River Axe Diffuse Water Pollution Plan

Environment Agency & Natural England

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Version 6.1

Document Version Control

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6.1	22/04/2025	A. Taylor (EA)	Template update Additional maps/map changes Actions update

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List of Abbreviations

AMP Asset Management Plan
AONB Area of Outstanding Natural Beauty
BOD Biochemical Oxygen Demand
CSF Catchment Sensitive Farming (Natural England)
CSFA Catchment Sensitive Farming Advisor
CSM Common Standards Monitoring
DO Dissolved Oxygen
DWMP Drainage & Wastewater Management Plan
DWPP Diffuse Water Pollution Plan
EA Environment Agency
ELM Environmental Land Management
EPR Environmental Permitting Regulations
FIO Faecal Indicator Organisms
FiPL Farming in Protected Landscapes
FRfW Farming Rules for Water
FWAG Farming & Wildlife Advisory Group
N Nitrogen
NE Natural England
NLHF National Lottery Heritage Fund
P Phosphorus
SAC Special Area of Conservation
SAGIS Source Apportionment Geographic Information System
SIMCAT SIMulation of CATchments (model)
SSAFO Silage, Slurry and Agricultural Fuel Oil (Regulations)
SSSI Site of Special Scientific Interest
SRP Soluble Reactive Phosphorus
STW Sewage Treatment Works
SuDS Sustainable Drainage Systems
SWW South West Water
TP Total Phosphorus
TraC Transitional and Coastal (waters)
WEIF Water Environment Improvement Fund
***WER** Water Environment Regulations
WFD Water Framework Directive
WINEP Water Industry National Environment Programme
WRT Westcountry Rivers Trust

*Referring to the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

1. Plan coverage and contacts

This diffuse water pollution plan (DWPP) is written in conjunction with the options appraisal, which is appended to this document. The options appraisal is underpinned by the most recent SAGIS-SIMCAT modelling (EA OCS, 2024), which identifies key sources of phosphorus in surface waters and assesses measures for reducing phosphorus concentrations to achieve the Site of Special Scientific Interest (SSSI) targets.

Where diffuse pollution is preventing the SSSI from achieving favourable condition this plan will:

- identify the causes, evidence of impacts and knowledge gaps
- identify remedies and plan when and how action will be taken
- identify the monitoring required to validate remedies

This plan will be a live document under continual review.

Protected site designations & interest features

The River Axe SSSI is made up of 5 units covering around 70 ha. Units 1-3 cover the river and stream habitat and are entirely within the River Axe Special Area of Conservation (SAC). Units 4 & 5 are designated for their geomorphology and extend across the floodplain at Axminster south of Bow Bridge and again at Whitford.

The site runs from the Blackwater River confluence down to the tidal limit near Colyford and is approximately 13km in length (Figure 1). The plan encompasses all the SSSI units and SAC and aims to protect the designated interest features shown in Table 1. The site also hosts Kingfisher (*Alcedo atthis*) and is notable for a large population of Short-leaved Water Starwort (*Callitriche truncata*), a nationally scarce species usually more associated with ditches.

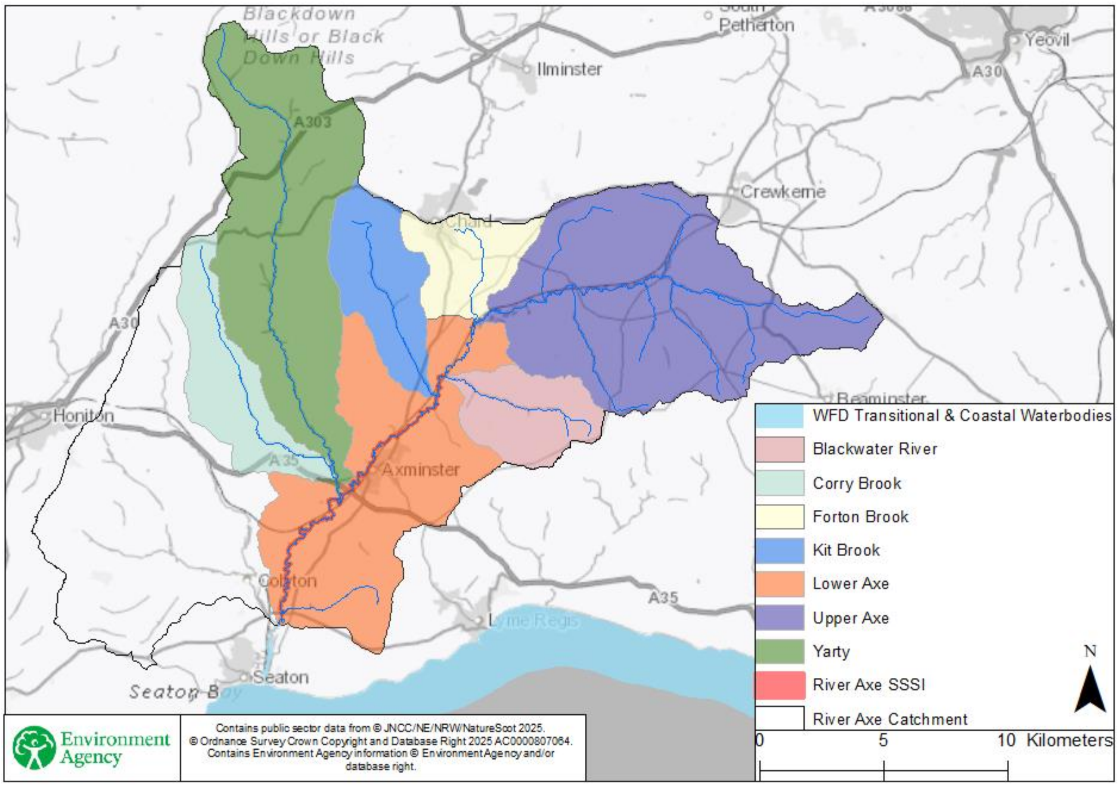

Figure 1 *River Axe SAC/SSSI and connected waterbodies*

Table 1 *River Axe SAC/SSSI designated features*

BAP Broad Habitat type / Geological Site Type	Specific designated features	Explanatory description of the feature for clarification	SSSI designated interest features	SAC designated interest features
Active Process Geomorphological (IA)	Fluvial Morphology	Geomorphological interest of national importance, demonstrating contrasting patterns of meander formation.	*	
Rivers and streams	River type II	Slow flowing, naturally eutrophic lowland rivers, dominated by clays	*	
Rivers and streams	River type IV	Rivers with impoverished ditch floras	*	
Rivers and streams	River type V	Lowland river type, widespread over resistant rocks in England and Wales	*	
Rivers and streams	Rivers with floating vegetation of the *Ranunculion fluitantis*	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation		*
Rivers and streams	Otter *Lutra lutra*	Habitats Directive Annex II species	*	
Rivers and streams	Sea lamprey *Petromyzon marinus*	Habitats Directive Annex II species		*
Rivers and streams	Brook lamprey *Lampetra planeri*	Habitats Directive Annex II species		*
Rivers and streams	Bullhead *Cottus gobio*	Habitats Directive Annex II species		*
Rivers and streams	Medicinal leech *Hirudo medicinalis*	Schedule 5 species	*	
Rivers and streams	Invertebrate assemblage	An invertebrate assemblage of W121 sandy river margin and W122 riparian sand, with RDB and nationally scarce species	*	

Waterbodies encompassed by this plan

The SAC/SSSI is fully within the Lower Axe waterbody (GB 108045008870). A further six river waterbodies drain into the River Axe SSSI, namely the Upper Axe, Forton Brook, Blackwater River, Kit Brook, River Yarty and Corry Brook (Figure 1). Land use and water quality in these catchments impact upon water quality and ecology in the River Axe SSSI. None of the connected waterbodies is at good ecological status (Table 2). Further detail regarding Water Environment Regulations (WER) status is provided in section 3.

***Table 2** Water Environment Regulations ecological status of catchment waterbodies*

Name	Waterbody ID	Ecological Status 2022	Target 2027
Kit Brook	GB108045014830	Moderate	Good
Corry Brook	GB108045009300	Moderate	Good
Blackwater River	GB108045008850	Moderate	Good
Upper Axe	GB108045014840	Moderate	Good
Lower Axe (encompassing SAC & SSSI)	GB108045008870	Moderate	Good
Yarty	GB108045015130	Moderate	Good
Forton Brook	GB108045014820	Bad	Good

Members of the steering group

Alex Taylor: Environment Planning Specialist (Devon & Cornwall), Environment Agency.

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Alex Swan: Catchment Co-ordinator, East Devon, Environment Agency.

Tom Beard: Catchment Sensitive Farming Lead Adviser (River Axe), Devon & Cornwall Area Team, Natural England.

Stuart Hunter: Senior Advisor, Agriculture, Environment Agency.

2. Characteristics of the catchment

Catchment overview

The River Axe catchment covers an area of 308 km^2 across Devon, Somerset, and Dorset. The Axe rises near Chedington (~190m AOD) in Dorset and flows west and then southwards via Axminster to the south coast of England at the coastal town of Seaton. Seaton has a designated bathing water, which has been classified as excellent since 2021. The Axe estuary became a Marine Conservations Zone in 2019 serving to protect the coastal saltmarsh and reedbeds, and estuarine intertidal habitats. The coastal waters at Seaton are also part of Lyme Bay and Torbay SAC, designated for reefs and submerged/partially submerged sea caves.

Hydrology

The catchment is characterised by a rapid response to rainfall owing to the combination of steep slopes and low permeability soils, leading to significant runoff during wet weather. The gauged mean flow at Whitford is 5.3 m^3/s, though the river is subject to winter and spring spates with peak flows around ten times the mean flow. Q95 and Q10 flows are 1.3 m^3/s and 11.3 m^3/s respectively (Table 3).

There are several tributaries feeding the River Axe SSSI, the largest being the River Yarty which joins the main river south of Axminster near Higher Abbey Farm in the lower reach of SSSI Unit 2 (Figure 1). Other significant tributaries that have an influence on the Axe SSSI are Kit Brook, Blackwater River, Forton Brook, River Synderford, Temple Brook and Clapton Stream.

The headwaters of the River Axe flow from Upper Greensand and Chalk Formation geologies. The mid and lower reaches of the River Axe are predominantly underlain by low permeability Mudstone and Upper Greensand Formations. These formations are also characteristic of the River Yarty and Corry Brook catchments. Steep slopes and low permeability of the underlying geology result in flashy responses to rainfall events and visual evidence of soil erosion and sediment mobilisation is widespread (Collins et al., 2009). However, there are major and minor aquifers and groundwater draining from greensand and some areas of chalk in the headwaters. Groundwater is mainly derived from the Upper Greensand, which does not occur beneath the designated reaches of the Axe but plays an important role storing and gradually releasing groundwater to the headwater springs of tributaries to the main river (Figure 2). This sandy formation, therefore, helps to maintain river flows through dry periods. Baseflow generally provides around 48% of flow to the River Axe. Some of the Upper Greensand springs and wells also provide a reliable source of water for public supply, particularly in the Blackdown Hills, but these abstractions do not impact the Axe catchment.

