range of considerations when taking land out of agricultural use for phosphate offsetting.

Table 4.5: *Taking land out of agricultural use key considerations*

Key considerations	
Delivery Timescale	Short-term
Duration timescales	Short-term
P removal potential	Average banking opportunity of 0.5kg/ha/yr.
Farm Typologies applicable	Unlikely to be applicable to indoor pig or poultry farms
Management / Maintenance requirements	For miscanthus growing – no fertiliser needs to be added until it is established and less needs to be applied than most farming practises. Harvesting needs to be completed every 2-4 years. Energy Crop Schemes are available.
Additional benefits	Reduced Nitrate loading. Energy crops can be used in Anaerobic Digestors.
Based on best available evidence?	Yes – Although some doubt may remain over legacy phosphates and may require further research or monitoring to gain a better understanding.
Effective beyond reasonable scientific doubt?	Yes
Precautionary?	Yes
Securable in perpetuity?	Yes - However, it is unlikely this solution would be used for long term solutions. Plantations may need to prove they can be in place for the lifetime of the development, or offer a fallback option.
Cost estimation	Initial costs: £1500-£1700. Harvesting costs: £170/ha. An estimated range of net profits from miscanthus grown for biofuel are £183-£211/ha per annum (minus haulage).[3] As a long-lived plant, sustainable over 15-20 years of annual harvests, miscanthus may bring in an annual profit without yearly establishment costs. The average rental price in the South West during 2019 was £231/ha. The average removal potential is approximately 0.5kg/ha/yr.

4.1.1.5 Variations between districts

58. The agricultural land within the catchment of the Somerset Levels and Moors is primarily occupied by mixed livestock grazing farms. There are also significant areas of cereal farms and dairy farms. The catchment contains a low abundance of poultry and pig farms which

[3] *Farming Connect (https://businesswales.gov.wales/farmingconnect/news-and-events/technical-articles/miscanthus-alternative-crop-welsh-farmers)*

typically have the greatest phosphate runoff rates. Variations in farming types are observed across the catchment of the Somerset Levels and Moors. There is a greater abundance of arable farms observed in the South Somerset and Somerset West and Taunton districts compared to the overall catchment. Arable farms offer greater certainty in phosphate reductions than livestock farms when used as a short-term solution and can achieve greater phosphate reductions than other farming types in the catchment. Greater numbers of dairy farms and land used for livestock grazing are observed within the Mendip district. The Sedgemoor district within the catchment typically contains more arable farmland in the south of the district and a greater abundance of livestock grazing in the north.

4.1.2 Cessation of fertiliser and manure application

59. Where full land abandonment is not available, a change of farming practises or cessation of fertiliser application may be applicable. Stopping fertiliser or manure will have an immediate short term impact by reducing the amount of soluble phosphate runoff that is usually lost following application, particularly during rainfall events. There will also be a longer-term impact on particulate phosphate loss should the solution be implemented for consecutive years due to a reduction in soil phosphate reserves. Particulate forms of phosphorus are typically lost through soil erosion when phosphorus is bound to soil.

60. In a study of long-term (45 years) land use, cropping without fertilisation reduced legacy phosphorus significantly (Zhang *et al*., 2020). This was also confirmed in Zhang *et al* (2020) where after 11 years of cultivation, in which the yield and phosphorus uptake by maize-soybean crops was not affected by withdrawal of phosphate fertilizer down to the critical level, legacy phosphorus was significantly reduced. The study also found that reliance on legacy phosphorus improved farmers' economic margins and reduced the soil test phosphorus levels to safe levels for surrounding catchments. Legacy phosphorus does serve as a potential source for crop use and could potentially decrease the dependence on external fertilisers. Cessation of fertiliser allows land to still be farmed whilst also providing phosphate reductions, with the loss of productivity from the lack of fertilisation balanced by income from phosphate mitigation. This could be secured as a short term bridging solution by planning conditions. Legal agreements to cease fertiliser application for a set area and duration will be required and spot checks undertaken to monitor farming practises and phosphate concentrations in runoff. Monitoring will be required to ensure that estimated phosphate removal rates are achieved and validate that fertiliser / manure application has ceased. This is likely to comprise 3-4 visits per year, including an initial round of sampling to establish the baseline conditions.

61. This solution would be best implemented on farms in arable use, but could also be extended to farms with grazing and mixed livestock. This method would have a significant impact on crop yields, with the greatest impact on responsive crops such as potatoes and some vegetables, which may increase the cost of this solution for these farming types.

62. Soluble phosphorus runoff reductions from the cessation of 100% of fertiliser application is estimated to be 50% (Newell Price *et al*., 2011). Soluble phosphorus constitutes the main proportion of the Total Phosphorus losses (Ekstrand et al., 2010). Long-term studies in Sweden indicate that soluble phosphorus generally accounts for more than 80% of Total Phosphorus for sandy or loamy soils, which is the dominant soil type within the Camel

catchment. This value drops to 60-70% for silty and clayey soils (Djodjic *et al*., 2004). In terms of land use types, White and Hammond (2009) found that soluble phosphorus accounts for 60% of the total phosphorus loss from improved grassland. However, on arable land particulate forms of phosphorus typically have more of an influence than on grassland areas, due to the lack of dense vegetation preventing particulate loss. Neal *et al*. (2010) studied the relationship between soluble and particulate phosphorus in nine major UK Rivers and found that soluble phosphorus in agricultural and rural setting made up 50% of the Total Phosphorus. As such, taking a precautionary approach, it was assumed that soluble phosphorus makes up 60% of Total Phosphorus for grassland and 50% for arable farms. Therefore, the total phosphorus removal values for cessation of fertiliser and manure application for grassland and arable farms is assumed to 30% and 25%, respectively.

63. The phosphate removal that can be achieved for each farming typology in presented in **Table 4.6**. The average phosphate removal for the catchment is 0.16kg/ha/yr on freely draining soil and 0.24kg/ha/yr on impermeable soil.

Table 4.6: *Phosphate removal from the temporary cessation of fertiliser and manure application*

Land use	Phosphate removal from cessation of fertiliser / manure application (kg/ha/yr)	
	Freely draining	Impermeable
Cereals	0.03	0.15
Dairy	0.05	0.12
Cropping	0.03	0.16
Horticulture	0.02	0.12
Pig Farming	0.09	0.95
Lowland Grazing	0.04	0.07
Mixed Livestock	0.04	0.15
Poultry Farming	0.09	0.28
General Arable	0.03	0.14
Average	**0.16**	**0.24**

64. **Table 4.7** outlines the likely costs associated with this solution, both for arable and grassland farming. Cessation of fertiliser application to arable land is estimated to have a 50% reduction in yield on the affected area. Similarly, cessation to grassland is assumed to have a reduction of 30% to an average yield of 8t/ha (Newell Price et al., 2011). The actual costs per farm are likely to differ due to the variety of variables, such as fertilisation rates, soil types, crop types, etc.

Table 4.7: *Cessation of fertiliser / manure cost estimation*

Description	Cost (£/ha/yr)	
	Arable	**Grassland**

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Saving in fertiliser	-100.82	-35.96
Reduced use of fertiliser spreaders	-6.65	-6.65
Reduced yield / Forage replacement	781.86	311.12
Soil testing	600	600
Total	**1,274.39**	**868.51**

65. A 10ha arable farm on impermeable soil could deliver approximately 1.4kg/yr of mitigation. Assuming the costs outlined in **Table 4.5**, this would be equivalent to £9,103 per kg/yr mitigation for every year the solution is used.

66. A 10ha grassland farm in mixed livestock use could deliver approximately 1.5kg/yr of mitigation. Assuming the costs outlined in **Table 4.7**, this would be equivalent to £ per kg/yr mitigation for every year the solution is used.

67. **Table 4.8** presents a range of considerations for cessation of fertiliser / manure application for phosphate offsetting.

Table 4.8: *Cessation of fertiliser and manure application key considerations*

Key considerations	
Delivery Timescale	Short-term
Duration timescales	Short-term
P removal potential	0.12-0.50kg/ha/yr, average 0.27kg/ha/yr
Farm Typologies applicable	Arable and Grassland
Management / Maintenance requirements	None
Additional benefits	Nitrogen reduction
Based on best available evidence?	Yes – monitoring likely to be needed to confirm
Effective beyond reasonable scientific doubt?	Yes
Precautionary?	Yes
Securable in perpetuity?	No – likely to be utilised as a bridging solution
Cost estimation	Arable: £1,274.39 ha/yr Grassland: £868.51 ha/yr

4.1.3 Riparian buffer strips

68. Riparian buffer zones are strips from 5m wide composed of permanent grass and/or woodland cover that act as a separation between the agricultural field and a watercourse. It can also act as a filter between point sources of phosphates and rivers. Phosphorus reductions are achieved through sedimentation of phosphate bound particles and uptake via vegetation. Vegetation within buffer strips reduces surface runoff rates, which in turn promotes infiltration (Hoffman *et al.*, 2009).

69. Riparian buffer strips are typically located at field margins and are, therefore, more likely to be adopted by farmers. **Table 4.9** shows a summary of recent published research on phosphorus removal using buffer strips. Buffer strips composed of woody material as opposed to herbaceous material can store significant amounts of biomass phosphorus (Fortier *et al.*, 2015), whilst woody buffers are more effective at trapping sediment than grasses (Hoffmann *et al.*, 2009, Anguiar *et al.*, 2015). The phosphorus removal rate is greatest during the first few metres of the buffer strip. However, the highest total removal rates are typically only achieved in buffer strips 15m to 20m wide. Vought *et al* (1994) found that in grass buffer strips the phosphorus removal in the first eight metres was 66%, and by 16m, 95% removal was achieved. To obtain maximum nutrient retention a buffer width of 10m to 25m is needed, alongside a density of vegetation (Vought *et al.*, 1994).

***Table 4.9**: Summary of phosphorus removal rates using buffer strips*

Factor	Key points	Problems	Reference
Composition of buffer strips	Poplar and willow buffer strips can store 3-7x more biomass phosphorus; fast growing poplars result in higher reduction rates than many other species. Conversion of herbaceous buffers to poplar buffers could increase P storage in biomass by 3.2kg/ha/yr to 15.6kg/ha/yr, over 9 years. Replacing unmanaged herbaceous buffers with poplar and willow buffers could rapidly increase biomass P storage along farm streams, which would be beneficial for water quality protection.	Long lead-in time for effective results (9 years) – unclear when P uptake becomes effective before this. Poplars need to be managed and harvested/replaced every nine years. Limited potential for biodiversity gains due to the large-scale planting of a single species. A mixture of appropriate native species would deliver greater biodiversity benefits, but may not achieve the same P reduction rate.	Fortier *et al.*, 2015
Runoff pathways and phosphorus retention	Main buffer runoff pathways are: • Overland flow across buffers. • Irrigation of the riparian buffer. • Flood inundation of the riparian buffer (floodplain). Retention rates of total phosphorus range between 32% – 93%; median 67%.	Several studies show significant release of dissolved phosphorus (i.e., up to 8 kg P ha−1 yr−1) from buffers.	Hoffmann *et al.*, 2009
Riparian buffer zone contaminant removal	Woody vegetation zones have high (99.9%) efficiency of removal nitrogen and phosphorus. Grasses did not show a good removal efficiency for phosphorus (61.6%). The removal effectiveness is largely influenced by buffer zone width and vegetation type. 10-25m wide buffer strips are generally considered to be effective.	Wide buffer strips may be unrealistic in many UK settings, particularly in areas where field size is small.	Anguiar *et al.*, 2015

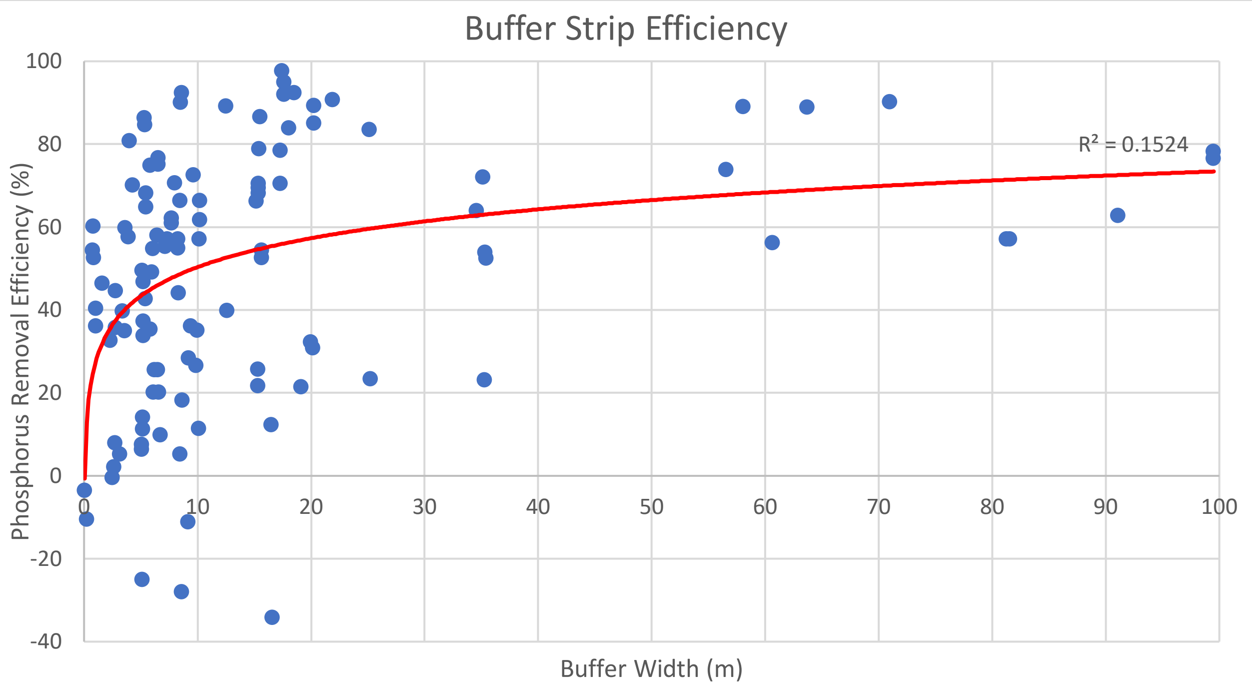
70. **Table 4.10** outlines the phosphorus removal efficiency achieved by riparian buffer strips depending on their soil types and width (Zabronsky, 2016). The data confirms that removal effectiveness increases with buffer strip width and that the optimum total removal rates can be achieved by buffer strips approximately 20m in width. The major soil type does not appear to have a strong control over removal effectiveness.

__Table 4.10:__ Riparian Buffer Effectiveness depending on buffer width and soil type (edited from Zabronsky (2016))

Study	Vegetation Cover	Buffer Width	Phosphorus removal efficiency (%)	Major Soil Type
Chaubey *et al*., 1995	Grass	3.1	39.6	Silt
	Grass	6.1	58.4	Silt
	Grass	9.2	74.0	Silt
	Grass	15.2	86.8	Silt
	Grass	21.4	91.2	Silt
Meals, 1996	Grass	Unknown	86	Clay
Lee *et al*., 1998	Grass	3	39.5	Loam
	Grass	3	35.2	Loam
	Grass	6	55.2	Loam
	Grass	6	49.4	Loam
Lim *et al*., 1998	Grass	6.1	76.1	Silt
	Grass	12.2	90.1	Silt
	Grass	18.3	93.6	Silt

71. **Figure 8** Presents the findings from a study by Tsai et al. (2016) which reviewed phosphorus retention in riparian buffers. The data confirms that removal effectiveness increases with buffer width and that buffer widths of 15m to 25m are most favourable. Beyond 25m the removal effectiveness does not dramatically increase and is not viable for the agricultural land take required.

__Figure 8:__ Buffer Strip Efficiency (Edited from Tsai et al. 2016)



72. Site-specific factors also play a role in controlling the phosphate reduction of riparian buffer strips and should be considered when considering the most appropriate location for buffer strip placement. For example the orientation of the buffers and the adjacent agricultural activity are important considerations. Typically, riparian buffers adjacent to agricultural land used for cropping will achieve the greatest real-world reduction rates due to the potential to remove a high degree of phosphate bound sediment in the runoff.

73. Key risks associated with riparian buffer strips include the following:

- Where buffer strips are used as a long-term, in perpetuity solution, the long term management of the adjacent fields presents a risk. Should the adjacent land be taken out of agricultural use or significant changes in agricultural practises this could reduce the phosphate sources and subsequent removal potential.
- Improper upkeep of buffer strip vegetation, fencing and silt could reduce the removal potential.
- Should overland flow not be maintained and flow becomes channelised, the buffer strip will not operate at optimum removal rates.

74. Key considerations are summarised in **Table 4.11**. Riparian Buffer Zones need continued maintenance to ensure they achieve the desired loading rates – maintenance is mainly limited to cutting vegetation and removal of accumulated sediment. This is an important process to prevent the area from becoming a nutrient source rather than a sink. Unmanaged buffer strips may not provide a permanent sink and could become a source of phosphorus. Monitoring of management practises and water quality may be required after to establishment to ensure continued functionality. Riparian buffer strips could also be implemented as a short-term solution to bridge the gap until longer term solutions can be established. Typical costs are shown in **Table 4.12**, **Table 4.13** and **Table 4.14**.

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Table 4.11: Riparian Buffer Strips key considerations

Key considerations	
Delivery Timescale	Medium-term
Duration timescales	Medium / long-term
P removal potential	Median TP retention rates of 67% (Hoffmann *et al*., 2009).
Farm Typologies applicable	All applicable
Management / Maintenance requirements	Cutting/vegetation removal
Additional benefits	• Stabilised river banks. • Water quality. • Reduced erosion. • Habitat creation. • Improved amenity value. • Carbon offsetting.
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	No – there is doubt over initial removal rates and if these rates can continue to be achieved.
Precautionary?	Yes
Securable in perpetuity?	Yes – management agreements may be needed where the solution is intended to provide medium term solutions to ensure it does not revert back to agricultural use and is maintained correctly. Where buffer strip management has an additional value to land managers (e.g. energy crops, trees for firewood) then this could reduce the risk of reverting to agricultural use.
Cost estimation[4]	Typical costs are: • Setup – £58/ha - £93/ha based on arable or dairy systems. • Maintenance – £6 - £38 per ha based on arable or dairy systems. • Detailed costs are provided in **Table 4.10**.