Table 3 *River flow statistics for Whitford Bridge gauging station. Statistics derived from 1964 - 2022 dataset. Flow exceedance: Q10 (90 percentile flow); Q50 (50 percentile flow); Q95 (5 percentile flow)*

River Flow statistic	Whitford Bridge (45004)
Mean Flow m^3/s	5.31
Q10 m^3/s	11.3
Q50 m^3/s	2.85
Q95 m^3/s	1.26
Baseflow index	0.48

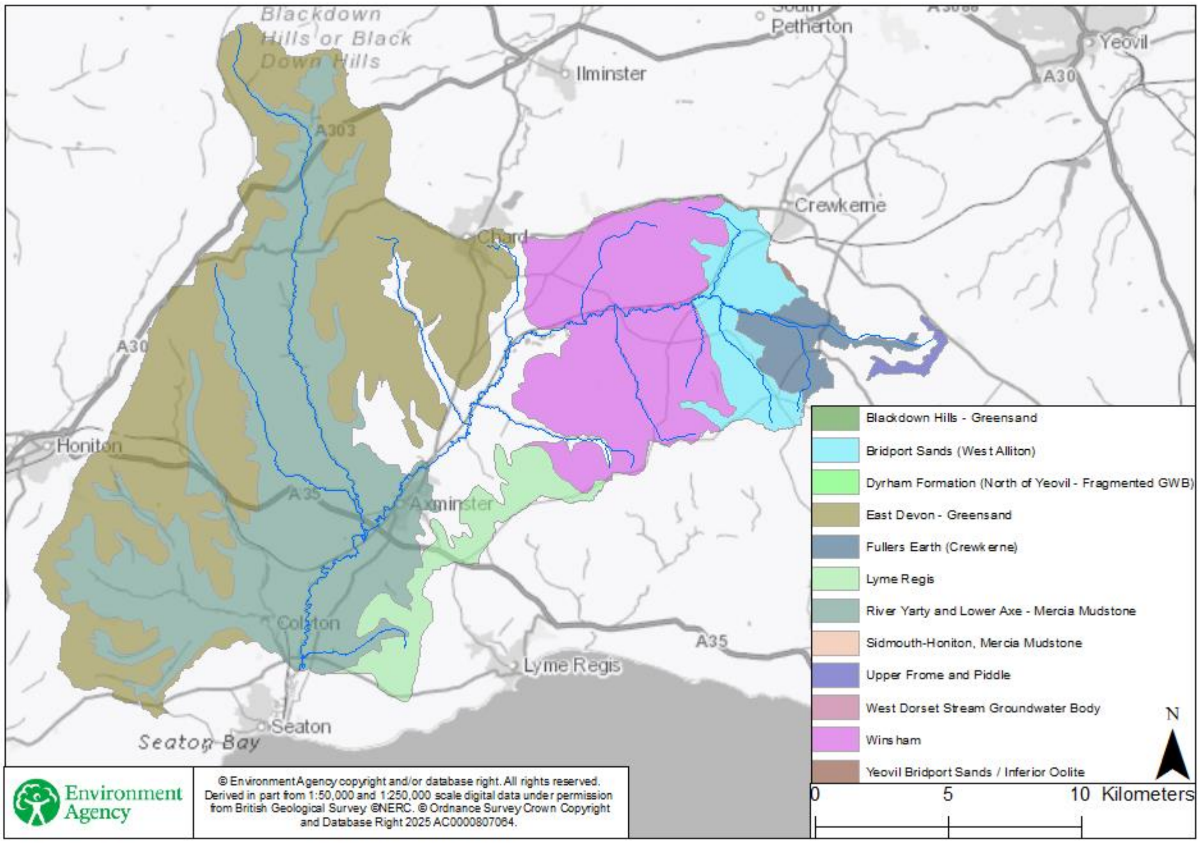


***Figure 2** Groundwater bodies in the River Axe catchment*

Geology

<u>Solid geology</u>: Much of the catchment is underlain by Triassic mudstone, siltstone, sandstone and limestone.

Upper portions of the catchment are dominated by the Jurassic Blue Lias formation which is overlain by Cretaceous Upper Greensand and some chalk on isolated hill summits in the east of the Axe catchment. Western portions of the catchment are underlain by Triassic Mercia Mudstone and the lower catchment is characterised by a well-developed active floodplain system meandering through deep sandy alluvium.

<u>Drift geology</u>: The underlying geology of the riverbed is alluvium with areas of valley gravel, clay, shale and marl. The water is base-rich with a high content of dissolved solids.

Appendix A shows the bedrock geology for the Axe catchment.

Soils and topography

Soils: The catchment draining into the River Axe SSSI and the tributaries are dominated by two broad soil landscapes which have a high inherent risk of runoff or erosion:

- clay rich heavy soils
- light textured soils

The map in Appendix C shows the broad soil characteristics that dominate the Axe catchment.

Alluvial soils are also relatively widespread throughout the catchment comprising stoneless clayey soils variably affected by groundwater. Steep slopes, geology and soil types in the Axe catchment combine to make large areas of land a high risk for runoff and erosion.

Land use

The River Axe SSSI runs along the western boundary of the town of Axminster, which has a population of 6,000. The largest urban area in the catchment is Chard with a population of 14,000. Foul drainage and much of the surface drainage from the Chard urban area drain north and not into the Axe catchment. Small villages, isolated dwellings and farmsteads are scattered around the catchment. Significant consented discharges are shown in Figure 3.

The main land use in the catchment draining to the SSSI is agriculture with some light industry around the urban areas of Chard and Axminster. The main farming sectors in the catchment are dairy, beef and sheep. This includes improved intensive grassland for grazing and forage, and some arable including winter and spring cereals and maize (Figure 4).

The intensity of farming in the catchment has increased in the last 30 years, with dairy herds becoming larger with increased feed and manure management pressures (Environment Agency, 2010). Land area for maize cultivation increased significantly between 2000 and 2010 (Figure 4) and maize is still widely grown in the catchment. The late harvest of maize has led to an increase in runoff and erosion from bare and compacted stubbles left over winter. Appendix B shows land cover maps for 2007 and 2021 (Marston et al., 2022; Morton et al., 2014), suggesting an increase in land area used for improved grassland in more recent years.

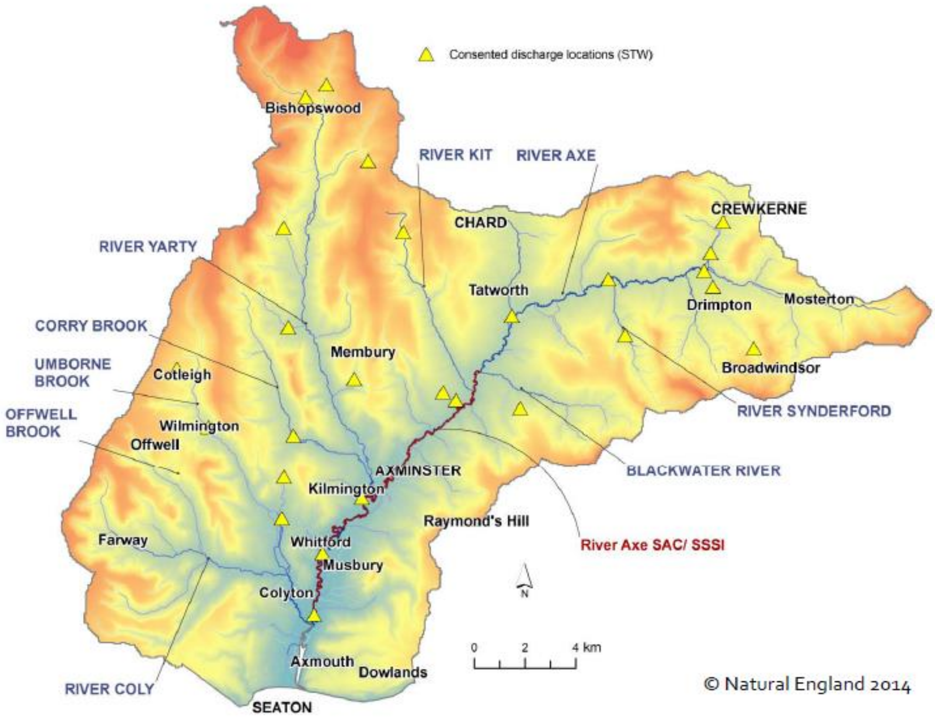


Figure 3 *Distribution of significant consented discharges in the Axe catchment. Source: Natural England (2015). Contains public sector information licensed under the Open Government Licence v3.0.*

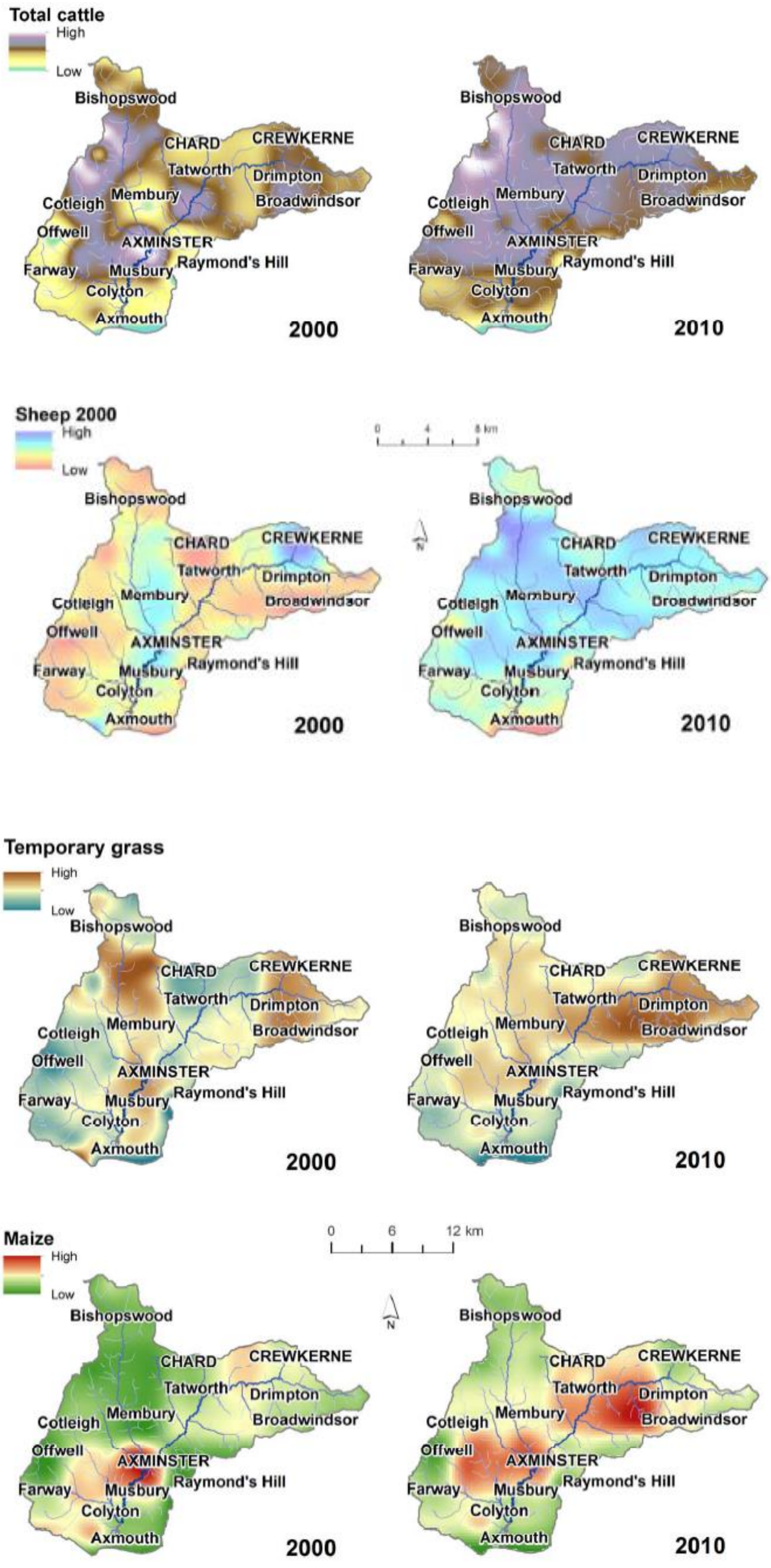


Figure 4 *Agricultural Census data from 2000 and 2010 showing changes in area of land being cultivated for maize or temporary grassland and for the numbers of cattle and sheep Source: Natural England (2015). Contains public sector information licensed under the Open Government Licence v3.0.*

3. Water Quality

SSSI water quality compliance

<table>
<tr><th>Water quality pollutant</th><th>SSSI objective/target</th><th>Compliance</th><th>Evidence used to support assessment</th></tr>
<tr>
<td>Phosphorus</td>
<td>Common Standards Monitoring (CSM) long-term target = 0.05 mg/L soluble reactive phosphorus (SRP)*

Interim target for 2021 = 0.082 mg/L.
Site specific targets agreed between EA and NE, March 2014.

*EA ‘orthophosphate reactive as P’ data used in assessment</td>
<td>Condition Assessment: Fail
The table below shows the 2024 condition assessment data for orthophosphate reactive as P concentrations from six long-term monitoring points (Appendix D).

The 3-year mean orthophosphate concentrations recorded at each monitoring site exceed the interim and long-term targets. These sites form part of the wider WER monitored sites network in the Axe catchment. For context, the WER good status boundary for phosphate is 0.077 mg/L and 0.078 mg/L at Slymlakes and Bow Bridge respectively.

Table 4 Orthophosphate reactive as P (OP) concentrations at monitoring locations used in the SSSI condition assessment 2024
<table>
<tr><th>Monitoring site</th><th>SSSI Unit</th><th>OP 3 yr mean (mg/L)</th><th>OP 3 yr growing season mean (mg/L)</th></tr>
<tr><td>River Axe at Broom</td><td>Unit 1</td><td>0.11</td><td>0.11</td></tr>
<tr><td>River Axe at Bow Bridge</td><td>Unit 2</td><td>0.09</td><td>0.08</td></tr>
<tr><td>River Axe at Slymlakes</td><td>Unit 3</td><td>0.10</td><td>0.09</td></tr>
<tr><td>River Axe at Whitford Bridge</td><td>Unit 3</td><td>0.10</td><td>0.09</td></tr>
<tr><td>River Axe above Colyton STW</td><td>Unit 3</td><td>0.12</td><td>0.09</td></tr>
<tr><td>River Axe at Axe Bridge</td><td>Unit 3</td><td>0.14</td><td>0.14</td></tr>
</table>
</td>
<td>Environment Agency. Water Information Management System (WIMS) data extract 2023

Natural England (2024). Condition Assessment of River Axe SSSI/SAC-An assessment of river & stream features.</td>
</tr>
</table>

Water quality pollutant	SSSI objective/target	Compliance	Evidence used to support assessment
		Long term data (2005 to 2013) highlight historical pressure from SRP (Natural England, 2015).	
Suspended Solids	**Rivers – Types II, IV, V and rivers with *Ranunculion fluitantis*** Targets should be set locally according to river type, catchment characteristics and an analysis of available data. The highest value that may be appropriate is 25 mg/L (annual mean), based on the (now revoked) EC Freshwater Fish Directive. Considering prevailing concentrations in most SSSI rivers, a more precautionary target of no more than 10 mg/L is likely to be suitable for most river reaches	Historical data analyses (Entec, 2003) indicated that suspended sediment concentrations in the Axe catchment could be highly elevated, with concentrations easily exceeding 100 mg/L along the length of the main river and in some tributaries. Data from Whitford Bridge in 2002 showed a mean suspended solids concentration of around 58 mg/L. Suspended solids are not part of the WER classification system and are not, therefore, monitored on a routine basis, but some datasets exist in the sample archive, and a few continue on an ad hoc basis for local needs. Recent available data (2021-2023) from Whitford Bridge show a mean suspended solids concentration of 18 mg/L, and a range <3 mg/L to 120 mg/L. The Natural England (2015) pollution risk assessment report provides a summary of EA data for the rivers Corry and Coly from Jan 2005 to June 2012. 91% of samples met the guideline standard of 25 mg/L and 86% of samples met the 10 mg/L standard. Recent available data for sites within the SSSI (2021-2023) show 67% of samples achieve the 10mg/L standard and 86% the 25 mg/L standard. Environment Agency (2022) assessment of Proportion of Sediment-sensitive Invertebrates (PSI) indicates moderate impact at monitoring locations within the SSSI.	Entec (2003) The Site Characterisation of Habitats Directive designated rivers in Southwest England. Natural England (2015) Pollution risk assessment and source apportionment: River Axe. Environment Agency (2022) Sediment impacts in the River Axe catchment.

Water quality pollutant	SSSI objective/target	Compliance	Evidence used to support assessment
Siltation	**<u>Bullhead, lamprey, river types II, IV, V, rivers with *Ranunculion fluitantis*</u>** No excessive siltation of substrate. Channels should contain characteristic ranges of substrate types for unmodified rivers. The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the spawning, juvenile and dispersal requirements of the species. The close proximity of different habitats facilitates movement to new preferred habitats with age. Operations that widen, deepen and /or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within the SSSI, whilst restoration may be needed in some reaches. Points to consider also include: Extent of unsilted coarse (gravel / pebble / cobble) dominated substrate; the males guard sticky eggs on the underside of pebbles/cobbles. Elevated levels of fines can interfere with egg and fry survival. Sources of fines include runoff from arable land, land (especially banks) trampled/poached by livestock, and sewage and industrial discharges.	**Condition Assessment: Pass** The most recent River Habitat Survey (RHS) did not identify unnaturally high levels of siltation but there is low confidence in the use of the RHS for identifying siltation impacts. There are known siltation issues on the River Axe. Livestock poaching and field ditches provide significant volumes of fine sediment to the river. Tipping of sediment on the channel banks also contributes sediment to the SSSI section of the Axe. Diffuse sediment supply is largely via soil erosion and overland flow, though fluvial bank erosion and geotechnical failure is also widespread in the Axe catchment. Sediment supplied is predominantly fine, particularly in areas where the land is tilled. Coarse sediment sources are significant along the lower Blackwater River, lower Yarty and locally along the River Axe. The occurrence of bank erosion is facilitated, particularly in the lower catchment, by the absence or degradation of natural riparian vegetation. This is a result of a combination of farming practices, spread of invasive species and the fall of diseased alders. Fine channel deposits are concentrated along the River Axe and are of low extent in the tributaries. This suggests that fine sediment supplied to the tributaries is transferred to the River Axe. A more thorough survey of substrate siltation is required. A specialist survey is required for medicinal leech.	Eyquem (2007) Axe Catchment Geomorphological Report ADAS (2009) Quantification of recent fine sediment sources in the River Axe ECSFDI priority catchment using a revised numerical mixing model framework. Natural England (2015) Pollution risk assessment and source apportionment: River Axe Natural England (2024). Condition Assessment of River Axe SSSI/SAC-An assessment of river & stream features.

Water quality pollutant	SSSI objective/target	Compliance	Evidence used to support assessment
	Some life-cycle stages are susceptible to damage from siltation, the source of which may lie outside the site boundary. Where there is a perceived risk of damage occurring, or where the species is believed to be in decline, a fluvial audit of the catchment is recommended. In the case of the Axe, sediment fingerprinting was carried out in 2009. **Medicinal leech** Stretches with some (suggested 11-25%) mainly organic and inorganic soft sediments (mud/silt) with little gravel and stone. Medicinal leech requires a substrate mostly with a large amount of organic sediment, moderate amount of inorganic sediment and little or no stony sediments or bedrock. This may occur in distinct stretches e.g., behind impoundments, silt banks on margins in glides and river cut-offs. In standing waters, the species requires a fairly shallow depth of water (average depth of <1 m; max depth unlikely to exceed 2 m) with shallow gently sloping margins that enables the water to be as warm as possible for as much of the year as possible and to be at least 20ºC for parts of the year.		

Water quality pollutant	SSSI objective/target	Compliance	Evidence used to support assessment
Total Ammonia **Unionised ammonia**	**CSM target:** 0.15 mg/L (90 %ile) CSM target 0.025mg/L (95%ile)	**Condition assessment: Pass** WER boundaries for context: High 0.3mg/L. Good 0.6 mg/L Moderate 1.1 mg/L **Condition assessment: Pass**	Environment Agency. Water Information Management System (WIMS) data extract. Natural England (2024). Condition Assessment of River Axe SSSI/SAC-An assessment of river & stream features.
Dissolved oxygen (DO)	**CSM target:** 85% saturation (10%ile)	**Condition assessment:** Units 1 & 2 **Pass**; **Unit 3 Fail** Unit 3 represents the lower reach of the SSSI extending from Whitford to the lowermost limit. DO values above Colyton STW 83% saturation; Axe Bridge 82% saturation. See Appendix D for sample locations.	Environment Agency. Water Information Management System (WIMS) data extract. Natural England (2024). Condition Assessment of River Axe SSSI/SAC-An assessment of river & stream features.
Biochemical oxygen demand (BOD)	**CSM target:** 1.5 mg/L	BOD is no longer routinely monitored by the EA.	

Summary of additional ecological evidence of impact (Natural England, 2024)

The SSSI target for diatom assemblages is high status as classified using WER methodology, and this was not achieved in any of the SSSI units. Macrophyte assemblages were also shown to be significantly impoverished across the SSSI.

Water Environment Regulations (WER) compliance

Failure to achieve good ecological status (Table 2) in the River Axe catchment is linked to macrophytes and phytobenthos, and phosphate (Table 5). For reference, WER site-specific boundaries for orthophosphate reactive as P are provided in the SSSI water quality compliance section above. Details of the classification including reasons for not achieving good (RNAG) status can be found in Catchment Data Explorer.

***Table 5** Summary Water Environment Regulations (WER) status (2022) for biological and physico-chemical parameters in the Lower River Axe waterbody. These parameters contribute to the ecological status shown in Table 2. BLUE=High; YELLOW=Moderate.*

Parameter
Macrophytes & Phytobenthos combined
Invertebrates
Acid Neutralising Capacity (ANC)
Ammonia
Dissolved oxygen
Phosphate
Temperature
pH

4. Sources of pollution leading to water quality failure

Sources of Sediment

Most of the sediment is derived from diffuse agricultural sources, roads and natural river erosion. The background geology, topography and soil types mean large areas of the catchment are vulnerable to runoff and erosion, which can be exacerbated by intensive agriculture. Suspended solid loadings are thus likely to be higher than in many other SAC rivers (Entec UK Limited, 2003).

Several surveys and monitoring programmes have been carried out in the Axe catchment and have identified sediment runoff, suspended solids and siltation as a major problem. Sediment has several impacts including siltation of important salmon and trout spawning gravels, nutrient enrichment (particularly from sediment associated phosphorus and organic matter) and restricted light penetration, which reduces the availability of high-quality habitat for aquatic flora (Collins et al., 2013). The surveys identified the different land uses contributing sediment to the River Axe SSSI and tributaries. These surveys and anecdotal evidence list the following as the main sources of sediment in the Axe catchment:

- Runoff from grassland (pasture and silage ground) due to compaction caused by livestock and machinery in wet conditions.
- Roads: damaged road verges are a source of sediment in the catchment, but road networks are also an important pathway for sediment to watercourses. Runoff from compacted grassland and arable fields also increases the mobilisation of the soil from the damaged verges.
- Riverbanks and ditches: A lack of marginal vegetation combined with grazing and poaching of the riparian zone is problematic in the catchment. A large proportion of sediment is derived from natural river processes, but intensive land use practices and degraded bankside vegetation increase susceptibility to fluvial erosion.
- Arable runoff, particularly form late winter cereals and maize production, has been identified as problematic in the catchment. Cranfield University surveys (Palmer, 2007) identified that underlying issues were crop type and timing of farming operations (e.g., sowing, manure spreading, fertiliser application, harvesting) rather than specific soil types, with problems similar across the catchment. This was particularly relevant to compaction caused by late harvest of maize in the autumn, linked with poor crop cover post-harvest. The same applied to late establishment of cereals on steeper ground that created significant runoff and erosion.