Table 4.12: Summary buffer strip costs

Measure	Cost
Arable field margins (seed cost only)	Annual cost: £7.50 per 100m
Buffer strip vegetation planting	Capital cost: £0.3/m for 2m wide field margin. Annual cost: £0.5/100m for 2m wide strip grass maintenance.
Planting hedges and fencing	£11/m planting hedges and fencing.
Fencing	£0.9/m - £1.10/m electric fence.
Provide alternative drinking spots	Capital cost: £400 per stabilised drinking area.

[4] *Environment Agency. 2015. Cost estimation for land use and run-off – summary of evidence (Report –SC080039/R12). (https://assets.publishing.service.gov.uk/media/6034eefdd3bf7f264e517436/Cost_estimation_for_land_use_and_run-off.pdf)*

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75. Where Riparian Buffer Strips are already present within the catchment, through stewardship and environmental land management schemes[5], phosphorus 'credits' cannot be achieved as this is likely to represent double counting. However, typically buffer strips under stewardship and environmental land management schemes are typically up to 10m in width whereas the optimum width for buffer strips for phosphate mitigation are 15-25m. Therefore, riparian buffers for land management schemes could run parallel to those for phosphate mitigation. A credit-based approach which utilises elements of the existing model could be established for new buffer strips. Riparian buffer strip grants are available under Mid-tier and Higher tier Countryside Stewardship Schemes. These grants have a typical term of 5 years, after which point new grants can be applied or from 2024 the Environment Land Management (ELMS) scheme will be in place. At the end of agreements, existing riparian buffers could be improved and extended for phosphate mitigation instead of payment schemes. This would reduce the need for significant areas of new Riparian buffer strips.

76. Riparian buffer strips also have the added benefit of stabilising riverbanks and reducing erosion. This is achieved by dissipating energy in river flows and through stabilisation of soils by roots (Cooper *et al*., 1990). This will also lead to a reduction in particulate bound phosphate entering rivers, although quantification of the reduction is difficult to predict. Buffer strips also provide habitats for wildlife.

77. **Table 4.13** outlines the predicted costs for establishing and managing riparian buffer strips on farms, including loss of income from land take (Newell Price *et al*., 2011) (based on average impacts per farm type rather than a defined width of buffer strip).

***Table 4.13**: Annual predicted costs for Riparian Buffer Strips on farms (Newell Price et al., 2011)*

Total cost for farm system (£/farm)	Dairy	Lowland Grazing	Mixed livestock	Crops	Combinable / Roots	Outdoor pigs	Horticulture
Annual	3,400	650	2,300	2,400	10,600	4,500	2,800

Additionally, **Table 4.12** outlines the rates received by farmers under the current Countryside Stewardship Grants.

***Table 4.14**: Annual Countryside Stewardship Grants for Riparian Buffer Strips*

Option	Description	£/ha/yr	£/ha/80yr
SW11 Riparian Management Strip	Riparian buffer up to 12m in width. Prohibits application of fertiliser and pesticides and use of permanent fencing to exclude livestock	440	35,200
SW4 12 to 24m buffer on cultivated land	12 to 24m buffer strip excluding vehicles or stock and prohibiting fertiliser and pesticides.	512	£40,960

78. An initial assessment of land suitable for Riparian buffers estimated that this solution could deliver phosphate reductions close to 3.5 kg/ha/yr. There are significant opportunities for

[5] https://www.gov.uk/government/publications/environmental-land-management-schemes-overview

riparian buffer strips throughout the catchment which could deliver significant phosphate mitigation. A 5ha buffer strip, located in an appropriate location, could deliver approximately 17.5kg/yr of mitigation. Assuming riparian buffers are paid at the same rate of current Countryside Stewardship grants, this would result in a total cost of £204,800 over 80 years, equivalent to £11,700 per kg/yr mitigation.

4.1.3.1 Variations between districts

79. Buffer strips are most effective where sheet flow dominates and flows are not channelised, as this will sufficiently slow the flow and spread the nutrients uniformly. Lowland areas located in close proximity to the designated Somerset Levels and Moors SSSI sites typically contain an abundance of interconnected drainage ditches that could result in nutrients bypassing the buffers. As a result, this solution is typically better suited to upland areas of the catchment. Lowland areas within the Sedgemoor, Mendip and South Somerset Districts are not suitable.

80. Where fields in upland areas contain field drainage, these should be redirected into the buffer strip to ensure there is no bypassing. Alternatively, field wetlands could be used to collect runoff prior to dispersing through a buffer strip, which will also increase the phosphate removal.

4.1.4 Wet woodlands

81. Wet (floodplain) woodlands occur on soils that are permanently or seasonally wet, either because of flooding, or because of the landforms and soil type. They are found on river floodplains, in peaty hollows and at the margins of fens, bogs and mires (Woodland Trust, 2022). Phosphate removal strategies utilising wet woodlands involve working with either existing floodplain woodland or creating new areas of planting (**Figure 9**). Natural flood management (NFM) interventions can also be used to divert water out of the channel and into the floodplain wetland (**Figure 10**) to enhance sediment and pollutant deposition. The role of wet woodlands in water quality management is to increase hydraulic roughness, which slows flow velocities and allows sediment and particulate bound pollutants to fall out of suspension and enter storage on the floodplain, or in a designed wetland setting. Riparian woods reduce diffuse pollution by trapping fine sediment runoff generated by agricultural practices (Cooper et al., 2021).

82. Similar gains (for managing diffuse pollution and flood risk) can be expected from extending fingers of riparian woodland into upstream source areas and intermittent flow/run-off pathways, although few studies are available to quantify impacts at a catchment scale (Nisbett et al., 2011).

4.1.4.1 Tree species

83. In the UK, the most suitable trees for creating wet woodlands are native species best suited to boggy ground. For the main canopy this includes alder (*Alnus glutinosa*), crack willow (*Salix fragilis*), white willow (Salix alba), and downy birch (*Betula pubescens*). Understory species may typically include grey willow (*Salix cinerea*), osier (*Salix viminalis*) and a range of grasses (e.g., purple moor grass (*Molinia caerulea*)) (Woodland Trust, 2022). It is uncertain how these species cycle and potentially uptake floodplain phosphates.

Figure 9: *Area of wet woodland created in Salford in 2016. The project led to the attenuation of pollutants by biodegradation (Natural Course, 2017).*

Figure 10: *Traditional Natural Flood Management structures, such as leaky barriers, can be used to enhance channel-floodplain connectivity to encourage pollutant deposition.*

4.1.4.2 Removal rates

84. Data on phosphate removal rates in wet woodlands are scarce. Olde Venterink (2006) analysed various floodplain communities in terms of their relative abilities to influence water quality through nutrient retention and denitrification. The results showed that productivity and nutrient uptake were high in reedbeds, intermediate in agricultural grasslands, ponds and semi-natural grasslands, and very low in woodlands (only understorey). Furthermore, rehabilitation of agricultural grasslands into ponds or reedbeds will probably be more beneficial for downstream water quality (lower P-concentrations) than into woodlands or semi-natural grasslands. Note that this study refers to woodland, not wet woodland, so comparisons are uncertain and do not necessarily reflect UK soils or climate. This study does not consider more effective sediment trapping in wet woodlands and associated standing water. Removal rates may have some similarities to riparian buffer strips.

4.1.4.3 Additional benefits

85. Wet woodland creation, or expansion of existing riparian woodland, has several co-benefits, such as: carbon sequestration, watershed regulation, biodiversity conservation, landscape and amenity, air pollution reduction and reduced flood risk (Nisbett et al., 2011). One of the major potential benefits of using woodland to improve water quality is the opportunity to supplement farm income by utilising short rotation coppice for biofuel (Mackenzie and McIlwraith, 2013).

4.1.4.4 Costs

86. Bare root stock suitable for tree planting programmes for typical wetland species are in the range of £2-3 per tree. Typically, bulk orders from suppliers reduce these unit costs to less than £1. Bulk order tree guards are a similar price. Planting density for creating new native woodlands is recommended to be 1600 trees per hectare (The National Forest Company, 2003). However, these figures are for general woodland creation, not floodplain wet woods where additional space may be needed for wetland landscaping (e.g., pools and scrapes). Typical planting costs (trees + guard) may be ~£5,000 per ha. Grants of up to £10,000 per ha could be available through the government's England Woodland Creation Offer (Gov.uk, 2022) and phosphate mitigation credits may need to match this figure.

4.1.4.5 Management

Wet woodlands by their nature thrive on non-intervention and limited to no management. Light management includes:

- Coppicing some areas to create a more diverse woodland structure with some clearings
- Allowing woodland edges to grade upwards from grass, through scrub, to woodland
- Coppicing to provide wood fuel
- Managing areas of willow and scrub to maintain some open areas and wet scrub
- Controlling invasive species (e.g., Himalayan balsam *Impatiens glandulifera*)

87. **Table 4.15** presents a range of considerations for using cover crops for phosphate offsetting.

Table 4.15: *Wet woodlands key considerations*

Key considerations	
Delivery Timescale	Medium-term
Duration timescales	Medium / long-term
P removal potential	Uncertain
Farm Typologies applicable	Riparian land holdings (withing FZ3)
Management / Maintenance requirements	Minimal – some coppicing to encourage understory growth; removal on invasive species (e.g., Himalayan balsam)
Additional benefits	Recreation carbon sequestration Biodiversity conservation Air pollution reduction Flood risk reduction Biofuel

Key considerations	
Based on best available evidence?	Limited evidence available – monitoring may be required
Effective beyond reasonable scientific doubt?	No – there is doubt over removal rates (lack of research and data)
Precautionary?	Yes
Securable in perpetuity?	Yes – land suited to wet woodland is very unlikely to revert to any other land use
Cost estimation	Cost of trees and guards. In the region of £5,000 per ha. A typical leaky dam to enhance floodplain connectivity is £50-£100 depending on design and materials

4.1.4.6 Variations between districts

88. This solution would be best suited to upland areas and areas of existing wet woodland. Lowland areas within the Sedgemoor, Mendip and South Somerset Districts are not suitable.

4.1.5 Cover crops

89. Surface runoff and erosion represents the principal mechanism for phosphorus loss from many agricultural systems. The risk of runoff is primarily controlled by timing, rate and method or fertiliser or manure application, as well as post-application rainfall. Natural factors such as slope, surface roughness, infiltration capacity and magnitude of erosion also have a strong control. Bare soils are very prone to erosion and cover crops help maintain soil cover during the autumn and winter. They are especially useful to mitigate erosion on high risk sloping land typically found in upland areas. Cover crops act to encourage infiltration and reduce overland flow velocity. They are best employed when land would otherwise be left bare during the crop rotation process. They are typically used either prior to main production cycle (e.g. potatoes, sugar beet) or post-harvest (e.g. cereals).

90. Phosphorus reduction rates are variable within the literature. Some studies suggest significant phosphorus removal can be achieved, such a study by Novotny and Olem (1994) which suggested phosphorus removal of 30-50% and Sharpley and Smith (1991) which found an average reduction of 77% from four different studies. However, other investigation concluded that phosphorus losses were not significant (e.g. Kleinman *et al*, 2005). Cover crops also provide winter cover and habitat for birds, mammals and insects.

91. Maintenance costs associated with cover crops include seeds costs, preparation, planting, destruction and cultivating. Cover crops are not harvested for cash like crops are.

92. **Table 4.16** presents a range of considerations for using cover crops for phosphate offsetting.

Table 4.16: *cover crops key considerations*

Key considerations	
Delivery Timescale	Short-term
Duration timescales	Short-term
P removal potential	Large uncertainty
Farm Typologies applicable	Arable farms (particularly cereals)

Key considerations	
Management / Maintenance requirements	Time and money costs associated with preparation, planting, destruction and cultivation.
Additional benefits	Water quality; habitat creation
Based on best available evidence?	No
Effective beyond reasonable scientific doubt?	No
Precautionary?	Yes
Securable in perpetuity?	Yes – management agreements will likely need to be put in place, especially where land in leased.
Cost estimation	Maintenance costs: £150/ha/yr (AHDB, 2020)

4.1.6 Beaver reintroduction

93. **Table 4.17** summarises key considerations associated with beaver reintroductions. Beavers, primarily through the building of dams, can deliver reductions in nutrient and sediment fluxes. The dams act to slow water and promote sediment drop out where it accumulates on the bed of the ponds. The process primarily reduced particulate bound phosphate, with little impact to soluble phosphate concentrations.

94. Total phosphorus (TP) reductions from beaver dams are variable, with the literature showing a range of values between 13 - 84%, with median values close to 50%. The beaver habitats would be confined to upland areas with upstream catchment areas typically up to 1,000ha. Phosphate sources would be derived from the hydrological catchment upstream of the dam. Beaver dams would be most efficient where placed downstream of catchment that have a high sediment runoff rate. The catchments typically have a TP loading rate of 100kg/yr - 150kg/yr. Assuming 50% of the TP is permanently removed (median values) from the catchment, phosphate reduction rates per beaver introduction scheme may achieve phosphate reduction of approximately 50kg/yr - 75kg/yr. Research undertaken by the University of Exeter on existing beaver introduction trials run by the Devon Wildlife Trust in Devon have revealed that dams have helped reduce the flow of soils and nutrients from surrounding farmland.

95. The sediment deposits remain on the bottom of a beaver pond until either the beaver dam collapses (most dams last 2 – 3 years) or the pond becomes full of sediment. The ponds in some circumstances can act as a nutrient source, rather than a sink for phosphates. If the beaver dam collapses, at least some of the sediment and pollutants stored in the upstream pond are re-released into the river. If this occurs in a single event, it may be more damaging than the gradual release that might occur without the beaver dam. If the beaver pond dries out, the sediment will eventually become covered in vegetation, in which case the sediment and pollutants are removed in the longer term. The condition of beaver dams and associated sedimentation would need to be monitored to determine whether further management is required to maintain their efficacy as a sediment trap in perpetuity and prevent the remobilisation of sediment stored upstream. Any sediment removal could adversely affect habitat quality and disturb beaver habitats.

96. Beaver introduction schemes are still in trial phases and any scheme for phosphate reduction would need to be licensed and likely introduced in an enclosed area of 2ha to 3ha. The lack of substantial removal rates means that any scheme would need to undertake significant monitoring over a period of years to determine the actual phosphate reductions. Furthermore, there may be some concerns regarding the suitability of this solution in perpetuity given that it may at some point rely on the un-controlled introduction of beavers where there is no control over which areas the dams are built in.

4.1.6.1 Capital and maintenance costs

97. There may be the potential to work in partnership with local wildlife trusts and universities to reduce the financial burden of monitoring phosphate loads and care of the animals.

98. **Table 4.17** presents the key considerations for the use of beavers for phosphate offsetting.

***Table 4.17:** Beaver reintroduction key considerations*

Key considerations	
Delivery Timescale	Medium / long-term
Duration timescales	Medium-term
P removal potential	Median TP reduction rates of 50%, range 13-84% (Stubblefield et al., 2006).
Regions applicable	Typically headwater areas where sediment runoff is highest.
Management / Maintenance requirements	Significant monitoring period for first 2-3 years Periodic (every 2-3 years) removal of sediment Local riparian management to protect trees (e.g., orchards, amenity space)
Additional benefits	Water quality Reduced erosion Habitat creation Flood risk Biodiversity
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	No – There is doubt over initial removal rates and if these rates can continue to be achieved.
Precautionary?	Yes
Securable in perpetuity?	No – Management agreements may need to be in place regarding sediment removal. It is difficult to give assurances on continued phosphate removal when working with wild animals, and as such, it is unlikely this solution would be deliverable in perpetuity.
Cost estimation	Capital costs: £1,000s Maintenance costs: £2000 per year

4.1.6.2 Variations between districts

99. Beaver reintroduction is confined to upland areas which limits this solution to the perimeter of the catchment. This solution would be best suited to the areas of the Blackdown Hills and Mendip Hills that are located within the catchment, as well as regions to the east of the South

Somerset District. The majority of the Sedgemoor district is unlikely to be suitable for beaver reintroduction.

4.1.7 Constructed wetland creation

100. Wetland creation is the best-established method for natural pollution reduction including phosphate reduction (**Table 4.18**). There are numerous published nutrient removal rates for constructed wetlands. Luederitz *et al.* (2001) reviewed a variety of wetland types in different countries and found typical removal rates for total P are 40% to 60%, depending on wetland type and inflow loading. Similarly, Land *et al.* (2016) reviewed studies on a large number of wetlands and found that medium removal rates of 12 kg/ha/yr were achieved. It was found that median removal efficiency was 46%, with a 95% confidence interval of 37% - 55%.

101. Constructed wetlands represent a medium to long term solution due to timescales associated with planning and consent, and the time it takes for the wetland to establish and become effective at phosphate removal. Wetland can be constructed in catchment where flow is taken water from rivers for filtration prior to returning to the river. Alternatively, wetlands can be designed to take effluent from sewage treatment works prior to discharge to watercourses (see section 4.2.2). It is a solution that is applicable to all regions within Somerset. The phosphate reduction potential is greater than other solutions but can vary as it is dependent on factors such as wetland size, flow velocity, retention times, vegetation type, input concentrations, depth, aspect ratio and sediment removal potential (Land *et al.*, 2016). Therefore, a bespoke value should be predicted for each site and confirmed via monitoring which is likely to be required for 1-2 years. Phosphate removal is achieved through fall out of particulate P bound to sediment and plant uptake of bioavailable P. Constructed wetlands have a significant mitigation potential.

102. Wetlands require periodic maintenance to remove sediment build up (approximately every 5 – 10 years) and replace vegetation to ensure the wetlands do not switch from a nutrient sink to a source. It is important to remove plants before they die and decompose to prevent phosphates from being re-released. Wetlands are subject to cycles of uptake and release and monitoring may be required to understand how the maintenance regime can achieve optimal phosphate removal (Land *et al.*, 2016). Monitoring is likely to be required for a period of 2/3 years at fortnightly intervals in order to provide enough data to account for seasonal variations. Management agreements will need to be put in place to ensure the wetland will operate at the intended rate. Natural England have advised that periodic monitoring may also be required throughout the lifetime of the wetland. However, they will assess the removal percentage rather than the removal rate (kg/ha/yr) which is likely to decrease in the future due to other catchment-based solutions.

103. The location of wetlands within a catchment is important to secure a source of phosphates in perpetuity. Natural England have advised that where a wetland is dependent on the input from a small number of farms / land uses for phosphates then this may not be achievable in perpetuity. This is due to uncertainties in the continued management / use of the sources over long periods of time. Instead, wetlands should be located further downstream within catchments if possible, where they are more likely to have a secured source of phosphates to remove. However, this does not necessarily preclude their use for developments in other parts

of the catchment (e.g. as a solution for a small development). Analysis of inputs vs outputs is likely to be needed in perpetuity as sources are reduced to non-polluting baselines.

104. In order to gain consent, wetlands are likely to require various permit / applications which are likely to include the following:

- Flood defence consents (varies depending of main river . ordinary watercourse)
- Flood risk activity permit
- IDB land drainage consents (within IDB district)
- Impoundment license should more than 20 cubic meters be impounded per day
- Town and Country planning

105. The solution also has the potential to provide added benefits such as increased flood resilience, amenity space, habitat creation and improved water quality. There is the potential to develop wetland alongside strategic flood alleviation schemes. Wetlands are a water dependant environment and have the capacity to operate at higher water levels for short durations of time, providing the reeds are not drowned and the silt trapping mechanism are not compromised. Wetland creation is likely to be achievable in perpetuity providing management agreements and funds are in place.

106. **Figure 11** shows a typical example of a horizontal flow constructed wetland.

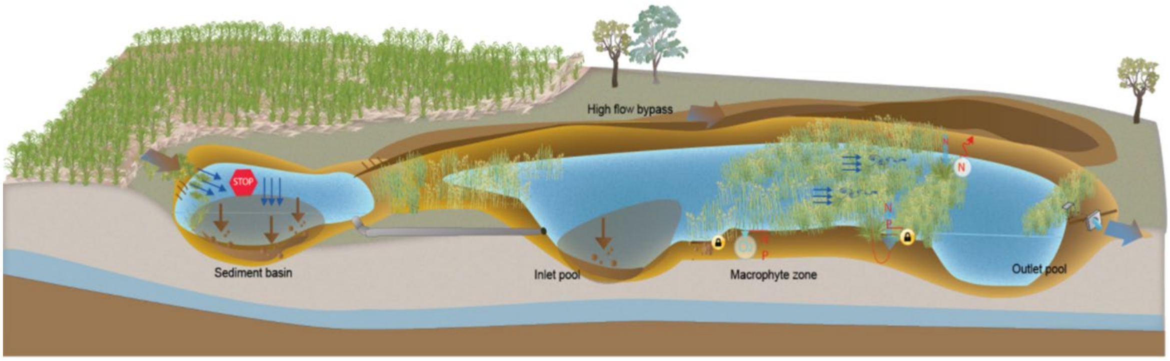

Figure 11: *Horizontal Flow Constructed Wetland (Source: Queensland Government)*

107. Where housing developments are phased (typically 200+ dwellings), then wetlands can be constructed alongside the phasing. An initial design that estimates the size of the wetland needed to offset the intended houses can begin construction and monitoring alongside the development. The design of the wetland can be altered, and the size increased and decreased as a greater understanding of the potential phosphate removal potential is established through monitoring. Starting the monitoring process as early as possible will reduce the time needed for bridging solutions.

108. One of the key risks with wetland creation is that the modelled removal potential overestimates the measured removal and the scheme cannot deliver as much mitigation as

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initially proposed. Precautionary estimates should be used during the modelling stage to mitigate against this problem and be in a position where real world measured removal rates are out performing the modelled rates. Other risks include improper maintenance of the wetlands. This can be mitigated by ensuring management and maintenance is undertaken by professionals with appropriate experience to undertake this task.

4.1.7.1 Cost estimations

109. The following cost estimates have been developed in relation to wetlands, noting that costs are highly dependent on location, extent, physical environment, and many other factors. The example below sets out the expected costs for a 8ha wetland:

- Land rent (assumes 8 ha): £1,848 per year, £147,840 over 80 years;
- Consenting cost: £50,000 - £70,000;
- Construction costs: £50,000 - £75,000;
- Maintenance costs: £2,000 every 5 years for desilting, £32,000 over 80 years. £1,000 - £2,000 upkeep and plant replacement every year - £160,000 over 80 years; and
- Monitoring costs (years 1-5): £6,000 per year, intermittent monitoring for remaining duration - £40,000 (economies of scale will apply if more than one site is monitored by the same company).
- Total estimate: £524,840

110. The cost for wetlands smaller or larger in size than the above estimates will vary, with the greatest changes mainly coming from land rent, construction and maintenance costs. Consenting and monitoring costs are unlikely to reduce/increase at the same rate due to inherent costs associated with these stages.

111. There is the potential for land prices to increase as a result of demand for offsetting schemes. Within the River Stour catchment, land that is suitable for offsetting sites or adjoining streams and rivers, can be worth more than the agricultural value if sold for nutrient off-setting.

112. The cost of offsetting will vary depending on the permit limit of the WwTWs the development drains to. WwTWs with a lower permit limit (typically large populations served) can accommodate far more dwellings for the same phosphate loading than WwTWs without a permit limit. There is a danger that if costings are calculated depending on the receiving WwTWs then some areas could be priced out for development.

113. Assuming a conservative removal rate of 8kg/ha/yr, a 8ha wetland would deliver 64kg/yr of mitigation. Taking the costs outlined above, this would represent £8,200 per kg/yr of mitigation.

114. **Table 4.18** presents the key considerations for wetland creation as a means for phosphate offsetting.

***Table 4.18:** Wetland creation key considerations*

Key considerations	
Delivery Timescale	Long-term
Duration timescales	Long-term
P removal potential	Average removal efficiency of 46% (Land *et al*., 2016).
Farm Typologies applicable	All applicable – However, there remains some doubt over wetlands constructed on intensively farmed land with high legacy phosphate inputs.
Management / Maintenance requirements	• Periodic silt removal • Plant removal prior to dying and decomposing • Maintenance of the surrounding vegetation may be required more frequently until fully established.
Additional benefits	• Reduced Flood risk • Increased amenity value • Habitat creation • Community engagement • Educational / learning opportunities • Water quality
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	Yes – Monitoring will be necessary on a case-by-case basis to establish bespoke removal rates.
Precautionary?	Yes
Securable in perpetuity?	Yes – Management agreements are likely to be necessary, particularly where land is leased.

4.1.8 WwTW additional treatment wetlands

115. Wetlands that receive effluent directly from WwTWs have a significant mitigation potential due to the elevated phosphate concentrations of the effluent. There is the potential to divert the effluent from Wessex Water owned treatment works within the Somerset Levels and Moors Catchment on to constructed wetlands for secondary treatment, prior to release into the rivers and streams. Key considerations are outlined in **Table 4.19**.

***Table 4.19**: WwTW secondary treatment wetland key considerations*

Key considerations	
Delivery Timescale	Long-term
Duration timescales	Long-term
P removal potential	Average removal efficiency of 46% (Land *et al*., 2016).
Farm Typologies applicable	All applicable – However, there remains some doubt over wetlands constructed on intensively farmed land with high legacy phosphate inputs
Management / Maintenance requirements	• Period silt removal • Plant removal prior to dying and decomposing • Maintenance of the surrounding vegetation may be required more frequently until fully established. • Ability to take water samples from original outfall • Control structures to prevent back up
Additional benefits	• Reduced Flood risk • Increased amenity value

Key considerations	
	• Habitat creation • Community engagement • Educational / learning opportunities • Water quality
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	No – Monitoring will be necessary on a case by case basis to establish bespoke removal rates.
Precautionary?	Yes
Securable in perpetuity?	Yes – Management agreements are likely to be necessary, particularly where land is leased.

116. An assessment of suitable mitigation solution sites surrounding WwTWs within the catchment of the Somerset Levels and Moors Ramsar Site identified 47 fields located adjacent to WwTWs that offered the potential for wetland creation[6]. Twenty-three of these sites were considered unsuitable due to a variety of reasons including topography, water supply, size etc. Of the remaining sites, 16 are in South Somerset, four in Mendip, five in Somerset West and Taunton and one in Dorset. Only one site was identified in Sedgemoor and this was considered unsuitable for wetland creation. Collectively, the remaining sites have the potential to offset approximately 1,283kg/yr TP. **Table 4.20** provides a breakdown of the potential mitigation that could be achieved in each river catchment, based on WwTW phosphate permit limits in AMP7 (2020-25). Note that future improvements to sites with no current permit levels, for example during AMP8 (2026-30), will impact upon the level of phosphate offsetting that can be achieved.

Table 4.20: *Total phosphorus mitigation opportunity and housing equivalent per catchment*

District	Site area (ha)	Mitigation opportunity (kg/ha/yr)	Housing equivalent (5mg/l)	Housing equivalent (2mg/l)	Housing equivalent (1mg/l)
Parrett	138.22	734.58	1,498	4,226	8,459
Axe and Brue	40.57	227.78	471	1,311	2,624
Tone	59.98	320.62	664	1,847	3,696
Total	**238.77**	**1,282.98**	**2,633**	**7,384**	**14,779**

117. WwTW secondary treatment wetlands are subject to monitoring maintenance requirements. It is unlikely that Wessex Water would accept any responsibility for the management or maintenance of the wetland. Additionally, to gain approval from Wessex Water it is likely that control structures to prevent back-up during blockages would be required and the ability to take water samples from the original outfall / wetland influent as required for compliance purposes.

118. Environment Agency guidance indicates that where wetlands are constructed for treating secondary effluent, and where this is not required for compliance with permit, then the wetland shall be treated as a waste treatment activity and this requires an environmental waste permit to discharge to controlled water. This would be in addition to existing water discharge permit

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of treatment works that may also need to be altered. The Environment Agency charging scheme would apply which requires a permit application cost of between £4,000 - £7,750[7]. Annual subsistence charges are also required which may be up to £2,000 - £3,000 per year.

119. As well as Royal HaskoningDHV's work in Somerset, a good UK example of wetland creation for phosphate reduction purposes include the River Ingol in Norfolk, which filters water directly downstream of a Wastewater Treatments Works. More information on this project can be found by following the link below:

4.1.8.1 Further Reading

- River Ingol Project brochure.indd (norfolkriverstrust.org).
- *Can an Integrated Constructed Wetland in Norfolk Reduce Nutrient Concentrations and Promote In Situ Bird Species Richness? (springer.com)

[7] *The Environment Agency (Environmental Permitting) (England) Charging Scheme*

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4.2 Non-catchment based solutions

4.2.1 Water company improvements and permit limits

120. Wastewater treatment works represent the greatest contributor of phosphorus sources in the Somerset Levels and Moors catchment. This is partly reflected by the abundance of small rural treatment works that do not have phosphate stripping in place. As a result, water company improvements and lower permit limits represent a clear opportunity for achieving mitigation. Any mitigation measures would need to be above and beyond what is agreed in the current AMP period. Phosphate mitigation could be achieved by the following mechanism:

- Increase the number of treatment works with P stripping infrastructure;
- Increase the phosphate stripping potential for treatment works with existing infrastructure;
- Bring forward scheduled improvements to provide short term mitigation;
- Reduce leakage from foul sewerage systems;
- Increasing connectivity to mains sewerage; and
- Alterations to effluent discharge locations.

121. Wessex Water have already agreed to the scale of phosphate stripping to be installed during the current AMP cycle and any further reductions would either need to be negotiated for the next cycle (AMP8) starting in 2025 or funded through contributions. However, the water industry is heavily regulated and water companies are subject to strict spending caps. As a result, there is no mechanism currently in place to allow for water companies to accept developer contributions towards improvements to treatment works. Further consultation with central government and Ofwat is required in order to establish a pathway for achieving phosphate mitigation.

122. The actions that are being delivered during AMP7 were agreed during the 2019 Price Review (PR19); the implications of the Dutch N Case were not fully understood when actions and associated funding were being agreed. However, improvements to treatment works beyond the current AMP period are likely to form a key solution in achieving long term strategic solutions. Informal consultation with Wessex Water, the Environment Agency, Ofwat and Natural England is already being undertaken in advance of the next Price Review (PR24), when the improvements to treatment works that can be delivered as part of the next AMP8 period (2025-30) will be negotiated.

123. The number of current and planned wastewater treatment works with phosphate stripping and permit limits in place varies across the catchment. The Tone catchment will undergo substantial improvement under the current AMP cycle to introduce / reduce permit limits across the majority of the treatment works. On the other hand, the Parrett and Brue catchment contains many treatment works that do not contain permit limits and planned upgrades are focussed to the more densely populated areas. Under the assumption that a future pathway exists for improvements to treatment works, key sites for improvements are outlined in **Table 4.21**.

124. Whilst treatment works such as Taunton, Wells and Wellington operate at a current or future permit limit of 1mg/l, further improvements could lead to significant phosphate reductions. Treatment works such as Yeovil and Shepton Mallet are due to be upgraded to permit limits of 0.65mg/l and 0.35mg/l under the current AMP7 cycle, respectively. Reducing the permit limit at Taunton from 1mg/l to 0.75mg/l, would achieve a phosphate reduction of approximately 830kg/yr. Similarly, introducing permit limits of 2mg/l to Butleigh, East Coker and Stoke St Gregory would result in phosphate reductions of approximately 350kg/yr, 465kg/yr, and 240kg/yr, respectively. The Environment Agency considers that small rural treatment works where water companies' Fair Share is low will provide the greatest opportunity to sustainably implement additional phosphate stripping.

***Table 4.21:** Key wastewater treatment works for potential upgrades*

Wastewater treatment works	Catchment	Population served	Current permit limit (mg/l)	Future permit limit (mg/l)
Bradford-on-Tone	Tone	1,343	None	None
Butleigh	Brue and Axe	2,746	None	None
East Coker	Parrett	3,640	None	None
Stoke St Gregory	Tone	1,854	None	None
Taunton	Tone	92,902	1	1
Thornford	Parrett	4,434	2	1.5
Tintinhull Ash	Parrett	1,442	None	None
Wellington	Tone	17,583	2	1
Wells	Brue and Axe	17,004	2	1

125. Bringing forward scheduled improvements to treatment works, which in most cases are scheduled to be online by 2025, will lead to increased phosphate reductions above and beyond what was originally planned. Due to the number of upgrades required, Wessex Water would need to complete upgrades in advance of the deadline, but would not operate at the reduced permit limit until required in order to save operational costs. Contributions to cover the operational costs could achieving significant phosphate reduction in the short term, up until the scheduled completion deadline.

126. Leakage from foul sewage into the subsurface has the potential to contribute to phosphorus loads to the environment. Leakages can occur through burst or damaged pipes, failures at pumping stations or due to insufficient capacity of the network. Reducing leakage rates will lead to phosphate reductions. However, further investigation would be needed to identify where the leaks are located and to quantify the phosphate reduction to rivers. It is also not possible to provide costs for implementation due to the highly variable nature of the work. The polluter pays principle may apply to some pollution incidents which would prevent this counting towards phosphate mitigation.

127. Increasing connectivity to the sewer network for communities who predominantly use package treatment plant / septic tanks could achieve phosphate mitigation. Existing septic tanks without phosphate stripping typically operate at a higher effluent concentration than

treatment works, especially treatment works with phosphate stripping in place. Requirements for existing dwellings to connect to mains sewerage would need to be ordered by the Environment Agency. Installing new pipeline would have a significant cost associated and would only be a viable solution where new pipeline did not exceed approximately 500m and a significant number of dwellings would be impacted. Further investigation would be required in order to identify potential areas where this solution could achieve significant phosphate reductions.

128. Alteration to the effluent discharge locations of treatment works within the catchment also has the potential to achieve significant phosphate reductions. The River Brue is perched above the surrounding floodplain and does not introduce new phosphate loads to the catchment. As such, the upstream catchment of the Brue does not impact on the Ramsar Site and any effluent discharged to this catchment would lead to a reduction in phosphate loads. **Table 4.17** outlines the treatment works in close proximity to the defined catchment where effluent discharge locations could be altered, assuming that the treatment works are operating at full capacity and within 90% of their permit limit. Water usage was assumed to be the regional average for existing dwellings of 145l/person/day.

Table 4.22: *Alternative effluent discharge locations*

Treatment works	Description	Distance from defined catchment (km)	Phosphate reduction (kg/yr)
Glastonbury	Change effluent discharge from the Glastonbury Millstream to the River Brue to the west of the treatment works.	0.44	1044.45
Evercreech	Change effluent discharge from an unnamed tributary of the River Alham to the Whitelake to the west of the A371. This route would require crossing roads and a watercourse.	1.32	143.28
Shepton Mallet	Change effluent discharge from the River Sheppey to a tributary of the Redlake. This would require crossing the River Sheppey and the A371.	1.15	691.13
Croscombe	Change effluent discharge from the River Sheppey to a tributary of the Redlake. This would require crossing the River Sheppey and the A371.	0.98	161.42

129. In all cases, consideration would need to be given to downstream summer flows in the streams where effluent discharge would be taken from to ensure there is no starvation. In some cases, flow may need to be diverted from elsewhere to account for the loss from effluent discharge. Changes to the effluent discharge location would likely require approval from the Environment Agency and Defra and would have a lead time of 2-3 years. Significant costs would be associated with the improvements, particularly where a significant distance of new pipeline is required. A large majority of these costs would need to be covered by Wessex Water through the next AMP cycle, with a smaller contribution from development within the Somerset Levels and Moors catchment. Alteration to remove effluent from the Somerset

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Levels and Moors catchment would also mean that future development served by that treatment works would not need to consider additional phosphate loading from wastewater.

4.2.2 Willow buffer areas

130. Short-rotation willow coppice can be used to treat wastewater whilst producing woody biomass for energy purposes. The solutions can be used to treat domestic (i.e. Package treatment plants and septic tanks) and industrial wastewater (Wastewater treatment works effluent). The solutions consists of vegetation filter strips of short-rotation willow coppice irrigated with wastewater. The willow is harvested on a two to five year cycle, although most commonly every three years. The irrigation system will not completely eliminate wastewater pollution as some wastewater will run off or percolate into groundwater. As a result, timing and irrigation rates must be considered. Evapotranspirative willow systems have zero discharge and are an alternative to irrigated systems and are typically used to treat domestic wastewater from small settlements or individual households. When designed properly, all influent wastewater and precipitation are evapotranspired on an annual basis. They provide efficient wastewater treatment and do not require skilled personnel for operation and maintenance.