The River Axe sediment source apportionment work carried out by ADAS (Collins et al., 2009; 2013) used sediment fingerprinting to investigate the relative importance of different sources of fine sediment in the River Axe catchment, from the source of the Axe to Axe Bridge in the south. The relative contributions of sediment from four different source types and input from different tributaries were monitored by sampling over bank deposits. Figure 5 and Table 6 show the percentage contribution of sediment from each subcatchment and source type to the lower reaches of the Axe (within the SSSI). These data have been mapped by Natural England (2015) (Appendix E).

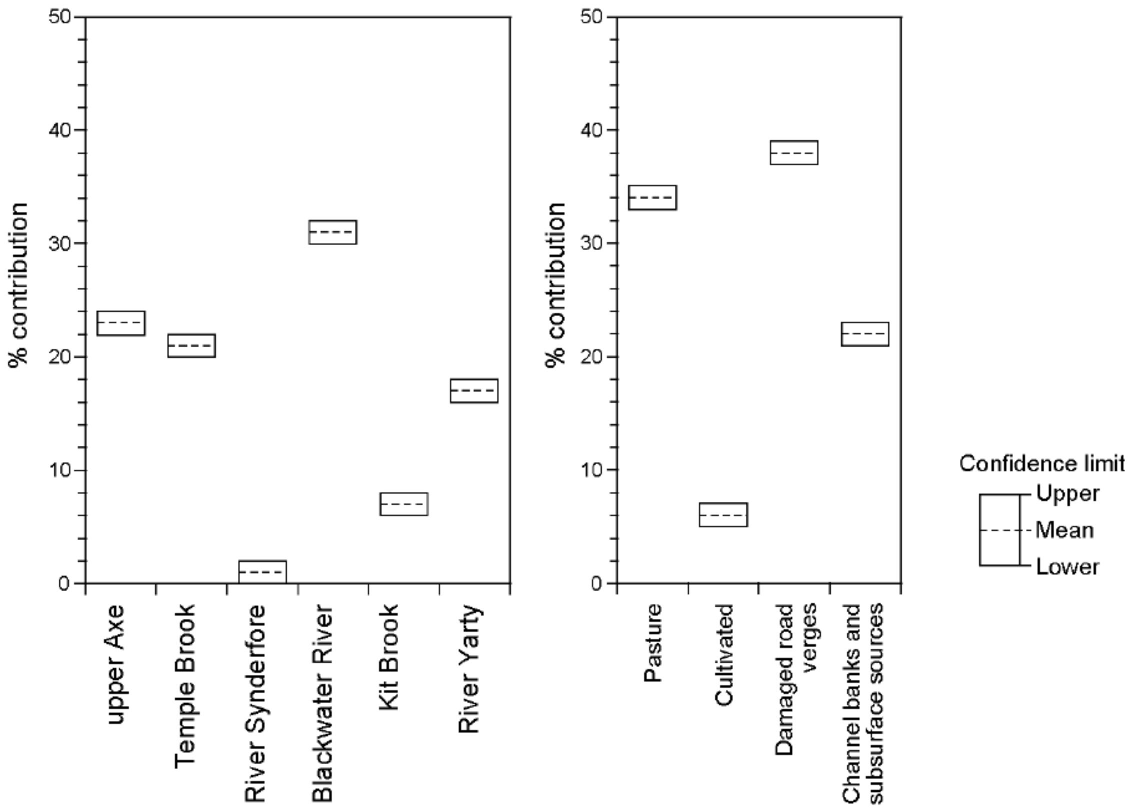


***Figure 5** Mean relative contribution of sediment from each subcatchment source and the spatially weighted contribution from sediment source type for the River Axe at Whitford Bridge. Source: Collins et al. (2009)*

This shows that the upper Axe, Temple Brook, Blackwater River and River Yarty are the most significant subcatchments in terms of input of sediment to the River Axe SSSI at Whitford Bridge. PSYCHIC modelling (see Davison et al., 2008) also identified the upper Axe, including Temple Brook, and the Blackwater as high risk for sediment loss. The PSYCHIC map (Appendix F) is an estimate of the agricultural sediment load that could be delivered to the river per year (kg/km^2/year) via surface or field drain pathways. This does not consider other sources of sediment such as riverbank erosion. SCIMAP outputs for the catchment also show the upper Axe, Blackwater River and River Yarty as high risk areas for fine sediment mobilisation and transport (Natural England, 2015) (Appendix G).

***Table 6** Mean relative contributions from different sediment source types to the floodplain of each subcatchment. Source: Collins et al. (2009)*

Tributary/ subcatchment	**Source Types**			
	Pasture topsoil	**Cultivated topsoil**	**Damaged road verges**	**Channel banks**
Upper Axe	**68±1%**	0±0%	21±1%	11±1%
Temple Brook	**39±1%**	2±1%	24±1%	**35±1%**
River Synderford	**60±1%**	1±1%	9±1%	30±1%
Blackwater	10±1%	16±1%	**69±1%**	5±1%
Kit Brook	20±1%	4±1%	39±1%	37±1%
River Yarty	28±1%	3±1%	26±1%	**43±0%**

The results in Table 6 show important differences in the relative contributions from each source type between subcatchments and suggest that the emphasis on sediment mitigation strategies will need to vary between subcatchments. For example, based on these results, mitigation planning and advice in the upper Axe, Temple Brook and River Synderford should focus on reducing erosion of pasture topsoils, whereas sediment reduction strategies in the Blackwater and Kit Brook should include some focus on protecting damaged road verges where practicable, alongside agricultural land use strategies. It should be noted that changes in land use since the time of study could mean that these results are no longer representative of the catchment. Nevertheless, in the absence of recent sediment source tracing, and given the increase in land area used for improved grassland (Appendix B), these results serve as a useful guide alongside contemporary risk mapping and monitoring.

Source types are explored in more detail below:

Cultivated land

Surprisingly, cultivated land was not shown by Collins et al. (2009) to be a significant source of fine sediment in any of the subcatchments, thereby suggesting that maize fields are not an important source of fine sediment on a catchment scale. However, maize is observed and increasingly recognised as a key source of localised sediment. In a wet autumn, soil compaction during harvest is a significant problem leading to runoff during the winter and early spring before cultivation is possible. Remediation of compacted soils on both pasture and cultivated ground is a major challenge during wet periods.

This is supported by the findings of the Environment Agency's Axe Rural Sediment Tracing Project (walk over survey) carried out by APEM in 2010 (Environment Agency, 2010). This work identified significant contributions of high and moderate priority sources of sediment from livestock farming and cultivated land as well as roads and public rights of way (Appendix H).

Although studies reach different conclusions about the dominant sources of sediment, they provide a good summary of the issues in the catchment and support the knowledge base of land management advisors. There is no doubt that the central objective of reducing sediment input to the river is to maximise rainfall infiltration by good soil husbandry and minimise overland flow, either direct from fields to the river or via roads and tracks.

Pasture topsoils

A significant proportion of the sediment input into the Axe SSSI is derived from pasture topsoils. This is most likely because of more intensive grassland management, particularly in relation to silage and slurry management in wet conditions leading to soil compaction and surface runoff.

The Cranfield University report (Palmer., 2007) highlighted that soil structural degradation is widespread in the Axe catchment with over 80% of sites inspected in 2004 and 2007 showing some form of structural degradation. The results also showed that, locally, soil structure under permanent grass is degrading, with the Blackwater and Temple Brook subcatchments demonstrating a decline in soil structure quality between 2004 and 2007. Increased compaction on grassland is leading to a reduction in water infiltration and an increase in runoff, which will enhance soil loss from grassland but will also have an impact on increasing the mobilisation of sediment from damaged road verges.

Damaged road verges

Damaged road verges were a significant source of sediment in the Blackwater and Kit Brook subcatchments (Table 6). Sediment mobilised from damaged verges is enriched in organics relative to the other source types, underlining the significance of such sediment for impacts on freshwater ecology (Collins et al., 2009). As mentioned above, the Axe Rural Sediment

Tracing Project (Environment Agency, 2010) also identified numerous roads as pathways for runoff from agricultural sites, which can exacerbate transport of road verge sediment.

Channel banks and subsurface sources

The ADAS sediment apportionment study (Collins et al., 2009) focussed on a range of sediment sources including riverbanks, ditches, gullies, and incised tracks. Other studies (Entec 2003; Eyquem, 2007) have focussed more exclusively on sediment derived from riverbanks, ditches, and tracks.

Downstream of Axminster, active bank erosion occurs as the river meanders across a widening floodplain. This coincides with a decrease in the extent of tree lining and riparian vegetation. The Axe channel through the SSSI, and the lower River Yarty channel are adjusting laterally through meander growth and cut off reflecting the low gradient and unconfined nature of the channels. Bank erosion is exacerbated by poaching of banks by livestock and the lack of riparian vegetation (Environment Agency, 2019a). Channel stability is further compromised by ad-hoc intervention by riparian owners.

Livestock poaching of riverbanks and field ditches can provide significant volumes of fine sediment to the river (Figure 6). The occurrence of bank erosion is facilitated, particularly in the lower reaches of the Axe and Yarty, by the absence or degradation of natural riparian vegetation. This is a result of a combination of farming practices, spread of invasive species (e.g. Himalayan Balsam) and the fall of diseased alders.

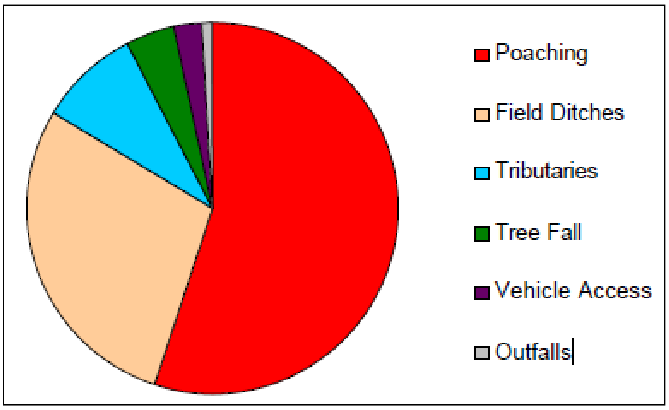


***Figure 6** Contributions of fine sediment to the river Axe. Source: (Eyquem, 2007).*

Eyquem (2007) stated that it is not desirable to limit natural fluvial erosion throughout the Axe catchment to reduce fine sediment input. However, fine sediment input and bank erosion within the Axe catchment is exacerbated by agricultural practices, both locally along the river and across the catchment. Efforts to implement best farming practices, through CSF and Countryside Stewardship schemes, should help to control fine sediment input from agricultural sources, as well as bringing other benefits to farmers.

Sources of Phosphorus

The updated SAGIS-SIMCAT model outputs apportion **86% of soluble reactive phosphorus to diffuse sources**, with rural land management being the dominant source. The remaining **14% is attributed to point source inputs**, mainly from water company assets (Figure 7). SAGIS-SIMCAT modelling results are detailed in the **Options Appraisal (Appendix I)**.

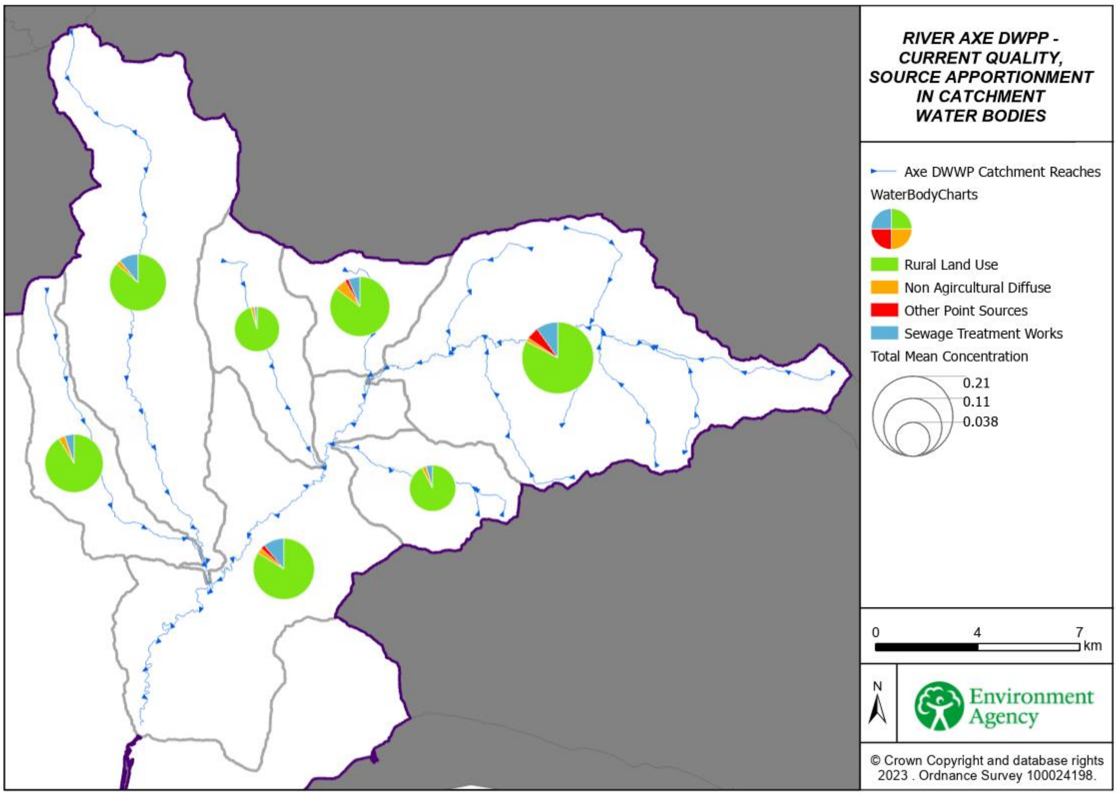


Figure 7 *Phosphorus source apportionment in River Axe catchment waterbodies*

Point sources

There are around 130 active consented discharges within the Axe catchment draining to the SSSI. The most significant point source discharges affecting the River Axe SSSI are the treatment works at Kilmington, Musbury, Whitford, and Tatworth. Colyton sewage treatment works discharges at the downstream limit of the site. Previous SIMCAT modelling and findings of the review of consents in 2007, concluded that remedial works should be carried out at Kilmington WwTW and the Dairy Crest creamery (now closed) to limit discharges to 1 mg/L. This achieved point source compliance to a proportionate (fair share) reduction, but the phosphate WER and CSM targets are still breached.

The present-day contribution from public sewage treatment works in the catchment was the subject of an AMP 7 investigation (SWW, 2022). This investigation considered the justification and feasibility of further phosphorus reductions at sewage treatment works in the catchment. Source apportionment modelling in the SWW report agrees with the recent EA modelling detailed in the Options Appraisal. Even with treatment at Colyton STW, Kilmington WwTW and Tatworth WwTW at the technically achievable limit (TAL) (required by the phosphorus sensitive catchment area designation under the Water Industry Act 1991), the CSM target would not be achieved owing to diffuse inputs.

Diffuse sources

Phosphorus losses from agriculture are dominated by the dairy sector (Figure 8), largely associated with soils and slurry from grassland (Figure 9), representing particulate (sediment-bound) and dissolved forms respectively.

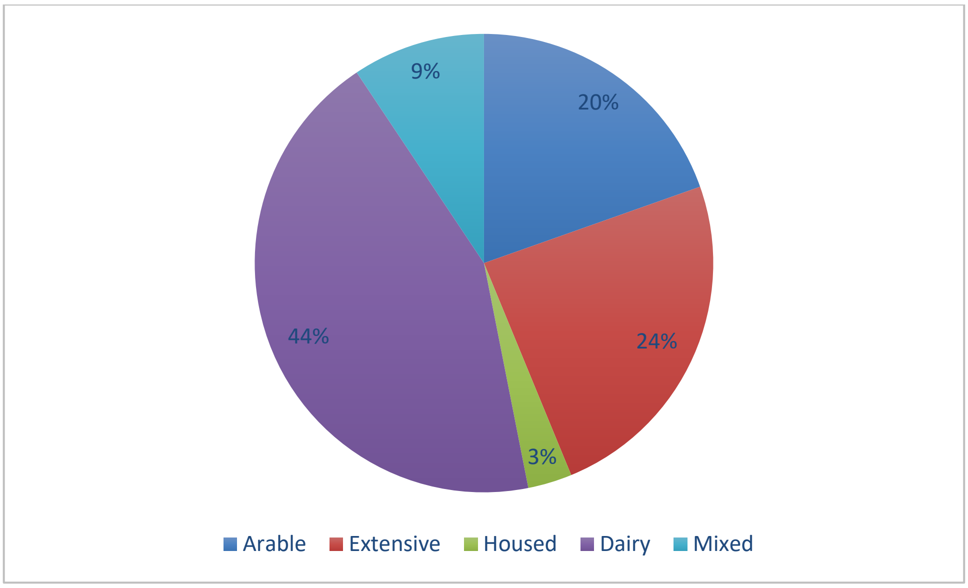
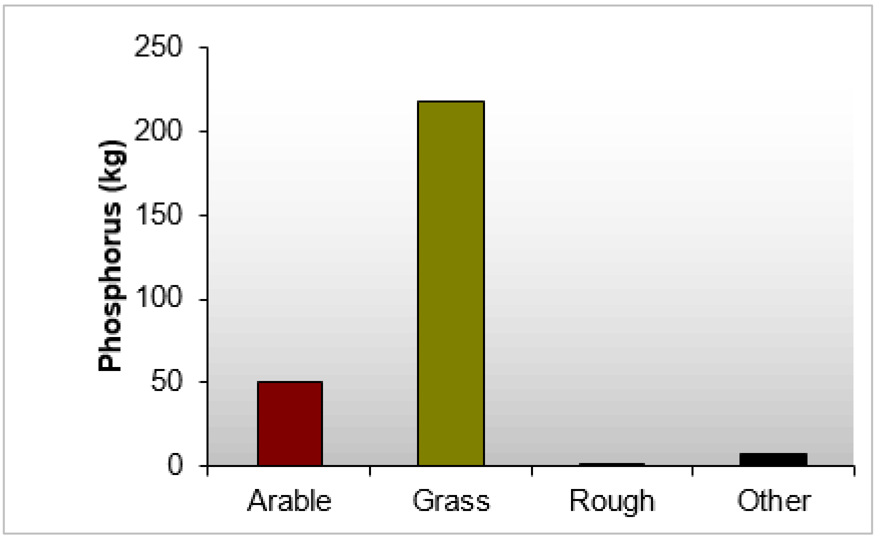


Figure 8 *Farmscoper source apportionment of phosphorus by farm type*



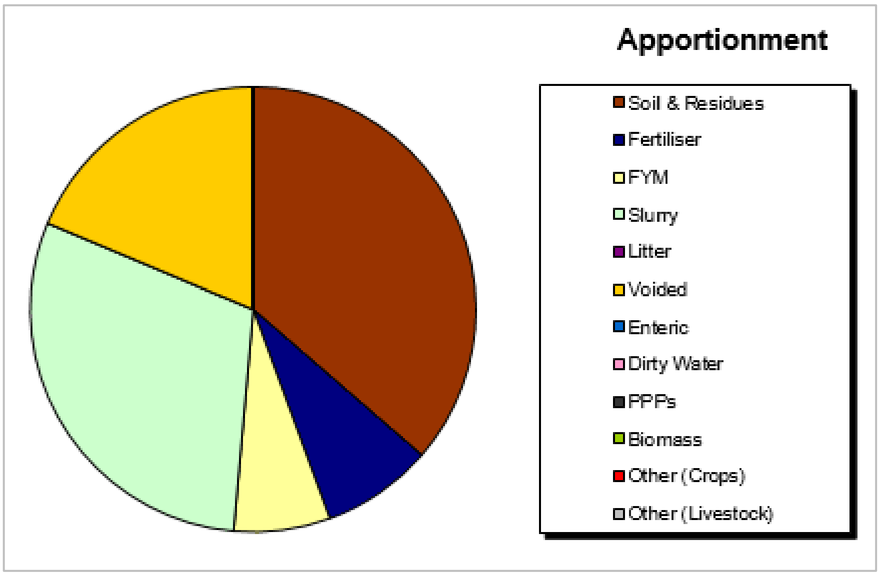


Figure 9 *Farmscoper outputs showing key sources of phosphorus from dairy holdings*

Gaps in our understanding of the sources

Small consented discharges and septic tanks

The likelihood that these sources contribute a significant contribution to the load in the SSSI is low. Targeted investigation of these sources is not considered worthwhile unless pollution is reported or other investigations reveal problems.

Natural England reviewed the distribution and density of small septic tank discharges in the Axe catchment as part of a study to assess the risk presented by these installations. It is estimated that small sewage discharges account for around 2% of diffuse phosphorus sources in the Axe catchment (May et al., 2016). This is supported by the most recent SAGIS-SIMCAT modelling (EA OCS, 2024), which showed minor contributions from non-agricultural diffuse sources (Figure 7).

Natural background concentration of phosphorus along the river system, especially from Upper Greensand.

An Environment Agency desk review of phosphorus concentrations at monitored boreholes in the catchment identified only negligible input of phosphorus to the river load. This is to be expected. Some local hotspots may occur, but these are not considered to be significant and no additional monitoring of groundwater is considered necessary.

Continuous monitoring on a small substantially agricultural tributary to better show the impact of land use practices on phosphorus concentrations and the effectiveness of mitigation measures.

Additional officer presence in the catchment from 2017 to 2019 was considered more effective than establishing and maintaining continuous monitoring for phosphorus. Visual assessment of land cover and regular visits by knowledgeable staff can be very effective at identifying risk and allowing pre-emptive visits to be done to avoid problems arising in the future. Continuous monitoring of supporting parameters (e.g., ammonium and turbidity) has been implemented on the River Yarty and two locations on the River Axe.

Phosphorus input pressures

It is widely accepted that P release from legacy P stores in catchment soils and sediment can influence water quality and create a time lag between measures implementation and downstream response. There is also growing evidence of a link between surplus P on agricultural land (i.e., the difference between the P added to soils and that removed by crops) and river P concentrations. Recent approaches applied elsewhere in the UK combine a substance flow analysis (SFA) (i.e., modelling phosphorus inputs, uptake, and outputs across the catchment system) with assessment of river P dynamics to estimate the key input pressures which influence river P concentrations (e.g., Withers et al., 2024). This approach can provide information, which is complementary to the existing modelling outputs by quantifying the reduction needed to improve agricultural efficiency and achieve P targets in receiving waters.

Catchment risk assessment research (e.g., Natural England, 2015)

This should be revisited using the most recent data and modelling approaches to provide a new and improved catchment risk assessment for phosphorus delivery.

5. Diffuse Pollution actions needed to achieve favourable condition

Evidence used to support the selection of management actions: Summary of the options appraisal approach

The options appraisal document (Appendix I) provides the main body of evidence to underpin the selection of future management actions.