131. Short-rotation willow coppice filter strips achieve phosphate removal rates of 67-74% (Larsson *et al.,* 2003; Perttu, 1994), although initial reduction rates are often closer to 95%. Lachapelle-T *et al.* (2019) suggested a significant increase in available phosphate in the soil, suggesting the soil can become saturated over time. In the case of evapotranspirative willow systems, wastewater is constantly applied and stored as an elevated water level. Phosphate accumulation is expected and results in a phosphate rich substrate which can be reused as fertiliser. Initial studies suggest that phosphate stored in woody biomass is between 31 – 45% of the influent, whereas phosphate stored in soil, roots and leaves is between 55 – 69% (Istenic & Bozic, 2021). They recommend phosphate application to prevent saturation of soils is 24 k/ha/yr (Caslin *et al.*, 2015), which is typically lower than what is applied directly from domestic wastewater. This solution could be used as a form of secondary treatment after domestic package treatment plants.

132. Harvesting of willow would be required every 3-5 years and replanting every 20-15 years. This solution typically sees a 30% increase in biomass yield (Buonocore et al., 2012).

4.2.2.1 Capital and maintenance costs

133. The cost for establishment is typically £2,500[8] per hectare. Operational costs including ploughing and cultivation and are likely to be £200 - £300 per ha per year. Potential returns vary hugely depending on many variables including price received for crop and drying requirements. Rising energy costs of oil and gas may provide greater future opportunities for willow chips as a fuel source.

134. **Table 4.23** presents the key considerations for the use of willow buffers for phosphate reduction and/or offsetting.

[8] Short Rotation Coppice (SRC) | Crops for Energy (crops4energy.co.uk)

Table 4.23: *Willow buffer key considerations*

Key considerations	
Delivery Timescale	Medium-term
Duration timescales	Long-term
P removal potential	70% long-term
Management / Maintenance requirements	Harvesting every 2-3 years.
Additional benefits	Water quality Biodiversity
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	No – there is the potential for phosphate saturation within soils
Precautionary?	Yes
Securable in perpetuity?	Yes
Cost estimation	Capital costs: £2,500 per hectare, operational costs £200 - £300 per ha per year.

4.2.3 Sustainable drainage systems (SuDS)

135. **Table 4.27** outlines key considerations associated with SuDS. SuDS are efficient sediment traps and reduce the amount of runoff entering watercourses. Examples include basins and ponds, filter strips and swales, constructed wetlands, soakaways, infiltration basins, gravelled areas and porous paving. SuDS systems require design specific to a development site and the phosphate reduction efficacy can vary between options. SuDS should be limited to drainage from roofs and impermeable surfaces, with foul drainage connecting to mains sewerage where reasonably practicable.

136. Many of the components of a SuDS design do not have a strong evidence base to determine removal efficiencies. Lucke *et al* (2014) reported total phosphorus removal of 20 - 23% under runoff simulation. Lucke et al., (2014) reviewed a range of other published data and found slightly higher mean TP reduction of 48%. Moderate phosphorus reductions associated with swales suggest they would be best used alongside a suite of other measures to achieve a greater cumulative impact and achieve neutrality (e.g. as a part of SuDS schemes used in new housing developments).

137. A recent systematic review of the effectiveness of wetlands for P removal (Land *et al.*, 2016) used data from 203 wetlands (typically natural marshes with areas of open water, floating vegetation and emergent plants). The median removal rate for wetlands that were included in this review was 12 kg/ha/yr TP. Median removal efficiency for TP in the same review was 46% with a 95% confidence interval of 37 – 55 %. SuDS are well-established and familiar to many developers and are likely to be an attractive method for achieving part of the required mitigation on-site.

4.2.3.1 SuDS typologies

138. SuDS systems that promote infiltration of water and settlement of sediment will have the greatest benefit for phosphorus removal. Similarly, SuDS that provide an environment for vegetation to uptake phosphorus will achieve good phosphorus removal rates. SuDS used in combination and that are linked in a treatment train, often culminating in a SuDS wetland, represent the most favourable scenario.

139. SuDS wetlands should typically comprise of an initial sediment fallout pond, a variety of deeper zones and shallow macrophyte zones. The wetlands should also be able to accommodate additional volume for excess rain. Regular wetland maintenance is also essential to ensure that removal rates are maintained and to ensure that an accumulation of phosphorus enriched sediment does not become a source rather than a sink. Post-scheme monitoring is recommended to classify dredged silts which may be categorised as hazardous waste. Indicative cost estimates are presented in **Section 4.2.2.2**.

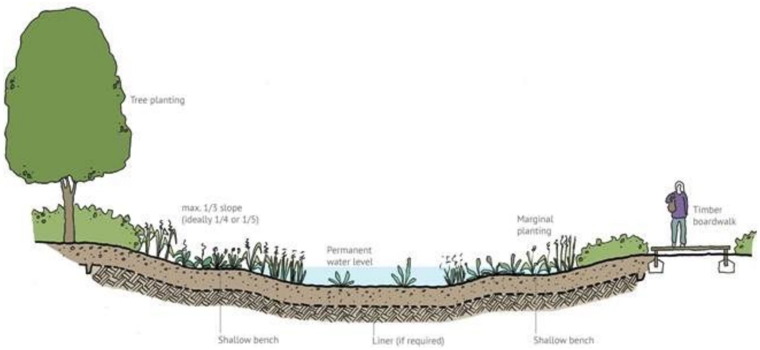

Figure 12: *Example of a SuDS wetland (Source: Susdrain)*

140. Swales are shallow, relatively wide and vegetated depressions that are designed to store and convey runoff and remove pollutants. They can also be used as conveyance structures to transfer runoff into the next stage of the SuDS treatment process. They are fairly easy to incorporate, with low capital costs and simple maintenance. They are best suited to low gradients on both sides and can be enhanced by placing check dams across the swale to reduce flow rate.

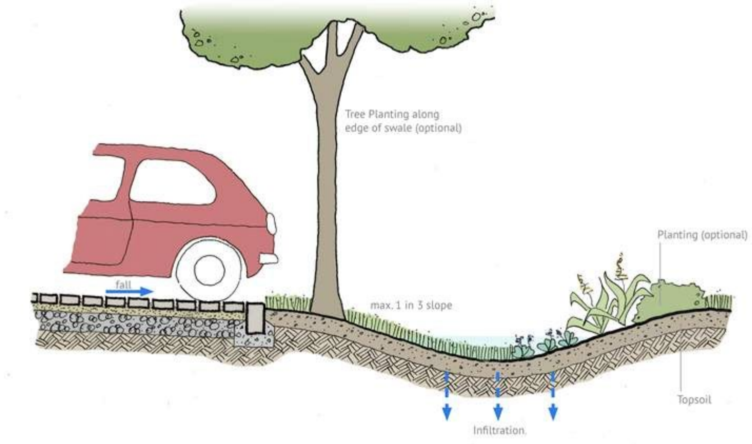

Figure 13: *Example of swales and conveyance channels (Source: Susdrain)*

141. Filter strips are gently sloping, vegetated strips of land that slow conveyance and promote infiltration. They typically lie between hard-surfaces and a receiving stream / surface water collection. Runoff is primarily by overland sheet flow. They are easy to construct and have low capital costs. They are unsuitable where the slope gradients is too steep.

Figure 14: *Example of filter strips (Source: Susdrain)*

142. Bioretention areas are landscaped depressions which use enhanced vegetation and filtration to remove pollution and reduce runoff. They are aimed at managing and treating runoff from frequent rainfall events. They are very effective at removing pollutants and flexible to install into the landscape.

Figure 15: *Example of a rain garden (Source: Welshwildlife.org)*

143. Source control is also a key method in reducing runoff. Permeable paving can attenuate flow and increase infiltration. Green roofs also provide interception storage and treat some of the more frequent but smaller, polluting rainfall events.

144. The latest advice provided by Natural England suggests that they may be able to give more details on how SuDS should be incorporated into the calculator and the mitigation potential this may have. Further details to this solution will be given following the guidance from Natural England.

145. SuDS can be best incorporated into new developments where they can be designed to achieve the greatest impact. The use of SuDS should be encouraged as this will treat excess phosphorus on site. Furthermore, Local Plan policies for the Somerset Districts indicate that surface water should be disposed of by SuDS unless it is demonstrated that is not feasible (e.g. Policy I4, Taunton Deane Adopted Site Allocations and Development Management Plan, 2016; Policy D1, Sedgemoor Local Plan, 2019). The SuDS manual (CIRIA, 2015) sets out further design approaches.

146. Urban retrofitting can be used to install SuDS. To accommodate surface water run-off from existing developments and built up areas Strategic driven retrofitting can achieve significant phosphorus reductions and can be combined with the need for urban regeneration and flood reduction.

147. SuDS can provide multiple benefits other than phosphorus removal. They mimic natural drainage process and reduce the quantity of runoff from developments as well as providing amenity and biodiversity benefits. Where appropriately designed and used, a SuDS treatment train will reduce runoff and storm flow, which can lead to a reduction in combined sewage overflows.

148. The long-term performance of SuDS would also need to be secured through maintenance agreements (e.g. via Section 106 rather than planning conditions given the required duration of these commitments). Key maintenance tasks are outlined in **Table 4.19**. Sedimentation will eventually compromise some aspects of the wetland's function and rejuvenation measures will be necessary (Kadlec and Wallace, 2008). Kadlec and Wallace (2008) indicate a sediment accretion rate in the order of 1cm/yr or 2cm/yr and give examples of rejuvenation after 15 and 18 years, but other wetlands have not needed any significant restoration in similar timespans.

Table 4.24: *SuDS maintenance tasks*[9]

Activity	Indicative frequency	Typical tasks
Routine/regular maintenance	Monthly (for normal care of SuDS)	• litter picking; • grass cutting; and • inspection of inlets, outlets and control structures.
Occasional maintenance	Annually (dependent on the design)	• silt control around components; • vegetation management around components; • suction sweeping of permeable paving; and • silt removal from catchpits, soakways and cellular storage.
Remedial maintenance	As required (tasks to repair problems due to damage or vandalism)	• inlet/outlet repair; • erosion repairs; • reinstatement of edgings; • reinstatement following pollution; and • removal of silt build up.

4.2.3.2 SuDS costs

Table 4.25 and **Table 4.26** present the costs for various SuDS types.

Table 4.25: *SuDS costs for buffers, bunds and wetlands (edited from Vinten et al (2017))*

Measure	Recurrent costs	Capital costs
8m buffer	£495 ha for 6m buffer	Nil
20m buffer	£495 ha for 18m buffer	Nil
Detention bund	Nil	£7m bund £10.50m^2 excavation £5.50m^2 perimeter fence

Table 4.26: *Indicative capital costs for SuDS options (edited from Environment Agency (2015))*

SuDS Option	Cost estimation	Source
Green roofs	£80/m^2 - £90/m^2	Bamfield, 2005
Rainwater harvesting (water butts)	£100 - £243 per property	Stovin & Swan, 2007
Advanced rainwater harvesting	£2,100 - £3,700 per residential property £45/m^2 for residential properties	Environment Agency, 2007 RainCycle, 2005
Greywater re-use	£3,000 per residential property	Environment Agency, 2007

[9] Susdrain (https://www.susdrain.org/delivering-suds/using-suds/adoption-and-maintenance-of-suds/maintenance/index.html)

SuDS Option	Cost estimation	Source
Permeable paving	£30/m^2 - £54/m^2	CIRIA, 2007 Environment Agency, 2007
Filter drains / perforated pipes	£120/m^2 £100/m^3 - £140/m^3	Environment Agency, 2007 CIRIA, 2007
Swales	£10/m^2 – £15/m^2	Environment Agency, 2007 CIRIA, 2007
Infiltration basin	£10/m^3 – £15/m^3 stored volume	CIRIA, 2007
Soakaways	£450 - £550 per soakaway	Stovin & Swan, 2007
Infiltration trench	£60/m^2 £55/m^3 - £65/m^3 stored volume	Environment Agency, 2007 CIRIA, 2007
Filter strip	£2/m^2 - £4/m^2	CIRIA, 2007
Constructed wetland	£25/m^3 - £30/m^3 stored volume	CIRIA, 2007
Retention pond	£16/m^3 pond £25/m^3 - £30/m^3 stored volume	SNIFFER, 2006 CIRIA,2007
Detention basin	£15/m^3 - £55/m^3 stored volume	CIRIA, 2007 Stovin & Swan, 2007
Onsite attenuation and storage	£449/m^3 - £518/m^3 for reinforced concrete storage tank	Stovin & Swan, 2007

149. **Table 4.27** presents the key considerations for the use of SuDS for phosphate offsetting or reduction.

***Table 4.27:** SuDS key considerations*

Key considerations	
Delivery Timescale	Short-term
Duration timescales	Medium / Long-term
P removal potential	Highly variable and will likely need site specific calculations.
Management / Maintenance requirements	The long-term performance of SuDS would also need to be secured through maintenance agreements. Maintenance works would include desilting of swales, wetlands and basins to maintain their efficiency. Vegetation management of buffers would be necessary to maintain the optimum roughness/composition and sediment trapping efficiency.
Additional benefits	• Water quality • Reduced erosion • Habitat creation • Improved amenity value
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	No – monitoring may be required to determine the efficacy of specific schemes
Precautionary?	Yes
Securable in perpetuity?	Yes – maintenance agreements may be required
Cost estimation	See **Table 4.15** and **Table 4.16**.

4.2.4 Third party credit scheme

150. **Table 4.28** shows key considerations associated with third party credit schemes. Third party credit schemes are likely to offer significant phosphate reduction potential by utilising many of the solutions identified, although are likely to focus on wetland creation. Wessex Water EnTrade[10] is the first third party credit scheme to become established in the Somerset Levels and Moors catchment, and is currently developing the Somerset Levels Catchment Market prior to trading. However, other third parties are likely to become established. This solution is likely to be suitable for both large and smaller scale developments.

151. The Nutrient pilot trading scheme in the Solent[11] is likely to have implications on this solution, by identifying the most appropriate processes and best practice for a nutrient trading platform. If the pilot is successful, then it is likely to be applied elsewhere in the country.

152. Third party schemes will need to be underwritten to ensure someone takes responsibility for addressing any future shortfall in credits delivered by projects that supply to the market. Third party schemes could also give an opportunity for developers to sell excess credits from private mitigation schemes.

153. There is the potential that credits could be locked up in projects that are either unlikely to progress or are not in a position to progress upon receiving the credits or will be purchased by very limited number of developers/businesses. Limiting forward buying will help to reduce price volatility from short-term high demand and allow credits to go to projects that need them imminently. Therefore, it could be proposed that a mechanism is incorporated into the platform to ensure that the credits obtained are used to immediately unlock development rather than being banked for the future. This could potentially include a time limit for their use, after which the credits have to be returned so that they are available for use by other developers.

154. In the case that a development will be completed in stages, then credits could be secured over multiple credit rounds, as opposed to one trading round. However, it is likely to be necessary to ensure that any trading platform includes a mechanism to provide developers with the assurances they need to manage risks and secure the credits they require for the whole multi-phase development at a reasonable price. Further measures which could be implemented include establishing viability checks of developments, by an independent party outside of the third party and the buyer, to ensure credits are not unnecessarily locked up.

155. The current high demand for the first credits when they become available is likely to lead to price volatility and under the current scenario there will be no control over who can enter the first round of credits and no guarantee that developments most in need of credits receive them. Consideration by the market operator should therefore be given to who is eligible to purchase the initial credits.

156. Prices in a market round will reflect the number and quality of the nature-based projects available (supply), and the number and 'willingness to pay' of buyers for the credits available (demand). Volatile prices may mean this is not a viable option for smaller developments,

[10] *Wessex Water EnTrade*
[11] *Solent Nutrient Market Pilot*

although prices are likely to stabilise as more supply becomes available. Furthermore, it is expected that smaller developments that do not have other contributions such as affordable housing, health and education, will be more likely to be able to afford the credits. There is also the potential for supply to vary year on year which will have implication for the viability of developments and projecting future development. There is also an assumption that costs management and maintenance costs would be provided upfront to secure the project in perpetuity and that these costs would not get passed down to future homeowners. The potential implications of this for the financial liability of a development, and the potential for adverse effects on levels of affordable housing and contributions to health, education and highways will also need to be considered, however.

157. **Table 4.28** presents the key considerations for the use of third party credit schemes.

***Table 4.28**: Third party credit scheme key considerations*

Key considerations	
Delivery Timescale	Medium / long-term
Duration timescales	Long-term
P removal potential	Varies depending on trading rounds Other third parties are not yet fully established in regions where EnTrade are not operating.
Management / Maintenance requirements	Management and maintenance dependant on mitigation option and as set out elsewhere.
Additional benefits	• Habitat creation • Carbon offsetting • Amenity • Reduced flood risk • Water quality Sustainability
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	No – Monitoring of the likely solutions will be required. Furthermore, a pilot study into phosphate credit / nutrient trading is likely to be needed prior to full establishment.
Precautionary?	Yes
Securable in perpetuity?	Yes
Cost estimate	£Thousands per dwelling

4.2.5 Portable treatment works

158. Portable treatment works that can be used as a secondary treatment specifically for phosphate removal (**Table 4.29**). Typically used by water companies during upgrades (One container can typically serve up to 20,000 population equivalent (PE), normally thousands. The containers are modular so can be used in parallel to handle any flow. They are typically built inside standard shipping containers making them easy to install and move to another site (**Figure 16**). They could be used as short-term solutions whilst other mitigations options and designed and developed. Other examples include portable vertical flow wetlands. The plants typically have a small footprint of <0.2ha. Environment Agency consultation indicated that these should be used downstream of permitted treatment works.