The effect of mitigation measures on river phosphorus concentrations was modelled by Environment Agency Operations Catchment Services using SAGIS-SIMCAT. Point sector improvements were captured using details derived from the asset management plan (AMP) process. For diffuse inputs from agriculture, the Environment Agency Agriculture Risk and Evaluation team carried out an assessment of pollutant load reductions for the River Axe catchment using Farmscoper (v.5) (Gooday et al., 2015). Farmscoper modelled the reductions in phosphorus loads from agricultural land in response to mitigation measures, which were then incorporated into SAGIS-SIMCAT as percentage reductions from livestock and arable land uses. Mitigation scenarios were set according to the uptake rate of regulatory and non-regulatory measures. The modelling estimated the effect of mitigation measures on overall SSSI targets, as well as the fair share targets for diffuse and point sectors set under the revised polluter pays principle.

Under a theoretical maximum scenario (100% uptake of *all* relevant land management measures), SSSI units were not predicted to achieve phosphorus targets. Identifying measures for reducing diffuse inputs to the SSSI, therefore, requires a thorough review of the evidence base to develop effective strategies under an adaptive approach to management. The options appraisal set out actions relating to key evidence gaps, which are captured in the table below. The actions table forms the basis of work packages, which are prioritised and developed by the steering group to inform management decisions within the adaptive framework.

For transparency, the actions table below provides a full outline of past and present management actions in the catchment alongside planned future actions arising from the options appraisal process. Issues affecting implementation and effectiveness are also listed as learning points to guide the adaptive management process.

River Axe SSSI actions table

Actions identified in the Options Appraisal: Actions identified as important for underpinning selection of effective strategies within an adaptive management approach. Refer to Appendix I for full details

Delivery Actions: Represent existing delivery activities using current approaches

Evidence Actions: Investigative actions either planned or currently underway in the catchment

Completed Actions: Historic activities used to inform current delivery

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
	Actions Identified in the Options Appraisal						
1	Implement regular (at least quarterly) DWPP steering group meetings.	DWPP steering group.	Catchment-wide.	EA Integrated Environment Planning (IEP).	Ongoing (quarterly).	Underway to plan.	
2	Investigate refinements to Farmscoper modelling for the Axe catchment using catchment specific data and updated measures suite.	Area team delivery Guidance from Environment Agency Agriculture, Risk and Evaluation team.	Catchment-wide focus. Could consider smaller spatial scales in relation to Landscape Recovery.	EA IEP.	Ongoing.	No further Farmscoper modelling undertaken. The National Once output for the Axe catchment remains the best estimate to date.	Dependent upon data availability.
3	Review the current monitoring programme in the catchment and identify needs.	EA Monitoring Commission.	Catchment-wide.	EA IEP; Analysis & Reporting (A&R).	Ongoing.	Thorough review undertaken for the 2025-26 monitoring commission. The needs assessment underpinned requests for continued and new monitoring, which includes water quality sampling in the upper SSSI to address the current data gap.	Dependent upon available resource within the monitoring commission programme.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
4	Comparing the most recent AgCensus data to that used in previous catchment risk assessment. Assess the need for an updated risk assessment.	Area team delivery with external support.	Catchment-wide.	EA IEP.	May 2025.	Identified need for updated P delivery risk assessment owing to land use change & availability of new data/approaches. Phosphorus pollution impact potential modelling/mapping for the SSSI catchment is underway. This utilises the latest data and risk assessment approaches.	Access to soil P data is somewhat limited across the catchment. Where possible, and in line with relevant regulations, work towards improved data sharing within catchment partnerships to ensure data from future sampling and analysis can be utilised in risk models.
5	Investigate legacy P in the catchment. Develop an understanding of the extent of P surplus in catchment soils and implications for nutrient management and P delivery to watercourses.	Potentially (in part) through the Upper Axe Landscape Recovery Project (LRP). External support will be required for a catchment-wide investigation.	Catchment-wide.	EA & NE area teams: Land & Water; IEP; Catchment Sensitive Farming (CSF)), with external support.	Ongoing.	Upper Axe LRP has a focus on drawing down P surplus. Farming & Wildlife Advisory Group (FWAG) has developed a farm and soil P balance approach. LRP development phase ends in May 2025. Developing a substance flow analysis approach investigating relationships between water quality and P input pressures for the SSSI catchment will require external support.	Upper Axe LRP subject to review process prior to moving into implementation phase. Catchment-wide investigation will require suitable funding for external support.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
6	Review spatial targeting of measures and alignment with catchment risk assessment data.	Area team delivery (EA/NE).	Catchment-wide.	EA Land & Water; IEP; NE CSF.	Ongoing from May 2025.	To be undertaken when the updated P delivery risk assessment outputs are available (action 4).	
7	Review of measures implementation rates & barriers to uptake.	Area team delivery (EA/NE).	Catchment-wide.	EA Land & Water; IEP; NE CSF.	Ongoing.	Captured in part through the CSF audit process.	Measures implementation has been affected by uncertainty over grant availability in recent years owing to changes to funding schemes.
8	Review the effectiveness of specific measures in the context of the Axe catchment i.e., if measures implementation is widespread, what factors limit effectiveness for sediment & P transfer?	Area team delivery (EA/NE).	Catchment-wide.	EA Land & Water; IEP; NE CSF.	Ongoing.	To be undertaken alongside the review of spatial targeting of measures (action 6).	Dependent on internal capacity.
	Delivery Actions						
9	Work with the Environment Agency's Environment Management team to target priority farms that have not engaged with NE or the EA. Initial contact between the EA and farmers could involve a referral to CSF before taking any enforcement.	Regulation (FRfW; SSAFO; EPR).	Catchment-wide.	EA Land & Water.	Ongoing.	This action developed into a substantial and significant piece of work: 2016-2023 220 farms visited. Investigating FRfW and SSAFO compliance. £350k of EA officer time invested; 95 new slurry lagoons identified for construction.	See EA 2019b report. Ongoing visits dedicated to non-compliance. Key focus on slurry infrastructure.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
						£12-14 million of funding via grants (with CSF support) and farmer investment. Ongoing visits with personnel dedicated to the Axe catchment. Targeted investigations supported by continuous monitoring data. Trialling a new approach for reporting and targeting incidents across the catchment.	
10	Continue to implement CSF advice with grant incentives in the target areas and, in addition, encourage uptake of advice in high-risk areas.	CSF visits and events. CSF advice via one to one and one to many approaches. Key funding streams: Countryside Stewardship, Sustainable Farming Incentive (SFI), Slurry Infrastructure Grant (SIG).	Catchment-wide.	NE CSF Advisor (CSFA).	Ongoing.	Around 80 CSFA visits in 2021-22, with 120 planned for 2022-23. Continued significant investment across the catchment via Mid-Tier, SFI and standalone capital grants. Work has been targeted to support EA regulatory visits.	Staff capacity required to identify key priority areas and high priority farms. Can be supported by the new P delivery risk mapping tool (see action 4). Requires capacity to undertake proactive investigation. Issue of balancing proactive versus reactive visits. Measures implementation has been affected by uncertainty over grant availability in recent years owing to changes to funding schemes.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
11	Reduce sediment and nutrient inputs from agriculture by engaging with farms to develop Farm Transformation Plans.	Triple Axe Project partnership events (one to one; one to many).	Catchment-wide.	Triple Axe Partnership with CSF/EA Catchment Coordinator support.	Ongoing.	The project is developing a website to showcase related work packages and other communications. 14 farm resilience plans to date largely through one to one visits/advice, with an aim to reach an additional 50 via group events. 30 farms are engaging in a soil & slurry testing programme focusing on phosphate.	Progress dependent upon suitable funding (Water Environment Improvement Fund (WEIF); Farming in Protected Landscapes (FiPL).
12	River channel restoration programme.	Triple Axe Project Funding sought from WEIF & National Lottery Heritage Fund (NLHF).	River Yarty.	Triple Axe Partnership with EA Catchment Coordinator support.	2024-27.	Rivers Run Through Us project focuses on community engagement with river restoration. Successful bid for National Lottery funding to support a two-year development phase followed by five-year delivery phase. Key focus on water quality & biodiversity. WEIF funding for river restoration works on a 1.5km reach of the River Yarty. Floodplain reconnection measures including wetland/wet woodland.	

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
13	Work with the Natural England sustainability team to review the potential for overlap with catchment nutrient mitigation schemes.	Nutrient Neutrality.	River Axe SSSI catchment.	Natural England Nutrient Neutrality lead.	Ongoing.	NE will lead the review of nutrient mitigation proposals. Spatial planning could potentially be supported by the updated P delivery risk assessment (action 4). It is important to ensure that mitigation under nutrient neutrality does not compromise the restoration of the site to favourable condition.	East Devon District Council Nutrient Management Plan 2020. Designation as a phosphorus sensitive catchment area requiring water company assets to meet the technically achievable limit (TAL) for discharges by April 2030.
14	Develop a relationship with the County Council highway teams to prioritise action for road drainage improvements where excessive road runoff is impacting on watercourses. Also consider impacts of excess sediment on highway infrastructure e.g., Beckford Bridge Obtain regular updates on incidents of soil on roads to target advice to farms.	County Council funding.	Targeted work following review of evidence and walk-overs.	EA Land & Water; Sustainable Places; Partnership and Strategic Overview.	No target set.	Not started.	Possible issues with lack of funding for County Council highways. Considered low priority as focus is on preventing suspended sediment losses from agricultural land.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
	Evidence Actions						
15	Review impact of sediment on ecology along the River Axe system using existing Environment Agency (EA) invertebrate data and the River Habitat Survey (RHS), and from this identify any reference sections where the sediment regime is favourable as a basis for target condition in the SSSI/SAC. Also use to inform spatial targeting of mitigation where possible.	EA Monitoring Commission.	River Axe SSSI catchment.	EA A&R.	Ongoing.	This action was expanded to include additional invertebrate sampling and analysis against sediment sensitivity indices for up to 30 monitoring sites in the Axe catchment.	2024 internal report completed and being used to inform delivery.
16	Install continuous monitoring on an agricultural tributary to investigate the impact of land use practices on water quality parameters and assess the effectiveness of mitigation measures.	EA Monitoring Commission.	Strategic sites in the SSSI catchment.	EA A&R; Land & Water.	Ongoing from 2021.	Included in the 2025-26 monitoring commission.	Successfully used to detect risk areas for targeted mitigation.
17	Carry out a wet weather walkover in specific areas at highest risk of sediment loss from road verges to prioritise action for road drainage improvements.	WEIF.	Prioritise Blackwater River & Kit Brook.	Natural England lead, but the Highways Agency and EA should be involved.	Winter 2014/15 and completed by March 2015.	Not started.	The focus for investigation and action has been slurry management and soil issues.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
	Completed Actions						
	Carry out a risk assessment for septic tanks in the Axe catchment to identify septic tanks that are of highest risk of impact to the river.	Funding via NE.	Catchment-wide.	Natural England SSSI responsible officer	Start: 18 November 2013. Report due by 14 March 2014.	Project is complete and published on NE website.	National study to develop risk assessment methodology which included the River Axe. Some theoretical hotspots identified based on density of non-sewered addresses and simplified soil types. Overall impact of small-scale diffuse inputs on P loads is deemed to be low.
	Review existing sediment fingerprinting and catchment walkover reports to identify main roads and tracks acting as sources and pathways for sediment runoff to watercourses.	CSFA and SSSI Responsible Officer time.	Roads, tracks and verges catchment-wide particularly Blackwater, Yarty, Kit, Upper Axe and Temple Brook.	Natural England (NE).	March 2014.	Completed.	No further sediment fingerprinting work has been carried out since the review.
	Continue to keep up momentum for licence change at a dairy processing site to reduce phosphorus emissions as part of the Habitats Directive Review of Consents (RoC) in 2008.	Habitats Directive Review of Consents (RoC).	River Axe.	Environment Agency.	Early 2015.	Site closed. Consent surrendered.	

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
	Obtain up to date data on flow rates discharges from point sources.						
	Carry out a detailed nutrient and sediment risk assessment and review of source apportionment to appraise how far existing action in the catchment is likely to go towards achievement of SSSI/SAC water quality objectives. This study will also include an appraisal of additional catchment interventions, including diffuse and point source measures that could be deployed in the future to improve water quality with regard to feasibility and cost effectiveness. Outputs will include updates of SAGIS, SCIMAP and SIMCAT	IPENS (Improvement Programme for England's Natura 2000 Sites).	Catchment-wide (i.e. River Axe SSSI and tributaries upstream of the Axe SSSI).	Natural England. This will involve the local CSFA and SSSI Responsible Officer.	Start: December 2013. Report completed August 2014.	Issued Natural England (2015).	Report used to inform management approaches. Will be used to refine ongoing actions. Share the report with East Devon Catchment Partnership and landowners.
	An understanding of the likely natural background concentration of phosphorus along the river system, especially from Upper Greensand.	Evidence funding, WFD, SSSI.	Top of catchment. Upper Greensand area.	EA and NE.	March 2016.	Groundwater sample data has been reviewed informally. There is a negligible P contribution from groundwater.	The evidence available does not support the development of new sampling boreholes. Groundwater is monitored routinely for WFD classification purposes.

No.	Action Description	Delivery Route/Mechanism	Location	Delivery Lead	Target Date	Progress	Issues/ effectiveness/ learning points
	Continuation of the control of invasive species, especially Himalayan balsam on the Axe.	Rural Development Programme for England Sustainable Development Fund. Collaborative work with AONB or East Devon Catchment Partnership (CaBA).	Priority catchments identified by previous Axe invasives project.	Natural England SSSI Responsible Officer.	Building upon Axe Invasives Project (2012-2017). Roll out of new programme planned from 2022.	Completed.	Additional work from 2022 did not go ahead. Potential for continued focus on invasive species through the river restoration actions listed above (see action 12).

6. Actions required on non-diffuse sources

The phosphorus sensitive catchment area designation under the Water Industry Act 1991, requires Colyton STW, Kilmington WwTW and Tatworth WwTW to meet the technically achievable limit (TAL) for phosphorus treatment by 1st April 2030. The recent SAGIS-SIMCAT modelling reported here, showed that these improvements will achieve the sector share of the CSM phosphorus target for the SAC, but that the overall target would not be met without significant further reductions from the diffuse sector.

Note on Nutrient Neutrality

The River Axe catchment has been identified by Natural England as a nutrient neutrality catchment. This DWPP identifies the sector share of nutrient reductions required to support the recovery of the SSSI/SAC to favourable condition. It also identifies the measures required to secure or work towards the reductions identified. If any measure identified in the DWPP actions is used for other purposes, such as providing mitigation to allow housing development, then this measure would no longer be able to be included in the DWPP or be implemented for site recovery to favourable condition. Any nutrient mitigation measures for nutrient neutrality should not compromise the restoration of the site to favourable condition.

7. Sign Off

Natural England and the Environment Agency commit to work together to gather evidence and implement necessary remedial measures as guided by this plan, to maintain an improving trend in nutrients and sediment in the River Axe catchment, so that SSSI condition targets are achieved in the future.

Organisation	Signed	Date
Natural England	Wesley Smyth	21st March 2024
Environment Agency	Steve Marks-Acting Area Director 	19th March 2024

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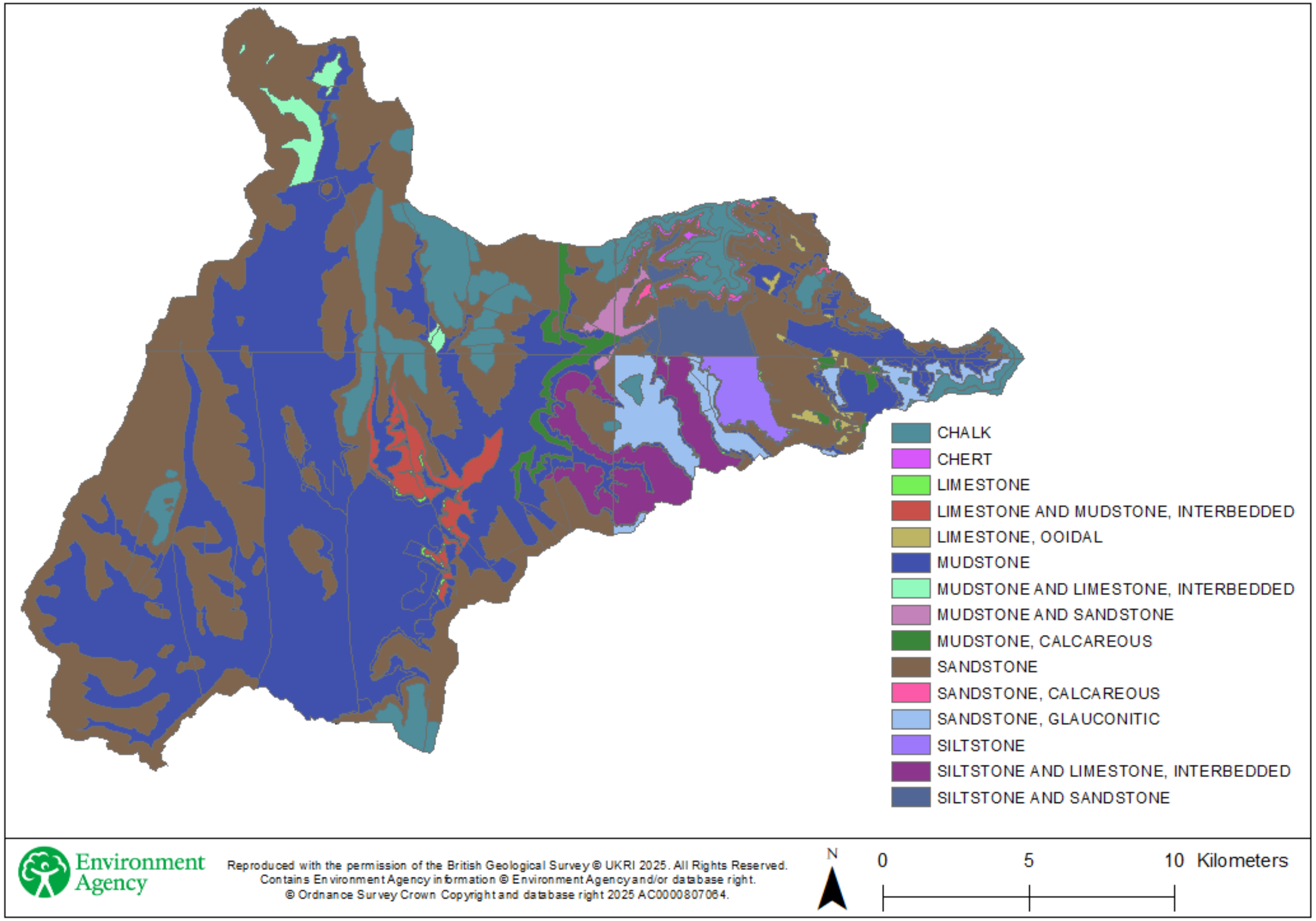
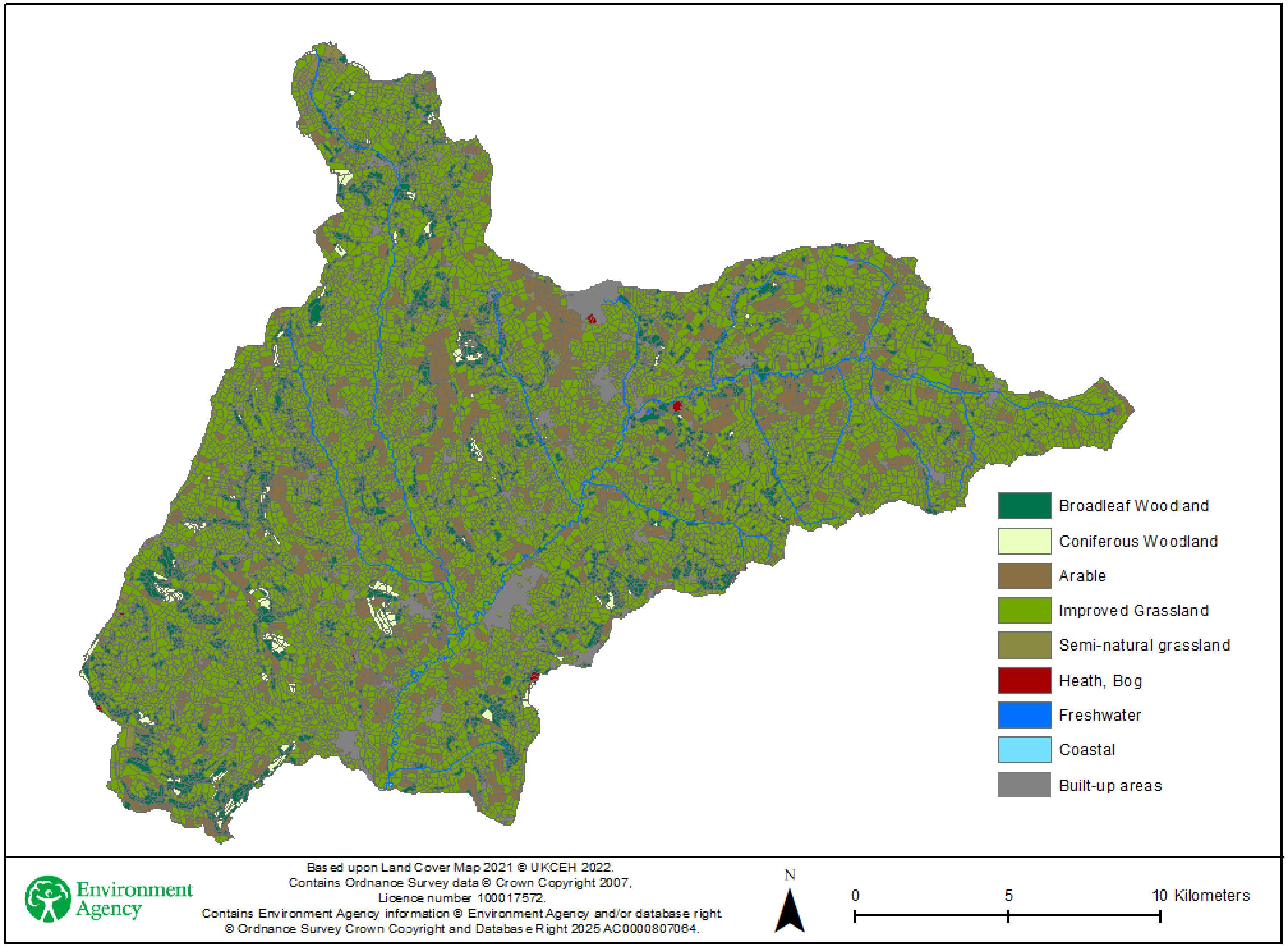
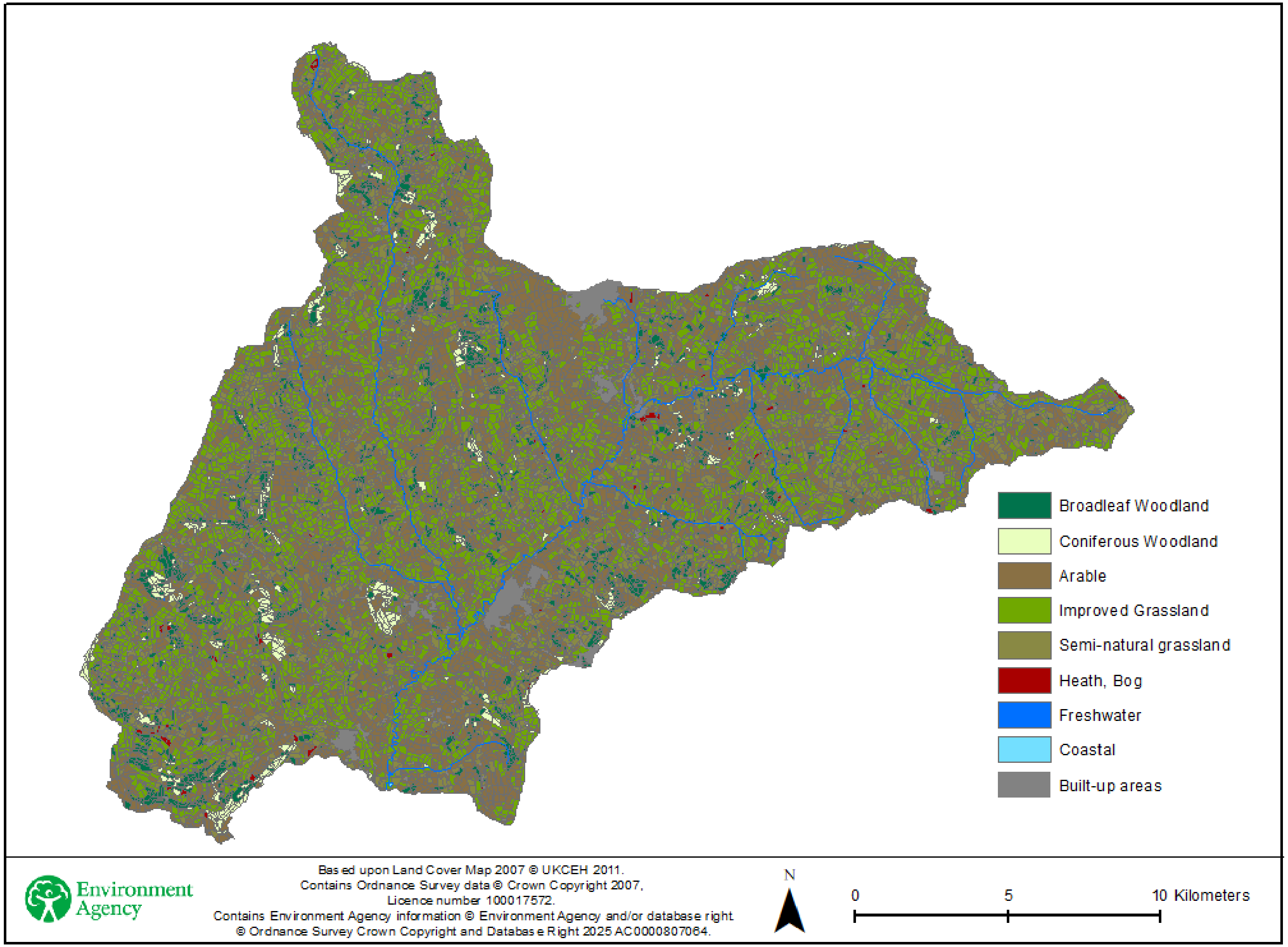
Appendices