Figure 16: Example of a portable containerised wastewater treatment works (Source: Vikaspumps.com)

Table 4.29: Portable treatment works key considerations

Key considerations	
Delivery Timescale	Short / medium term – typically 3 months to deliver and set up
Duration timescales	Short / medium-term
P removal potential	Effluent to 0.5mg/l can be achieved. This can apply to all existing houses downstream of treatment works.
Management / Maintenance requirements	Review of limited monitoring data may be required. Some maintenance on the system is required, equivalent to a few hours a week.
Additional benefits	Water Quality
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	Yes
Precautionary?	Yes
Securable in perpetuity?	No
Cost estimation	Capital costs £10,000 - £50,000 depending on size. Maintenance costs £1,000 - £2,000 a year.

159. Technically, the treatment works can be used for treating river water. However, there may be some difficulties in preventing plants, fish and invasive species from entering the system and pre-treatment would be needed. In this case, the systems could be used on proposed wetland creation sites during the design and construction phase to deliver short-term phosphate mitigation.

4.2.5.1 Capital and maintenance costs

160. Given the bespoke nature of the systems for phosphate removal, it is likely that the systems would need to be purchased. Rental is available for standard systems, but it unlikely to be

available for bespoke systems. Capital costs vary depending on the size of the treatment plant. Costs are expected to range from between £10,000 for treatment at small WwTWs and £50,000 for treatment at the largest WwTWs. Maintenance costs of £1,000 - £2,000 are expected but vary depending on the size / number of plants.

161. Placing portable treatment works downstream of treatment works could reduce effluent to 0.5mg/l. Assuming treatment works are operating at 1mg/l, this could achieve a short-term phosphate reduction of 46.80kg/yr. Assuming the solution is in place for 5 years, the total cost of the treatment works, maintenance and land rental would likely be £127,500. This solution could therefore deliver phosphate mitigation at a cost of £2,725 per kg/yr of mitigation.

4.2.5.2 Variations between districts

162. Portable treatment works will achieve the greatest phosphate reductions where used as a tertiary treatment system at WwTWs that are operating with little / no phosphate stripping in place. There would be little benefit to implanting this method to WwTWs where the permit limit is already very low (e.g. Yeovil, Shepton Mallet). The South Somerset district contains a significant amount of small rural treatment works that would be best suited for this solution.

4.2.6 Alternative wastewater treatment providers

163. New appointments and variations (NAVs) are companies that provide sewerage services to customers in an area which is currently or previously provided by the incumbent monopoly provider. These companies are Ofwat regulated. Companies that are not defined by region and that can operate anywhere in England and Wales could potentially provide alternative wastewater solutions.

164. Alternative wastewater treatment works providers will treat all the waste from new developments by designing, consenting and building an alternative treatment works. They are typically reserved for large developments (minimum 500 dwellings). It is possible for multiple customers to make up the numbers to the minimum required, however, due to the significant cost of pipeline (£1million per km), the sites need to be neighbouring. The sewage effluent would not drain into to the Wessex Water system and as such, would need to be located in close proximity to a watercourse. The customer would still receive potable water from Wessex Water and all maintenance of the treatment works would be paid for via normal sewage bills. The treatment works would need to comply with permits and ensure that visual and odour impacts are limited. Land uptake is often limited. However, the treatment works would need to be located within the boundary of a development.

165. Severn Trent Connect, a statutory undertaker and a wholly owned subsidiary of Severn Trent PLC, is one such company that can provide wastewater treatment. They have provided wastewater services to large developments such as the Wellesley development in Aldershot (up to 3,850 new homes) and Arum Green which is a development for 130 new homes in Basingstoke.

166. Due to the processes for phosphate removal, the solutions is not viable for treating wastewater or effluent from existing treatment works.

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167. Phosphorus effluent concentrations of 0.5mg/l are achievable, which is very close to industry best removal rates. **Table 4.30** outlines the costs and removal rates which could be achieved for various sizes of treatment plant.

Table 4.30: *Typical costs and removal rates achievable through alternative wastewater treatment works providers*

Plant size (PE)	Capex (£ million)	Land uptake (m^2)	Number of dwellings	£ / dwelling	Discharge limit (mg/l)	Wastewater loading (Kg P per year)
1200	1.95	600	500	3900	0.3	14.45
2700	2.4	1000	1125	2178	0.3	32.52
5600	3.3	1750	2333	1414	0.3	67.44
7000	3.8	2100	2917	1303	0.3	84.32

168. This solution would not completely mitigate excess phosphate loading from developments and mitigation would still be required through other solutions. However, it could significantly reduce the mitigation required which could potentially be addressed through on-site measures such as SuDS.

169. Assuming this solution is used on a housing development of approximately 500 dwellings, draining to a treatment works of 1mg/l, this could deliver a phosphate reduction of 10.8kg/yr. With an expected cost of £1,950,000 this solution could be delivered at a cost of £180,000 per kg/yr. Greater phosphate reductions can be achieved where developments would drain normally drain to treatment works without phosphate stripping, however, these treatment works are unlikely to be served my development large enough to utilise this solution.

170. **Table 4.31** presents the key considerations for the use of alternative wastewater providers for phosphate reduction and/or offsetting.

Table 4.31: *Alternative wastewater providers key considerations*

Key considerations	
Delivery Timescale	Long-term – typically 2.5 – 3 years
Duration timescales	Long-term
P removal potential	Effluent to 0.3mg/l can be achieved.
Management / Maintenance requirements	Maintenance paid through water bills
Additional benefits	Can be integrated with SuDS to deliver flood risk benefits and amenity space.
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	Yes
Precautionary?	Yes
Securable in perpetuity?	Yes
Cost estimation	See **Table 4.25**.

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4.2.7 Setting restriction on water usage

171. Introducing water efficient appliances and fitting (e.g., taps, toilets, showers) will reduce the wastewater loading per person per day that requires treatment, which for a WwTW that has a permit limit, will result in a reduction in phosphate concentrations. This solution is not applicable to WwTWs without a permit limit as the impact would be negligible. Similarly, WwTWs should be operating at close to capacity with little headroom, which is usually the case in Somerset.

172. There is the potential to retrofit water efficient appliances to older houses that generally have higher water usages per person and therefore have a greater potential for reducing phosphate loading. Actual phosphate reductions will be dependent on the population served and the permit limit of the WwTWs.

173. Certainty over the efficacy of this method is difficult to achieve due to the limited ability to measure reductions. Smart meters could be used for tracking loading but is unlikely that developments will have these fitted in high enough numbers to obtain sufficient data. This solution is also unlikely to pass the in-perpetuity test for private properties where there is no control over homeowners changing fittings in the future. Therefore, this solution is only applicable to existing dwellings where an organisation has control over fittings and any upgrade works. This is likely to include housing owned by local authorities or Registered Providers, and care homes. It is likely that wastewater reductions from new water efficient appliances could be achieved during planned refurbishment of such properties. The greater water saving is typically achieved through upgrades to bathrooms as opposed to kitchens, with improvements to toilets and showers providing the greatest reductions.

174. Wessex Water reports an average volume of water usage of 145 l/person/day in 2019/2020 for all of the areas that it serves, including Somerset (Wessex Water, 2021). As a result, this figure has been used for our baseline. The WRc water efficiency calculator (WRc, 2021) has been used to approximate the water usage per appliance / fitting for usage of 145 l/person/day. The findings are presented in **Table 4.32**.

Table 4.32: *Baseline (145 l/person/day) maximum water consumption values for appliances/fittings*

Fitting / Appliance	Maximum Consumption
Toilet	8.5/5.5 litres dual flush
Shower	12.5 l/min
Bath	200 litres maximum capacity
Basin Taps	7 l/min
Sink Taps	10.5 l/min
Dishwasher	1.25 l/place setting
Washing Machine	8.17 l/kilogram

4.2.7.1 Future water usage

175. Requirement G2 and Regulations 36 and 37 of the Building Regulations (2015) introduce a minimum water efficiency standard for new comes of no more than 125 l/person/day. The Government also introduced an optional requirement of 110 l/person/day for new residential developments (excluding properties owned by local authorities and Registered Providers), which should be implemented through local policy where there is a clear evidence need. As a result, these two figures were used as targets when retrofitting water efficient appliances and fittings.

176. In order to achieve maximum water usage of 125 l/person/day or 110 l/person/day, the Building Regulations (2015) suggest maximum usage per appliance as presented in **Table 4.33** and **Table 4.34**.

Table 4.33: *125 l/person/day maximum water consumption values for appliances/fitting*

Fitting / Appliance	Maximum Consumption
Toilet	6/4 litres dual flush
Shower	10 l/min
Bath	185 litres maximum capacity
Basin Taps	6 l/min
Sink Taps	8 l/min
Dishwasher	1.25 l/place setting
Washing Machine	8.17 l/kilogram

Table 4.34: *110 l/person/day maximum water consumption values for appliances/fitting*

Fitting / Appliance	Maximum Consumption
Toilet	4/2.6 litres dual flush
Shower	8 l/min
Bath	170 litres maximum capacity
Basin Taps	5 l/min
Sink Taps	6 l/min
Dishwasher	1.25 l/place setting
Washing Machine	8.17 l/kilogram

177. Phosphate reductions for retrofitting water efficient fitting and appliances in order to reduce the water usage from 145 l/person/day to either 125 l/person/day or 110 l/person/day are presented in **Table 4.35**, for varying permit limits.

Table 4.35: *Phosphate reductions per person from restrictions on water usage*

Current permit limit (mg/l)	Phosphate offsetting per person (kg/year)	
	125 l/person/day	110 l/person/day
1	0.0065	0.0115

2	0.0132	0.023

178. The greatest removal rates are achieved where the current permit limit is higher. By the end of the current AMP cycle, permit limits at some treatment works are expected to decrease and the phosphate mitigation achieved would be reduced once these permit limits come online.

179. However, there are likely to be issues associated with enforcing water use regulations and ensuring that they remain in place in perpetuity; compliance is likely to be difficult to monitor, and although planning conditions on developers could provide some security, spot checks may be required to prevent homeowners changing approved fittings in the future.

4.2.7.2 Key risks

180. The main risk of setting water restrictions is the certainty that the assumed water usage of appliances will be in place in perpetuity. This can be mitigated by restricting this solution to use by organisations that have control over fittings. Where properties that were used for mitigation are subsequently no longer under control of organisations, there is the potential that the appliances / fitting could revert to higher water usage than assumed, in which case the mitigation may no longer be achievable. In this case, any shortfall may need to be made up from additional measures that could be reserved as a contingency.

4.2.7.3 Cost estimate

181. **Table 4.36** provides an approximate cost estimate for installing new appliances / fittings that are likely to meet the 110 l/person/day limit.

Table 4.36: *Cost Estimation for installing appliances/fittings to meet the 110 l/person/day limit*

Fitting / Appliance	Approximate cost	Source
Toilet	£200 - £300 for a new dual flush toilet including labour. Retrofitting a traditional toilet with a dual flush mechanism may cost as little as £15.	https://www.thegreenage.co.uk/tech/water-saving-toilet/
Shower	£25 - £50	Water Efficient Showers | How To Save Water (how-to-save-water.co.uk)
Bath	£250	How Much Does a Bathroom Renovation Cost in 2021? | Checkatrade
Basin Taps	£100	How Much Does a Bathroom Renovation Cost in 2021? | Checkatrade
Sink Taps	£100	How Much Does a Bathroom Renovation Cost in 2021? | Checkatrade
Dishwasher	£300	Best dishwashers to buy 2021 - BBC Good Food
Washing Machine	£350	Top 5 Energy Efficient Washing Machines - Appliance City
Total	**£1,450 per property**	

182. Efficiencies could also be drawn from greywater harvesting, which involves the use of recycling systems to collect used water from sinks, dishwashers, showers and baths, and then

clean it up and plumb it straight back into your toilet, washing machine and outside tap. Greywater typically makes up between 50% - 80% of a household's wastewater – recycled greywater can save approximately 70 litres of potable water per person per day in domestic households [12]. Along retrofitting water efficient appliances, greywater harvesting could significantly reduce household consumption and loadings transferred for treatment. A new greywater system may cost £2,000 - £3,000 per dwelling, although it is hard to calculate the payback because it is dependent on current water usage, and what kind of system is installed.

183. **Table 4.37** presents the key considerations for setting restrictions on water usage as a means for phosphate reduction and/or offsetting.

Table 4.37: *Setting restriction on water usage key considerations*

Key considerations	
Delivery Timescale	Medium-term
Duration timescales	Long-term
P removal potential	Wastewater reductions of 10-30% achievable. Phosphate reductions dependant on population served and permit limit of WwTWs.
Management / Maintenance requirements	Replacement parts of the same or better efficiency must be used.
Additional benefits	• Sustainability • Water resources
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	Yes – The government published calculator would be used for calculating water usage for appliances.
Precautionary?	Yes
Securable in perpetuity?	No – It is unlikely this solution could be achieved in perpetuity unless the local authority or Registered Provider have ownership and control of dwellings that are due to be retrofitted with more water efficient fittings.

4.2.8 Anaerobic digestors

184. **Table 4.38** shows key considerations associated with anaerobic digestors. Anaerobic digestors that take slurry to extract methane which goes to the local Grid can also produce a digestate that can be separated into dry fraction and sold as fertiliser. The phosphate reduction can be achieved by removing slurry from farms that would have contributed to loading to rivers and streams. Whilst the process of anaerobic digestion is now well established, there is little within the literature with regards to phosphate reduction. As such, monitoring would be required to determine the efficacy of this solution.

185. Using the dry fraction as a fertiliser and replacing the current technique will contribute to the phosphate reductions providing the same or less phosphate is put on the land as fertiliser. This will also help to achieve a circular economy within the region. This solution can be applied to all farming types, however, it is best suited to farms with a significant number of housed livestock (e.g. indoor pigs, dairy, cattle) where animal waste can be easily collected and stored.

[12] *The Green Age (www.thegreenage.co.uk/tech/greywater-recycling)*

186. Energy crops such as poplar and willow can be used as fuel for anaerobic digestors and can be grown on former arable land or on riparian buffer strips. The lifetime of these plantations is typically 30 years. Therefore, this solution may need to be used in-combination with other techniques and have management agreements to replace the crops at the end of their lifetime. Controls of the movement of animal waste may be required.

187. In terms of costs, an International Energy Agency survey puts the cost for small farmers in the range of £3,000 – £6,915 per kWe (kilowatt of electric capacity). A ‘rule of thumb’ is that slurry from 200 dairy cows requires 200m^3 of digester space and produces about 20kWe continuous power. This must be added to the costs of feasibility studies, planning permission and any assessment and licences (typically 10% to 15%). This gives a minimum of £66,000[13].

188. Whilst certain anaerobic digestors can be used for phosphorus mitigation, a case by case review of planned anaerobic digestors may be required to ensure proposed practises do not results in an increase of phosphorus loading.

Table 4.38: *Anaerobic Digestors key considerations*

Key considerations	
Delivery Timescale	Medium-term
Duration timescales	Medium-term
P removal potential	Large uncertainty
Farm Typologies applicable	All applicable – best suited to farms with a large number of indoor livestock.
Management / Maintenance requirements	Waste must be stored correctly prior to use in AD Plant to avoid increases in P loading.
Additional benefits	• Sustainability • Circular economy • Energy production
Based on best available evidence?	No
Effective beyond reasonable scientific doubt?	No – further calculations / monitoring is required to confirm the phosphate reductions. Additional monitoring throughout the first years after establishment is likely to be required.
Precautionary?	Yes
Securable in perpetuity?	No – It is unlikely this solution could be achieved in perpetuity due to the lifetime of energy crops. AD Plants using animal waste are more likely to offer a solution in perpetuity. However, the AD Plant would need to keep the animal waste volumes fairly constant during operation to ensure the removal rate does not drop.
Costs	Tens of thousands of pounds

4.2.9 Package treatment plants

189. Package treatment plants (PTPs) can be used to treat wastewater onsite and are normally used where connection to mains sewerage system is not possible. Septic tanks are an alternative type of basic onsite wastewater treatment. However, phosphate reductions are typically low (O’Keeffe *et a*l., 2015) and effluent may require further treatment (e.g. by a soakaway). Correctly operated and well-maintained package treatment plants produce a

[13] *Natwest: Does AD pay off on smaller farms? (https://natwestbusinesshub.com/articles/does-anaerobic-digestion-pay-off-on-smaller-farms)*

higher quality effluent which may be able to be discharged to surface water or groundwater, as well as to drainage fields (May & Woods, 2015). In order to achieve the highest rates of phosphorus removal, a package treatment plant that has additional phosphate stripping should be used. This would require additional maintenance that would need to be secured through maintenance agreements. Management companies who are used for maintenance provide greater certainty that the treatment plants are operating to their optimum removal rate. Where PTPs are to be used in rural setting and regular chemical dosing is required, spot checks may be required to ensure management is carried out as specified in the maintenance agreements.

190. Building regulations require foul drainage to be connected to a public sewer or where this is not feasible (in terms of cost and/or practicality), to package treatment plants or Septic Tanks (Document H, Building Regulations 2010). The package treatment plant or septic tank must comply with the general binding rules (Environment Agency, 2021) or a permit will be required. It may be possible for package treatment plants to be discharged to surface water, whereas septic tanks must not discharge effluent to surface water.

191. Package treatment plants or septic tanks that drain to a field must be compliant with the Building Regulations in order to be used as mitigation. Part H2 of the Building Regulations 2010 requires that they are located:

- A minimum of 10m from watercourses;
- 50m from a point of abstraction of any groundwater supply;
- Not in any Zone 1 groundwater protection Zone;
- At least 15m from any building; and
- Sufficiently far from any other drainage fields

192. PTPs with additional phosphate stripping are capable of achieving reductions in the range of 95%. **Table 4.39** outlines some of the reductions available through leading brands.

Table 4.39: *Main PTP Manufacturers Phosphate removal rates*

System	Removal rate / concentration	Source
Graf One2clean plus	95.1% / 1.6mg/l	https://www.graf-water.co.uk/fileadmin/media/Catalogue_Wastewater_Treatment_Solutions.pdf
Graf Klaro E Professional KL24plus	94.5% / 0.4mg/l	https://www.graf-water.co.uk/fileadmin/media/Catalogue_Wastewater_Treatment_Solutions.pdf
Kingspan Klargester BioDisc	2 mg/l	Klargester Biodisc Sewage Treatment System | Kingspan | Great Britain
WPL HIPAF	3-6 mg/l	WPL HiPAF® Sewage System - WPL | WCS EE Division (wplinternational.com)

193. Reed beds, wetland treatment systems and willow buffers (**Section 4.2.2**) can be used to provide secondary or tertiary treatment of effluent from package treatment plants. The systems

purify the effluent as it moves through the gravel bed and is taken up by the roots. Both horizontal flow and vertical flow systems are suitable.

194. PTPs have potentially high phosphorus removal rates and when used can mitigate a substantial amount of the mitigation required. Furthermore, when combined with SuDS / wetlands, could achieve even greater removal / neutrality.

195. In order for the solutions to be achievable in perpetuity, maintenance would need to be in places for the lifetime of the development. Maintenance and regular emptying of package treatment plants and septic tanks is required under rules 11 and 12 of the General Binding rules (Environment Agency, 2021). The waste bi-products of PTPs are likely to be classified as sewage sludge and would need to be disposed according to requirements of the Environment Agency.

196. Alterations to existing PTPs and Septic tanks or installing new tanks to provide additional phosphate dosing could deliver mitigation. This solution is likely to be viable for properties under control of local authorities, registered providers or developers with existing developments in the catchment with management agreements in place.

4.2.9.1 Capital and maintenance costs

197. PTP cost varies according to the size required and PTPs with additional P stripping typically cost more than standard models. Upfront costs are typically £2,000 - £2,500 for plants serving 4/5 persons and up to £5,000 for plants serving 15/20 persons. Installation costs may vary but are likely to be £thousands. Average annual costs for operating and maintenance (including emptying) are typically £100 - £200.

198. A 10 dwelling development utilising PTP's without additional phosphate stripping (assumed to operate at 50% reduction) would result in an increase of 11.88kg/yr from wastewater. However, should PTPs with additional phosphate stripping (90% efficiency) be installed, phosphate loading would be reduced by 9.50kg/yr. The phosphate stripping would have an estimated additional cost of approximately £32,000. This is equivalent to £3,580 per kg/yr reduction.

199. **Table 4.40** presents the key considerations for the use of Package Treatment Plants for phosphate reduction and/or offsetting.

Table 4.40: *Package Treatment Plants key considerations*

Key considerations	
Delivery Timescale	Short-term
Duration timescales	Long-term
P removal potential	95% of Wastewater
Management / Maintenance requirements	Annual cleaning required in most cases
Additional benefits	Additional water quality benefits. Flood risk, habitat creation, amenity space when combined with SuDS / Wetlands.

Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	Yes
Precautionary?	Yes
Securable in perpetuity?	No
Cost estimation	Capital costs: approx. £5,000 Operational costs: £100 - £200

4.2.10 Cesspools

200. Closed Cesspool systems offer the possibility of tankering waste from dwellings within the catchment to registered waste facilities outside of the catchment. As a result, there would be no increase in wastewater loading from developments that use this approach. However, multiple criteria would need to be met in order for cesspools to be viable:

- Ensure it has a minimum capacity of 18,000 litres per 2 users (plus another 6,800 litres per each extra user)
- Waste would need to be transferred by a registered waste carrier
- Waste would need to be transferred to a registered facility outside of the catchment
- Planning permission would be required
- The cesspool would need building regulations approval, which includes the following
    - Cesspools should only be considered where mains drainage is not practicable
    - Sited at least 7m from any habitable parts of buildings
    - Sited within 30m of vehicle access
    - No opening except for the inlet
    - Cesspools should be inspected fortnightly for overflow and emptied as required

201. Cesspools would need to be emptied regularly and the owner would be responsible to ensure they do not leak or overflow. Where a cesspool causes pollution it would break the law and the Environment Agency could take legal action under the Water Resource Act 1991, which can carry a fine of up to £20,000 and 3 months imprisonment. Similarly, the Environment Agency and local council can enforce repairs or replacements of cesspools in poor condition.

202. Cesspools are an unsustainable solution that would have a significant carbon increase associated, particularly for dwellings in the centre of the catchment where the distance from registered waste facilities will be the greatest. Furthermore, if water company infrastructure allows for mains connection in the future, the water companies would be obliged to connect and wastewater would then be contributing to loads into the catchment, requiring further mitigation. Maintenance of the cesspools would need to be written as a planning condition as well as into the deeds of the dwelling.

203. Where cesspools are used as a short term bridging solution until longer term, more sustainable, solutions are in place, then details of these longer term solution would be required at the time of granting permission.

204. Cesspools should only be considered when other alternatives such as Package Treatment Plants and Septic Tanks are not possible.

4.2.10.1 Capital and maintenance costs

205. Cesspool costs and installation vary depending on size but are likely to be between £3000 - £6000. Emptying requirements are dependent on the capacity of the pit and the average waste amount of the household. On average, emptying would be required every 1 - 2 months with a cost of £400 - £700 depending on location. This is likely to result in annual costs of £3,200 - £5,600, which over 3 years equates to £9,600 - £16,800[14] per property.

206. **Table 4.41** presents the key considerations for the use of Cesspools for phosphate reduction and/or offsetting.

Table 4.41: *Cesspools key considerations*

Key considerations	
Delivery Timescale	Short-term
Duration timescales	Short / medium-term
P removal potential	100% of wastewater
Management / Maintenance requirements	Emptying every 1 – 2 months Regular inspection
Additional benefits	None
Based on best available evidence?	Yes
Effective beyond reasonable scientific doubt?	Yes
Precautionary?	Yes
Securable in perpetuity?	Yes
Cost estimation	Capital costs: approx. £3,000 - £6,000 Operational costs: £3,200 - £5,600 per year

[14] How much does a cesspool typically cost? - GRAF UK

5 Housing projections

5.1 Methods and assumptions

207. In order to understand the mitigation required to meet the upcoming housing requirements, a review of local plan documents and housing projections was undertaken. The additional phosphate loading from the projected housing was calculated using the Phosphate Budget Calculator (2021). Worst-case scenarios were assumed to ensure the phosphate loading value is not understated.

208. The following assumptions were made:

- All new dwellings were assumed to be houses with an average occupancy of 2.4 persons per dwelling;
- The previous land use of the sites was assumed to be mixed livestock which represents one of the dominant land use types in the catchment and has a runoff coefficient close to the average of all the land uses;
- Land use within the Sedgemoor district was assumed to be lowland grazing which reflects the dominant land use of this district which is caught up within the catchment of the Somerset Levels and Moors;
- The proposed land use was assumed to be entirely urban;
- Permit limits were retrieved from Wessex Water published values for the current AMP cycle and the future permit limits due to be in place prior to 2025;
- Where PTPs were expected to be used, a removal rate of 90% was assumed;
- The soil drainage type was derived from Soilscapes and the dominant soil of the area was chosen;
- The area of land required for the developments was calculated by multiplying the projected number of dwellings by the plot size, which was assumed to be 0.04ha per dwelling. It was assumed that a plot size of 0.04ha would provide a representative figure for the house, garden and accompanying roads / paths adjacent to the properties;
- A 20% buffer was applied to the calculations in line with natural England guidance on nutrient neutrality (Natural England, 2020).

209. The end dates of the Local Plans for the various local authorities did not align. In order to provide a standardised approach, the housing projections and associated additional phosphate loading were calculated for the next 10 years, for the period 2022 to 2032.

210. It was assumed that the affected houses development will be evenly spread across the period 2022 to 2032. WwTWs that have a permit limit that will be reduced at the end of the AMP7 Cycle (December 2024) will require the initial houses developed up to that point to deliver more phosphate mitigation than is required once the new permit limit is online. This excess mitigation can then be reallocated to future dwellings. This leads to a short term requirement for significant mitigation that in some areas can be significantly reduced by 2032.

211. The housing projection figures only include future delivery that is affected by the phosphates issue, and do not account for developments and allocations that are already permitted and being built out or developments that are not caught by the phosphates issue.

5.2 Mendip

212. The housing projections for the Mendip region were partially retrieved from the Mendip Local Plan Part II which was adopted in October 2021. The Local Plan Part II builds upon Part I which was adopted in 2014. Core Policy 2 of the Local Plan Part I outlined that the district should accommodate at least 9,635 dwellings over the period 2006 to 2029. Planned growth is expected to deliver a total of 11,855 dwellings, which represents a 19% uplift on the requirement set out in the Local Plan Part 1. Housing requirements beyond the local plan period were extrapolated using the average number of dwellings per year.

213. The planned growth figures presented in the local plan were adjusted for mitigation, with completions and commitments not requiring mitigation removed. The growth figures were altered to account for a limited number of major proposals not in the published local plan which may require mitigation. The updated planned growth figures adjusted for mitigation are presented in **Table 5.1**.

Table 5.1: *Summary of planned growth (2006 – 2029) adjusted for mitigation (edited from Updated Local Plan Table 3):*

Location of Dwellings	Completions	Commitments (started)	Commitments (not started) – No mitigation required	Commitments (not started) – Mitigation required	Part 1 & 2 Allocations	Other sites / Majors since 2019	Adjusted Planned Growth requiring mitigation
Glastonbury	636	142	60	31	167	0	**198**
Street	803	52	0	13	712	0	**725**
Shepton Mallet	727	5	146	35	600	30	**665**
Wells	802	312	270	39	345	47	**431**
Primary Villages	750	75	98	28	71	155	**254**
Secondary Villages	386	38	43	66	0	37	**103**
Other villages & Countryside	527	113	88	35	0	20	**55**
Total	**4631**	**737**	**705**	**247**	**1895**	**289**	**2431**

214. The planned growth for the district and the values used for basing the phosphate loading calculations are presented in **Table 5.2.**

Table 5.2: *Projected growth impacted by the phosphates issue per settlement in Mendip*

Location of Dwellings	Commitments (not started) – requiring mitigation	Planned Growth 2022 – 2032	Dwellings per year	Area required per year (Ha)	Treatment works	Soil Drainage Type
Glastonbury	31	239	24	1.0	Glastonbury	Impermeable
Street	13	1,017	102	4.1	Glastonbury	Impermeable
Shepton Mallet	35	900	90	3.6	Shepton Mallet	Freely draining
Wells	39	560	56	2.2	Wells	Impermeable
Primary Villages	28	323	32	1.3	Multiple	Impermeable
Secondary Villages	66	53	5	0.2	Multiple	Impermeable
Other villages & Rural	35	29	3	0.1	Multiple / PTP	Impermeable
Total	**247**	**3,120**	**312**	**12.5**		

215. Developments in Frome and the NE Mendip District (i.e. Midsomer Norton) were excluded from the Calculations as these areas are located outside of the Somerset Levels and Moors catchment area (**Figure 17**) The permit limits for the Primary villages was calculated by taking the average permit limits for the sites at Butleigh, Ditcheat, Evercreech, Croscombe. The permit limits for the Secondary villages was calculated by taking the permit limit for Meare. Other villages and Rural were assumed to be served by rural treatment works without phosphate stripping (5mg/l) or by package treatment plants (1mg/l).

216. The expected phosphate loading per year for the period 2022 to 2032 for the Mendip District is provided in **Table 5.3**.

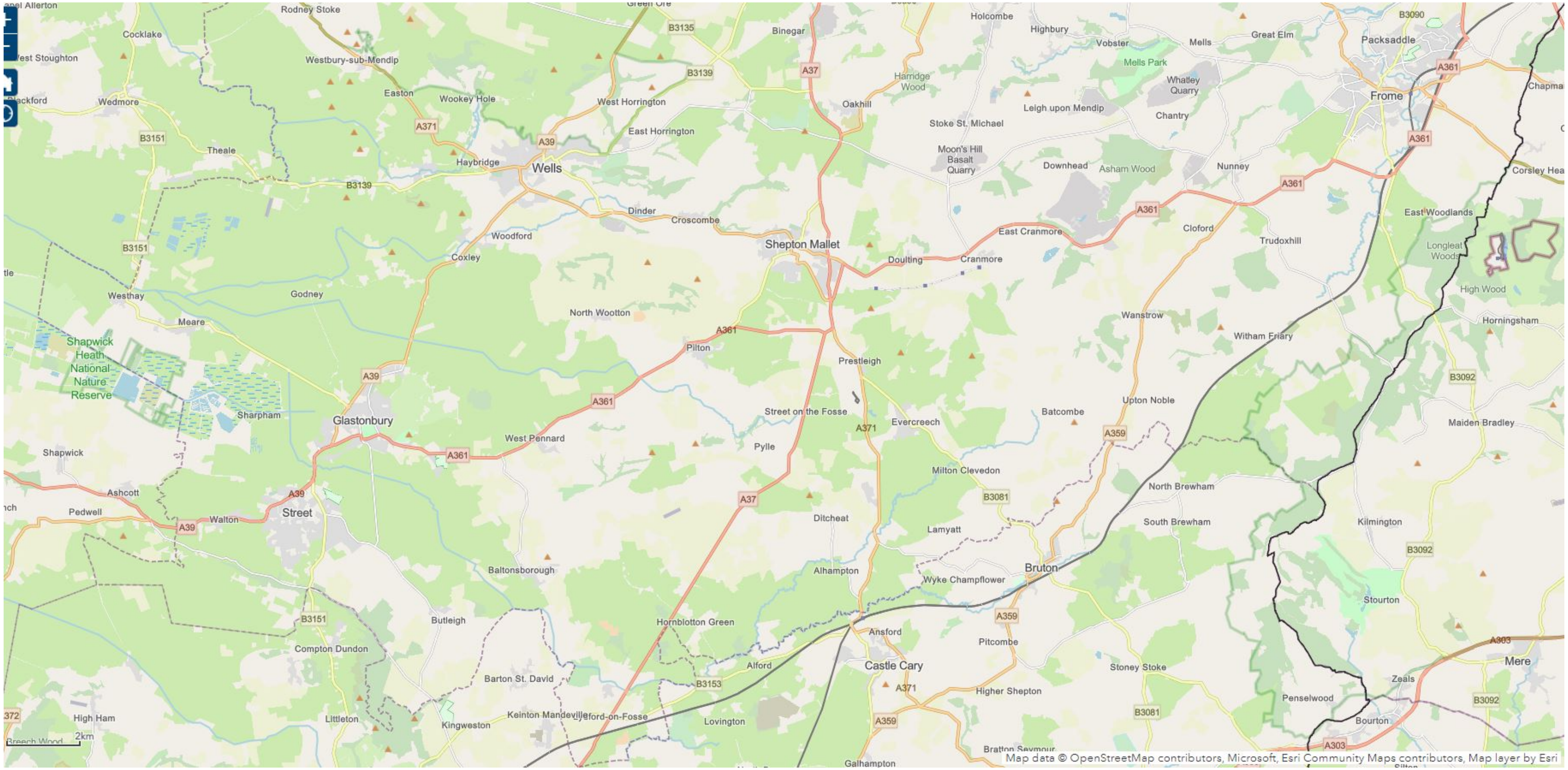

***Figure 17:** Mendip District*

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Table 5.3: *Phosphate loading per settlement in Mendip*

Location of Dwellings	Phosphate loading (kg/yr)											
	Commitments	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	**Total**
Glastonbury	6.94	5.34	5.34	5.34	0.69	0.69	0.69	0.69	0.69	0.69	0.69	**27.83**
Street	2.91	22.78	22.78	22.78	5.08	5.08	5.08	5.08	5.08	5.08	5.08	**106.85**
Shepton Mallet	8.46	21.76	21.76	21.76	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	**71.27**
Wells	8.74	12.54	12.54	12.54	3.95	3.95	3.95	3.95	3.95	3.95	3.95	**74.01**
Primary villages	12.68	14.62	14.62	14.62	13.62	13.62	13.62	13.62	13.62	13.62	13.62	**151.86**
Secondary villages	35.39	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	**63.73**
Other villages & Rural	11.48	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	**20.85**
Total	**86.60**	**80.82 per year**			**26.76 per year**							**516.40**

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218. The total additional phosphate load from the projected houses is predicted to be 516.40 kg/yr. Following the improvements to treatment works by 2025, the phosphate loading per year will be 26.76kg/yr.

5.3 South Somerset

219. The housing projections for the South Somerset region were derived from the South Somerset Local Plan, which was adopted in 2015, and the Five-Year Housing Land Supply Report 2021 (extant permissions), allocations and windfall. The calculations are conservative and do not account for:

- Extant permissions for development and existing allocations that are not caught by phosphates and continue to be delivered over the period 2022-2032.
- Dwellings that may come forward during this period in towns and rural settlements on greenfield sites consistent with policy.

220. The windfall rate has been calculated over 8 years as opposed to 10 years to avoid double counting. The planned growth for the district and the values used for basing the phosphate loading calculations are presented in **Table 5.4.**

Table 5.4: *Projected growth impacted by the phosphates issue per settlement in South Somerset*

Location of Dwellings	Planned Growth 2022 – 2032 (includes permissions and allocations requiring mitigation)	Dwellings per year	Area required per year (Ha)	Treatment works	Soil Drainage Type
Yeovil	721	72	2.9	Yeovil Penn Mill	Impermeable
Chard	587	59	2.3	Chard	Freely draining
Crewkerne	604	60	2.4	Crewkerne	Freely draining
Ilminster	554	55	2.2	Ilminster	Impermeable
Castle Cary	167	17	0.7	Castle Cary	Impermeable
Langport	37	4	0.1	Langport	Impermeable
Somerton	34	3	0.1	Somerton	freely draining

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Location of Dwellings	Planned Growth 2022 – 2032 (includes permissions and allocations requiring mitigation)	Dwellings per year	Area required per year (Ha)	Treatment works	Soil Drainage Type
Bruton	0	0	0.0	Bruton	Impermeable
Ilchester	0	0	0.0	Ilchester	Impermeable
Martock	61	6	0.2	Martock	Impermeable
Milborne Port	5	1	0.0	Milborne Port	freely draining
South Petherton	6	1	0.0	South Petherton	freely draining
Stoke Sub Hamdon	0	0	0.0	Martock	Impermeable
Rest of South Somerset	351	35	1.4	Various	Impermeable
Windfall	800	80	3.2	Various	Impermeable
Total	**3,927**	**393**	**15.7**		

221. The Somerset Levels and Moors catchment covers a significant extent of the South Somerset District (**Figure 18**). The Primary Market Town of Wincanton is located outside of the catchment and as such, was not included as part of these calculations. The permit limit for the rural sites was assumed to be 5mg/l.

222. The expected phosphate loading per year for the period 2022 to 2032 for the South Somerset District is provided in **Table 5.5.**

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Figure 18: *South Somerset District*

Table 5.5: *phosphate loading per settlement in South Somerset*

Location of Dwellings	Phosphate loading (kg/yr)									
	2022/23	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**2031/32**	Total
Yeovil	16.15	16.15	16.15	1.68	1.68	1.68	1.68	1.68	1.68	1.68	**60.19**
Chard	32.52	32.52	32.52	-6.75	-6.75	-6.75	-6.75	-6.75	-6.75	-6.75	**50.27**
Crewkerne	33.46	33.46	33.46	-2.46	-2.46	-2.46	-2.46	-2.46	-2.46	-2.46	**83.15**
Ilminster	29.70	29.70	29.70	-3.24	-3.24	-3.24	-3.24	-3.24	-3.24	-3.24	**66.43**
Castle Cary	8.95	8.95	8.95	-2.22	-2.22	-2.22	-2.22	-2.22	-2.22	-2.22	**11.34**
Langport	1.98	1.98	1.98	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	**4.44**
Somerton	1.88	1.88	1.88	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	**2.91**
Bruton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Ilchester	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Martock	3.27	3.27	3.27	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	**7.31**

Location of Dwellings	Phosphate loading (kg/yr)										
	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	Total
Milborne Port	0.28	0.28	0.28	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	**0.69**
South Petherton	0.33	0.33	0.33	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	**0.83**
Stoke Sub Hamdon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Rest of South Somerset	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	18.82	**188.20**
Windfall	39.49	39.49	39.49	9.03	9.03	9.03	9.03	9.03	9.03	9.03	**181.64**
Total	**186.84 per year**			**13.84 per year**							**657.40**

224. The total additional phosphate load from the projected houses is predicted to be 657.40kg/yr. The loading per year for the period 2022-24 (current AMP cycle) is 186.84kg/yr. However, following the improvements to treatment works by 2025, including to Yeovil Pen Mill, the phosphate loading per year is 13.84kg/yr. The largest contributors of phosphates will be from developments in Yeovil and rural areas within South Somerset due to the large number of small wastewater treatment works in the district that currently do have any permit levels for phosphates.

225. South Somerset District Council, through the preparation of their Local Plan Review, are proposing to change the spatial distribution of growth across the district, with figures based on the Government's standard method.

5.4 Somerset West and Taunton

226. The housing projections for the Somerset West and Taunton District were retrieved from the Taunton Deane Strategic Housing Land Availability Assessment Appendix C: Housing Trajectories – Taunton, Wellington & Rest of Borough. The documents sets out the housing projections for the period 2008 to 2032 for 18,721 dwellings. Development is primarily based in Taunton. The Planned growth for the district and the values used for basing the phosphate loading calculations are presented in **Table 5.6.**

Table 5.6: *Planned growth per settlement in Somerset West and Taunton*

Location of Dwellings	Planned Growth 2022 – 2032	Planned growth requiring mitigation	Treatment works	Soil Drainage Type
Taunton	10,646	8,561	Taunton	Impermeable
Wellington	1,419	558	Wellington	Impermeable
Rural	794	171	Various	Impermeable

227. Developments in the northern and western regions that are located outside of the Somerset Level and Moors catchment were excluded from the Calculations (**Figure 19**). The permit limits for the rural sites was calculated by taking the average permit limits for the sites at Wiveliscombe, Langford Budville, Milverton, Bishop's Lydeard, Bradford on Tone and Stoke St Gregory.

228. The Housing requirements were calculated per year and are set out in **Table 5.7**.

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***Table 5.7**: Detailed housing projections impacted by the phosphates issue per year*

Location of Dwelling	Projected no. of dwellings											
	2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**Beyond 2032**
Taunton	782	782	782	782	782	782	782	782	782	782	782	741
Wellington	54	54	54	54	54	54	54	54	54	54	68	0
Rest of borough	31	31	31	31	31	6	0	0	0	0	0	0
Total	**867**	**867**	**867**	**867**	**867**	**842**	**836**	**836**	**836**	**836**	**850**	**741**

229. The expected phosphate loading per year for the period 2022 to 2032 and beyond for the Somerset West and Taunton region is provided in **Table 5.8.**

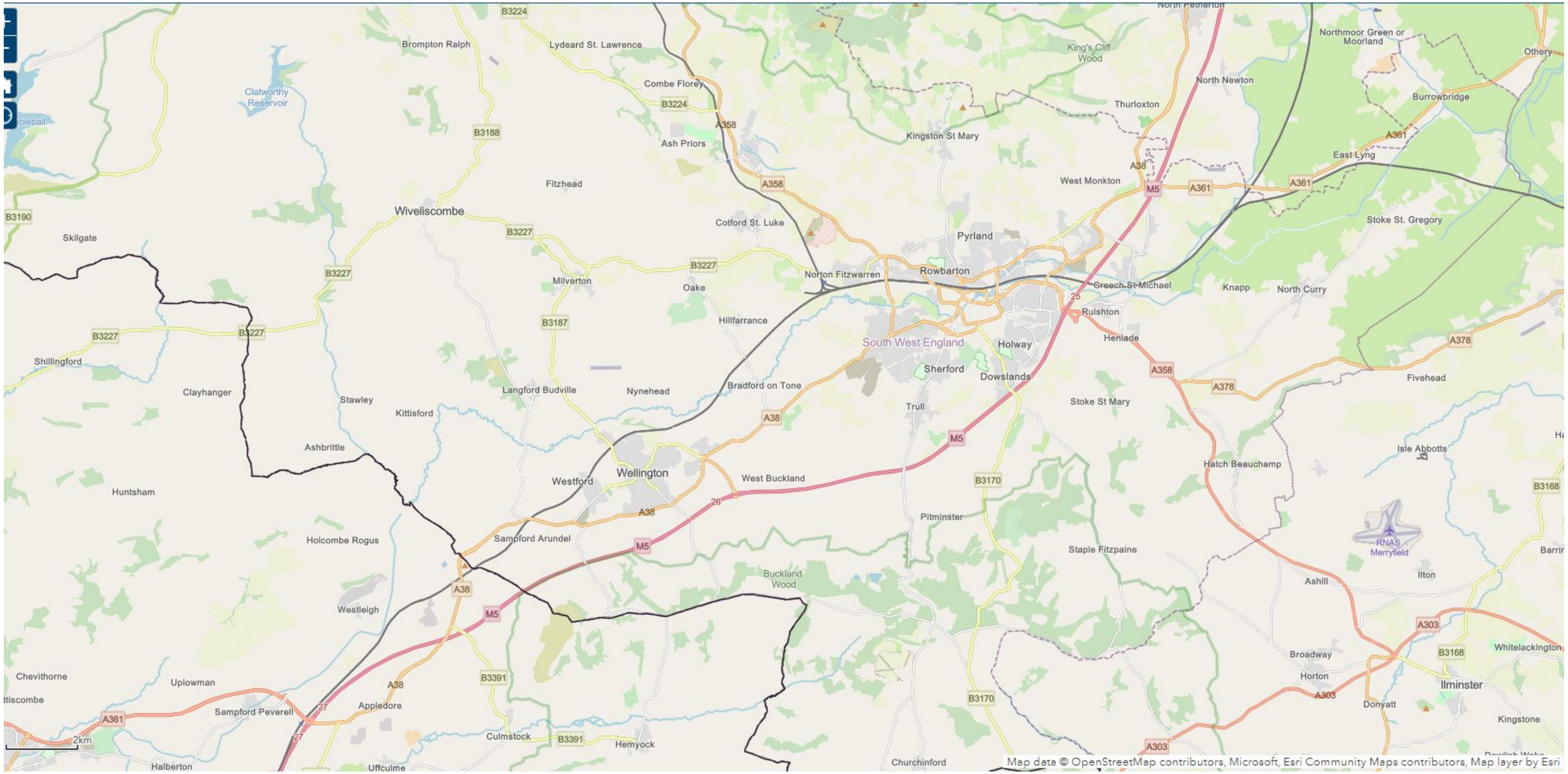

Figure 19: *Somerset West and Taunton District*

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Table 5.8: *Phosphate loading over the period 2022 - 2032 for Somerset West and Taunton*

Location of Dwellings	**Phosphate loading (kg/yr)**												
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	**Beyond 2032**	**Total**
Taunton	93.77	93.77	93.77	87.52	87.52	87.52	87.52	87.52	87.52	87.52	87.52	88.85	**1070.30**
Wellington	12.09	12.09	12.09	4.60	4.60	4.60	4.60	4.60	4.60	4.60	6.28	-1.87	**72.90**
Rural	16.62	16.62	16.62	6.79	6.79	-0.67	-2.46	-2.46	-2.46	-2.46	-2.46	-2.46	**48.03**
Total	**122.49**	**122.49**	**122.49**	**98.91**	**98.91**	**91.45**	**89.66**	**89.66**	**89.66**	**89.66**	**91.34**	**84.52**	**1191.23**

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231. The total additional phosphate load from the projected houses is predicted to be 1,191.23kg/yr.

5.5 Sedgemoor

232. The housing projections for the Sedgemoor district were retrieved from the Sedgemoor Local Plan for the period 2011 – 2032. A large part of this housing will be developed outside of the catchment of the Somerset Levels and Moors Ramsar site. The planned growth for the district and the values used for basing the phosphate loading calculations are presented in **Table 5.9.**

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Table 5.9: *Planned growth per settlement in Sedgemoor*

Location of Dwellings	Settlement hierarchy	Planned Growth 2011 - 2032	Estimated residual growth (yet to be completed) 2021-2032	Countryside windfall allowance	Average dwellings per year	Area required per year (Ha)	Treatment works	Soil Drainage Type
Wedmore settlement	Tier 2	116	54	n/a	4.91	0.20	Wedmore*	Impermeable
Edington	Tier 3	55.7	34.7	n/a	3.15	0.13	West Huntspill*	Freely draining
Ashcott settlement		55.7	34.7	n/a	3.15	0.13	Bridgewater*	Freely draining
Blackford settlement	Tier 4	39.6	25.8	n/a	2.35	0.09	West Huntspill*	Impermeable
Cossington settlement		39.6	25.8	n/a	2.35	0.09	West Huntspill*	Impermeable
Chilton Polden settlement		39.6	25.8	n/a	2.35	0.09	West Huntspill*	Freely draining
Catcott settlement		39.6	25.8	n/a	2.35	0.09	West Huntspill*	Freely draining
Shapwick settlement		39.6	25.8	n/a	2.35	0.09	West Huntspill*	Freely draining
Othery settlement		39.6	25.8	n/a	2.35	0.09	Bridgewater*	Impermeable
Wedmore Parish	Countryside	n/a	n/a	25.3	2.30	0.09	PTP	Impermeable

Location of Dwellings	Settlement hierarchy	Planned Growth 2011 - 2032	Estimated residual growth (yet to be completed) 2021-2032	Countryside windfall allowance	Average dwellings per year	Area required per year (Ha)	Treatment works	Soil Drainage Type
Chapel Allerton Parish		n/a	n/a	6.6	0.60	0.02	PTP	Impermeable
Burtle Parish		n/a	n/a	16.5	1.50	0.06	PTP	Impermeable
Cossington Parish		n/a	n/a	8.8	0.80	0.03	PTP	Impermeable
Chilton Polden parish		n/a	n/a	1.1	0.10	0.00	PTP	Freely draining
Edington Parish		n/a	n/a	0	0.00	0.00	PTP	Freely draining
Catcott Parish		n/a	n/a	3.3	0.30	0.01	PTP	Freely draining
Shapwick Parish		n/a	n/a	1.1	0.10	0.00	PTP	Freely draining
Ashcott Parish		n/a	n/a	7.7	0.70	0.03	PTP	Freely draining
Grienton Parish		n/a	n/a	8.8	0.80	0.03	PTP	Impermeable
Moorlinch Parish		n/a	n/a	8.8	0.80	0.03	PTP	Impermeable
Middlezoy Parish		n/a	n/a	6.6	0.60	0.02	PTP	Impermeable
Othery Parish		n/a	n/a	2.2	0.20	0.01	PTP	Impermeable

Location of Dwellings	Settlement hierarchy	Planned Growth 2011 - 2032	Estimated residual growth (yet to be completed) 2021-2032	Countryside windfall allowance	Average dwellings per year	Area required per year (Ha)	Treatment works	Soil Drainage Type
Total			**278**	**97**	**34**	**1.36**		

* Denotes that treatment works will discharge downstream of the Somerset Levels and Moors catchment. As a result, contributions from additional wastewater and not included in the calculations.

233. For Sedgemoor, the planned growth for Wedmore has been calculated by taking the 116 dwellings planned between 2011-2032 and taking off completions to date (62 dwellings). For tier 3 settlements, completions across all 17 settlements in this category have been taken into account, with the residual growth remaining apportioned equally across the tier 3 settlements. The tier 3 settlements which fall within the phosphate area are then listed in **Table 5.9**. The same methodology has been taken with regards to tier 4 settlements. In relation to development in the countryside that falls within the phosphates area, a windfall allowance has been included based on average annual completions in these areas since the start of the plan period. This is then used to calculate an allowance for the remaining 11 years of the plan. Across all the locations, existing commitments (i.e., sites with permission, but not yet built) have not been discounted. This is a conservative approach given the scale of commitments at a number of the settlements (particularly Wedmore), a number of which are already under construction. However, a precautionary approach is considered appropriate in relation to phosphates in case amended applications are submitted which need to then address the phosphate issue. Importantly this conservative approach also provides for a degree of futureproofing beyond 2032, end of the Local Plan period. The total number of houses to be developed in the remaining years of the plan period is 375.

234. The Sedgemoor district is outlined in **Figure 20**.

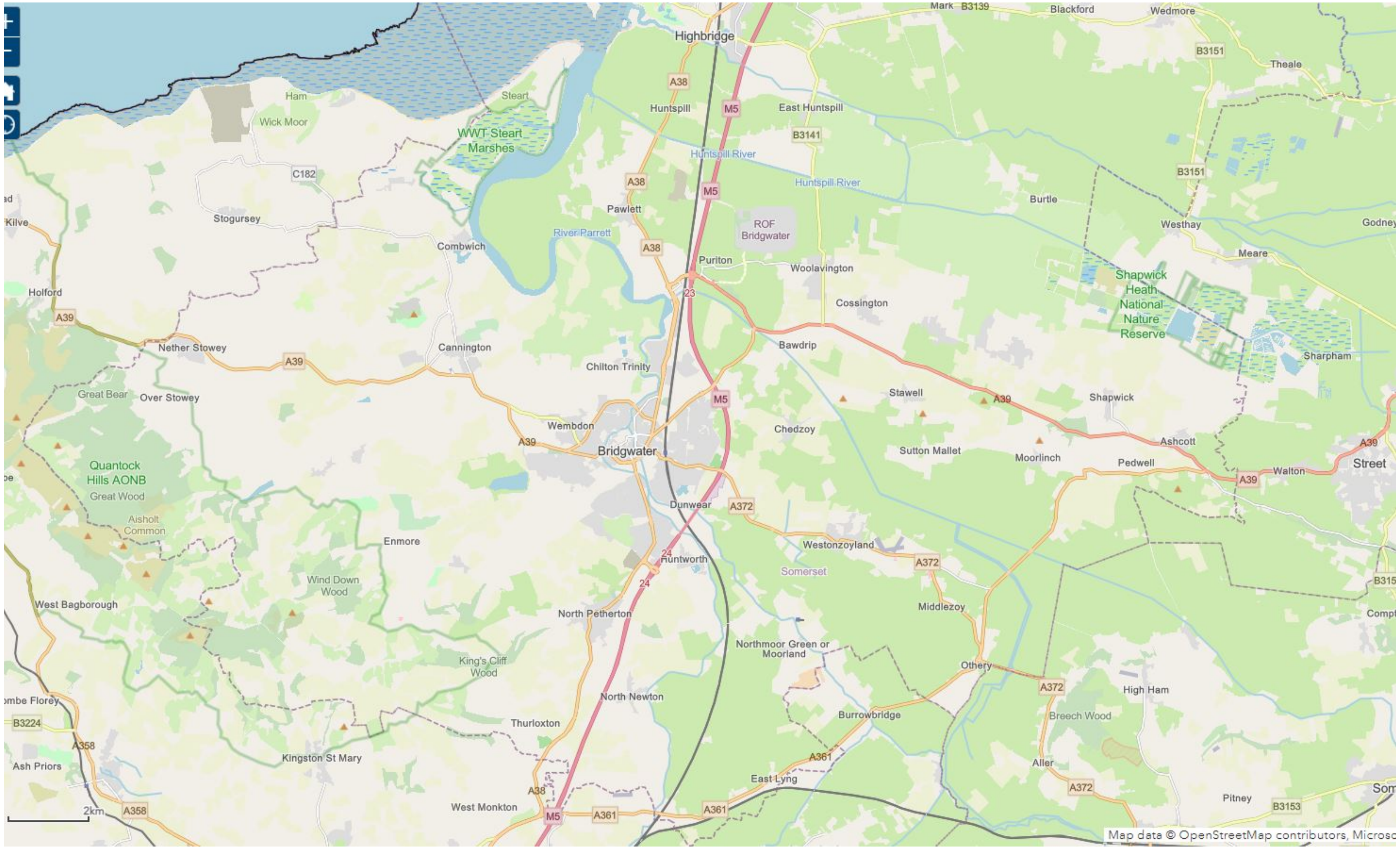

Figure 20: *Sedgemoor District*

235. The expected phosphate loading per year for the period 2022 to 2032 for the Sedgemoor District is provided in **Table 5.10**.

Table 5.10: *Phosphate loading over the period 2022 - 2032 for Sedgemoor*

Location of Dwellings	Phosphate load per year (kg/yr)	Total phosphate loading for remaining plan period (kg/yr)
Wedmore settlement	0.14	1.44
Edington	0.11	1.08
Ashcott settlement	0.11	1.08
Blackford settlement	0.07	0.69
Cossington settlement	0.07	0.69
Chilton Polden settlement	0.08	0.80
Catcott settlement	0.08	0.80
Shapwick settlement	0.08	0.80
Othery settlement	0.07	0.69
Wedmore Parish	0.07	0.67
Chapel Allerton Parish	0.19	1.89
Burtle Parish	0.47	4.72
Cossington Parish	0.25	2.52
Chilton Polden parish	0.03	0.32
Edington Parish	0.00	0.00
Catcott Parish	0.10	0.96
Shapwick Parish	0.03	0.32
Ashcott Parish	0.22	2.23
Grienton Parish	0.25	2.52

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Location of Dwellings	Phosphate load per year (kg/yr)	Total phosphate loading for remaining plan period (kg/yr)
Moorlinch Parish	0.25	2.52
Middlezoy Parish	0.19	1.89
Othery Parish	0.06	0.63
Total	**2.92**	**29.21**

239. The total additional phosphate load from the projected houses is predicted to be 29.21kg/yr. The loading per year is 2.92kg/yr. The largest contribution is from developments that will require PTPs. Developments connected to mains sewerage within this district will discharge effluent downstream of the Somerset levels and Moors catchment.

5.6 Dorset

240. Sherborne is one of the major housing growth regions located in Dorset which overlaps with the catchment of the Somerset Levels and Moors Ramsar site (**Figure 21**). The Dorset Local Plan consultation (Jan 2021) proposes sites at Sherborne. Around 1,230 dwellings are proposed (including as existing allocations and consented sites) for the period 2024 – 2038 (and possibly beyond). Details of the allocations are provided in **Table 5.11**.

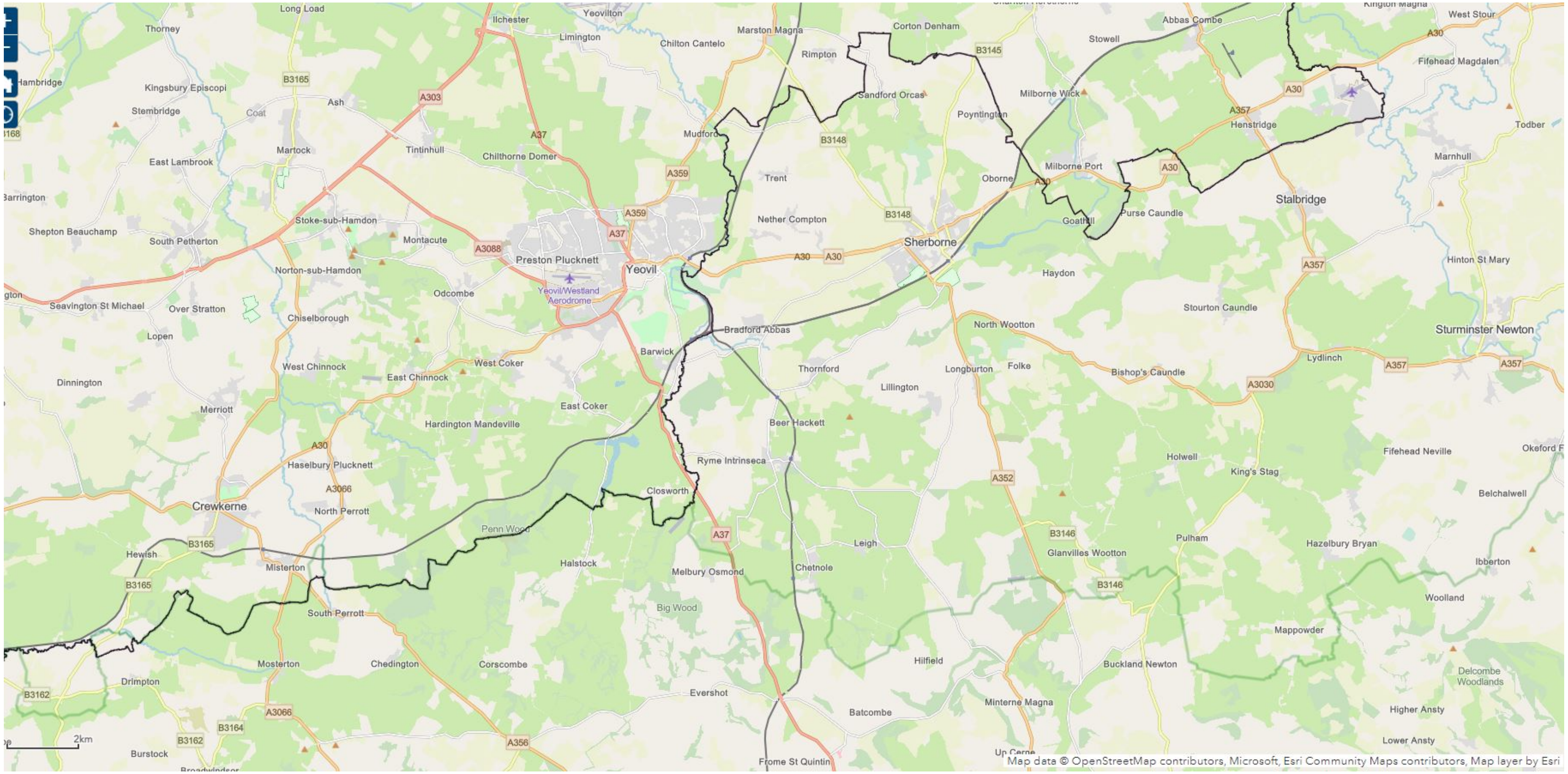

__Figure 21:__ Dorset District

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__Table 5.11:__ Sherborne Allocated sites

Location	No. of dwellings	Anticipated Delivery 2022 to 2032	Policy Reference
Former Gasworks site	50	50	SHER4
Barton Farm Extension (PO)	470	350	SHER5
North of Bradford Road (PO)	220	200	SHER6
South of Bradford Road (PO)	490	0	SHER7
Windfall	10 dpa	100	
Total	**1,330**	**700**	

241. This results in 70 dwellings per year for the period 2022 – 2032. The expected loading for Dorset is presented in **Table 5.12**.

__Table 5.12:__ Phosphate loading over the period 2022 - 2032 for Dorset

Location of Dwellings	Phosphate loading (kg/yr)										
	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	Total
Sherborne	14.50	14.50	14.50	1.12	1.12	1.12	1.12	1.12	1.12	1.12	**51.38**
Windfall	2.42	2.42	2.42	0.19	0.19	0.19	0.19	0.19	0.19	0.19	**8.56**
Total	**16.92**	**16.92**	**16.92**	**1.31**	**1.31**	**1.31**	**1.31**	**1.31**	**1.31**	**1.31**	**59.94**

5.7 Summary

Table 5.1 outlines the total number of dwellings projected and the predicted phosphate loading per district.

__Table 5.13:__ Total projected phosphate loading per district

District	No. of dwellings	Phosphate mitigation required (kg/yr)
Mendip	3,120	516.40
South Somerset	3,927	657.40

Somerset West and Taunton*	10,112	1,191.23
Sedgemoor	375	29.21
Dorset	700	59.94

*Includes development beyond 2032

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6 Summary and conclusions

6.1 Conclusions

243. **Table 5.1** provides a summary of short-listed solutions that could be used mitigate and offset additional phosphates arising from new developments that could adversely affect the Somerset Levels and Moors Ramsar site. Twelve solutions have been identified that each have specific requirements. It is likely that a combination of measures will be most effective in phosphate offsetting. For example, increasing water efficiency in existing properties through retrofitting, whilst incorporating SuDS into new developments and use of constructed and secondary treatment wetlands to lower the phosphate burden. A range of techniques can be used in the wider countryside and these are mainly aimed at slowing runoff and trapping sediment-bound pollutants – these range from cheap and simple measures (e.g., buffer strips) to more complicated approaches that may have long lead in times (e.g., beaver reintroductions) and require monitoring.

6.1.1 Mendip

244. The Mendip district is contains key settlement areas of Glastonbury, Wells and Shepton Mallet. There are a predicted 3,120 dwellings to be built between 2022 and 2032 which will require an estimated 516.40kg/yr of phosphate mitigation. The character and location of the district means that most solutions are suitable.

6.1.2 South Somerset

245. South Somerset is a largely rural district with the population distributed across many towns, villages and hamlets. The rural nature of the district means that many of the wastewater treatment works are small scale and do not have phosphate stripping installed. This generally results in greater phosphate loading from new dwellings. There are a predicted 3,927 dwellings to be built up to 2032, which will require 657.40kg/yr of phosphate mitigation. Whilst the rural nature of the catchment results in slightly inflated phosphate loading, this also presents greater opportunities for phosphate solutions at or downstream of waste water treatment works. The district covers a large area within Somerset and as such contains an abundance of upland and lowland areas. The district also contains a greater proportion of arable farming than other districts, which is more suitable to be taken out of agricultural use or for the use of cover crops over winter periods. It is likely that the Wessex Water EnTrade trading scheme will offer some phosphate credits within this district.

6.1.3 Somerset West and Taunton

246. The Somerset West and Taunton District contains the key settlement areas of Taunton and Wellington. The district contains both the headwaters and downstream reaches of the River Tone. The location and character of the district opens up the possibility for many solutions. Taunton and Wellington have phosphate stripping installed at their treatment works. Elsewhere in the district, phosphate stripping is not yet installed. However, significant upgrades are likely to come online by the end of 2024. Due to the allocation present, the use of alternative treatment works providers is likely to be most suitable to this district. The Local

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Authority also has a large housing stock in comparison to other districts which means that water usage reduction measures will deliver enough phosphate mitigation to justify this as a solution.

6.1.4 Sedgemoor

247. The Sedgemoor district is located in the lowland are of Somerset and the western area of the district overlaps with the catchment of the Somerset Levels and Moors. There are a predicted 375 dwellings to be developed up to 2032, which will require 29.21kg/yr of phosphate mitigation. The district is primarily located downstream of many of the major wastewater treatment works. Due to the location and nature of the district, which lacks upland regions, certain solutions are not applicable.

6.1.5 Suitability of solutions

Table 6.1 Outlines the short-listed solutions that are suitable in each of the districts.

Table 6.1: *Suitability of solutions by district*

Solution	Mendip	South Somerset	Somerset West and Taunton	Sedgemoor
Taking land out of agricultural use	✓	✓	✓	✓
Cessation of fertilizer / manure application	✓	✓	✓	✓
Buffer strips	✓	✓	✓	
Wet Woodlands	✓	✓	✓	
Cover Crops	✓	✓	✓	✓
Beavers	✓	✓	✓	
Constructed wetlands	✓	✓	✓	✓
Secondary treatment wetlands	✓	✓	✓	
Water Company Improvements	✓	✓	✓	✓
Willow buffer areas	✓	✓	✓	✓
SuDS	✓	✓	✓	✓
Third party credit scheme		✓	✓	
Portable treatment works	✓	✓	✓	✓
Alternative wastewater providers	✓	✓	✓	✓
Restrictions on water use			✓	
Anaerobic digestors	✓	✓	✓	✓
Package treatment plants	✓	✓	✓	✓
Cesspools				

6.2 Next Steps

248. The following sets out the next steps of what is required in order to develop the solutions presented within this report to functioning phosphate mitigation solutions. Whilst Natural England were consulted during the process of writing this report, this report was published prior to the anticipated formal Natural England advice on nutrient neutrality. As such, Natural England have not formally approved the solutions presented in this report.

- Identification of the preferred solutions to be delivered and the likely costs, timescales and delivery mechanisms. This will likely be undertaken by the creation of mitigation plans in order to formulate developer contributions which could be established through a supplementary planning document (SPD). Somerset West and Taunton Council have already gained approval on an interim programme to deliver phosphate mitigation (Somerset West and Taunton Council, 2021).
- A database / Miscrosoft Excel based tracking tool to register and record the phosphate loading for each development and through what schemes this will be mitigated. This should include details of any agreements. The tool should be able to assign credits from various mitigation schemes at various stages of the development lifetime. The local authorities are already aware of the need for this tool and are proactively seeking a solution by working with developers and solution providers in order to bring forward nutrient neutral development.
- A tracking tool could also be expanded to track ‘credits’ achieved through mitigation schemes that can be used for biodiversity net gain, carbon offsetting and nitrogen mitigation.
- One or more nutrient trading platforms could be established which would provide a mechanism for developers and landowners / farmers to buy / sell credits. A pilot study of a nutrient trading platform is scheduled to proceed around Spring 2022 operating in the Solent.
- Standardised legal agreements should be drawn up and used as a basis in future mitigation schemes.
- Should the Natural England SuDS guidance be insufficient, a Somerset specific template phosphate removing SUDs design specification should be developed for LPA’s and LLFA to use as part of pre-app and design discussions.

Table 6.2: Short-list solutions summary

Solution	Development timescale	Duration timescales	P removal	Farm type	Maintenance	Additional benefits	Best available evidence?	Effective beyond reasonable scientific doubt?	Precautionary?	In perpetuity?	£ / kg/yr	District Variations
Taking land out of agricultural use	Short-term	Short-term	Mean 0.5 kg/ha/yr	Not indoor pig or poultry	Harvesting every 2-4 years	Energy crops	Yes	Yes	Yes	No	£2,406 per kg/yr mitigation for 5 year rental of mixed livestock grazing land on impermeable soils.	Suitable in all districts. Greater abundance of arable farming in Somerset West and Taunton and South Somerset will provide more certainty in land use change and marginally greater phosphate mitigation per ha.
Cessation of fertilizer / manure application	Short-term	Short-term	0.12-0.50kg/ha/yr	Arable and grassland	None	Nitrogen reduction	Yes	Yes	Yes	Yes	£868.51-£1,274.39 per kg/yr mitigation for every year	Applicable to all districts.
Riparian Buffer strips	Medium-term	Medium / long-term	Mean ~67%	All	Vegetation management	Water quality Less erosion Habitats Amenity	Yes	No – initial removal rates may slow	Yes	Yes	£11,700	Appropriate in all districts. However, better suited to upland areas and areas of steeper gradients.
Wet Woodlands	Medium-term	Medium / long-term	Uncertain – likely to be similar to buffer strips	Riparian land holding with Flood Zone 3	Minimal	Carbon offsetting Biodiversity Air pollution reduction Flood risk Biofuel Amenity	No – Limited evidence	No – doubt over removal rates	Yes	Yes	£11,700	Best suited to upland areas

Solution	Development timescale	Duration timescales	P removal	Farm type	Maintenance	Additional benefits	Best available evidence?	Effective beyond reasonable scientific doubt?	Precautionary?	In perpetuity?	£ / kg/yr	District Variations
Cover Crops	Short-term	Short-term	Large uncertainty	Arable (particularly cereals)	Preparation, cultivating, destroying	Water quality Habitat creation	No	No	Yes	Yes	n/a	Suitable in all districts. There is a greater abundance of arable farms in the Somerset West and Taunton and South Somerset districts.
Beaver reintroduction	Medium/ Long-term	Medium-term	Mean ~50%	Headwaters	Monitoring Local interventions	Water quality Reduced erosion Habitat creation Flood risk	Yes	No – initial removal rates may slow	Yes	No	n/a	Suitable to upland regions which will likely limit to specific areas in
Constructed wetlands	Long-term	Long-term	Mean 46%	All	Vegetation/ sediment management	Flood risk Amenity Habitats Community engagement Educational opportunities Water quality	Yes	No	Yes	Yes	£8,200	Applicable to all districts.
Secondary treatment wetlands	Long-term	Long-term	Mean 46%	All	Vegetation/ sediment management	As above	Yes	No	Yes	Yes	n/a	Applicable to all Mendip, South Somerset and Somerset West and Taunton – greatest opportunities in the Parrett catchment.
Water Company improvements	Long-term	Long-term	Up to 40%	n/a	Monitoring	n/a	Yes	No	No	Yes	n/a	Applicable to all districts. Greatest benefit in Mendip and South Somerset.

Solution	Development timescale	Duration timescales	P removal	Farm type	Maintenance	Additional benefits	Best available evidence?	Effective beyond reasonable scientific doubt?	Precautionary?	In perpetuity?	£ / kg/yr	District Variations
Willow buffer areas	Medium-term	Long-term	70%	n/a	Harvesting 2-3 years	Water quality Biodiversity	Yes	No – potential for soil saturation	Yes	Yes	n/a	Applicable to all districts.
SuDS	Short-term	Medium / Long-term	Variable Site specific	n/a	Regular (e.g., desilting)	Water quality Reduced erosion Habitats Amenity value	Yes	No monitoring required	Yes	Yes	n/a	Applicable to all districts.
Third party credit scheme	Medium / Long-term	Long-term	Dependent on the mitigation solution	n/a	Depends on mitigation option	Habitats Carbon offsetting Amenity Reduced flood risk Water quality	Yes	No – Monitoring of the likely solutions will be required	Yes	Yes	n/a	Wessex Water EnTrade trading scheme likely to be limited to the Tone and Parrett catchment initially. This will exclude large areas of Sedgemoor and Mendip.
Portable treatment works	Short / medium-term	Short / medium-term	Up to 0.5 mg/l	n/a	General system maintenance	Water quality	Yes	Yes	Yes	No	£2,725	Applicable to all districts – greatest benefit in South Somerset.
Alternative wastewater providers	Long-term	Long-term	Effluent to 0.3mg/l	n/a	Paid for through water bills	Can be integrated with SuDS	Yes	Yes	Yes	Yes	£180,000	Applicable to all districts – limited to 500+ dwelling developments.
Restrictions on water use	Medium-term	Long-term	10-30%	n/a	Replacement parts	Water resources Sustainability	Yes	Yes	Yes	No	n/a	Applicable to all districts. However, Somerset West and Taunton has the largest housing stock compared to the other districts.

Solution	Development timescale	Duration timescales	P removal	Farm type	Maintenance	Additional benefits	Best available evidence?	Effective beyond reasonable scientific doubt?	Precautionary?	In perpetuity?	£ / kg/yr	District Variations
Anaerobic digestors	Medium-term	Medium-term	Large uncertainty	All	Waste management	Sustainability Energy Economy	No	No	Yes	No	n/a	Applicable to all districts.
Package treatment plants	Short-term	Long-term	95% of wastewater	n/a	Annual cleaning	Water quality	Yes	Yes	Yes	Yes	£3,580	Applicable to all districts.
Cesspools	Short-term	Short / medium-term	100% wastewater	n/a	Emptying 1 -2 months	None	Yes	Yes	Yes	Yes	n/a	Not applicable in any district

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