Appendix A Bedrock lithology of the River Axe catchment



Appendix B River Axe catchment landcover 2021 (above) & 2007 (below)




Broadleaf Woodland
Coniferous Woodland
Arable
Improved Grassland
Semi-natural grassland
Heath, Bog
Freshwater
Coastal
Built-up areas
Environment Agency
Based upon Land Cover Map 2007 © UKCEH 2011.
Contains Ordnance Survey data © Crown Copyright 2007,
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Contains Environment Agency information © Environment Agency and/or database right
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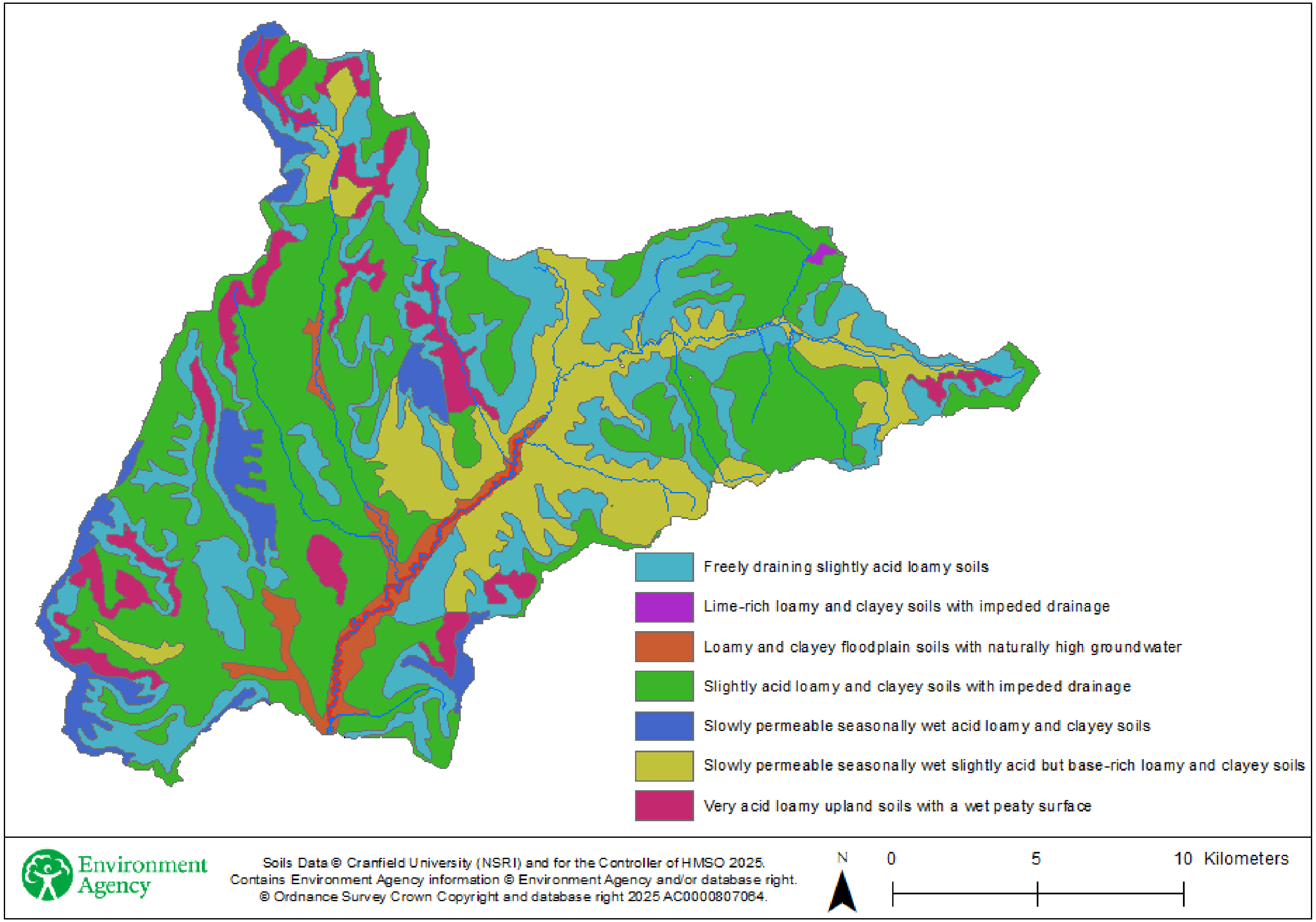
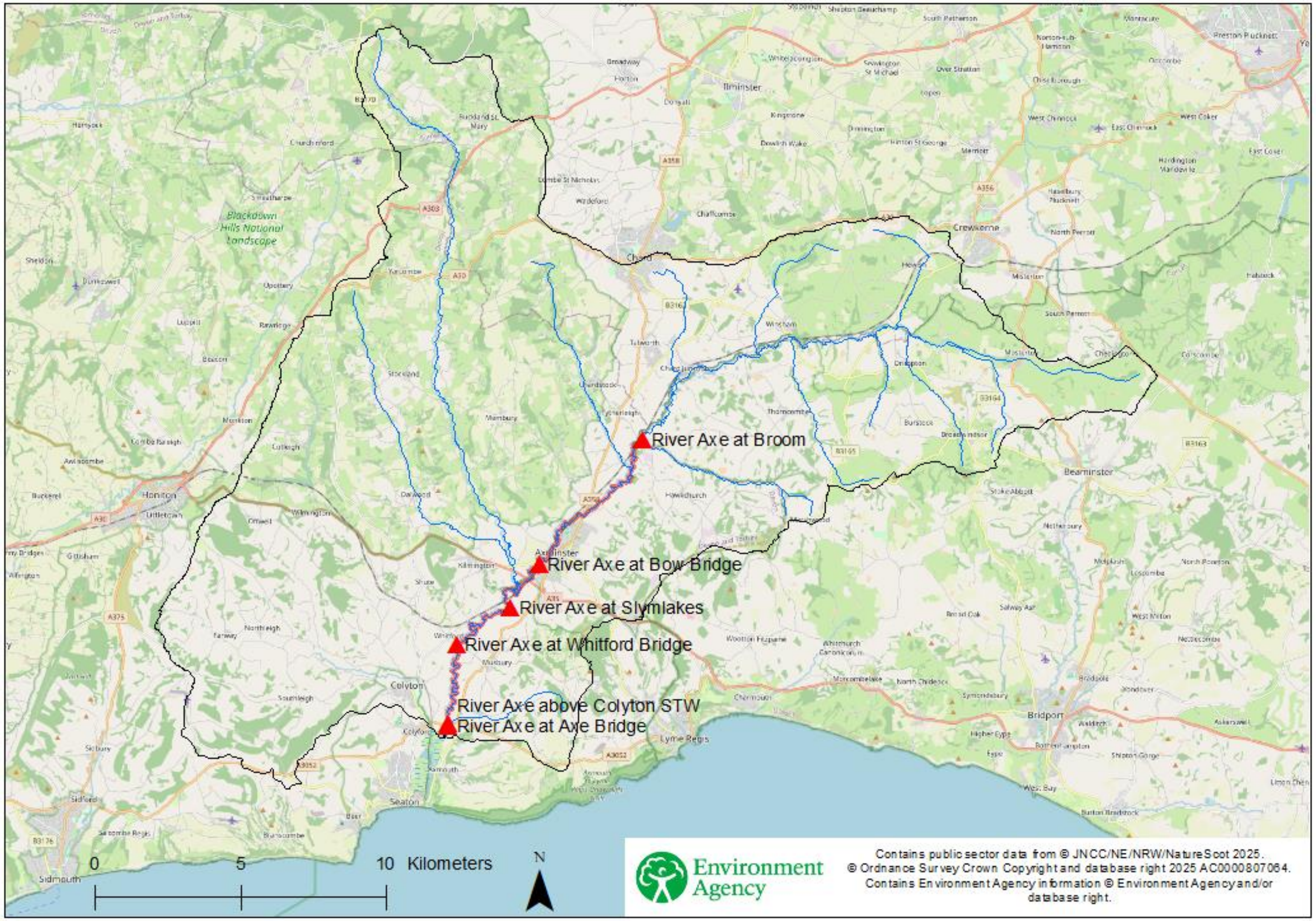
0
5
10 Kilometers

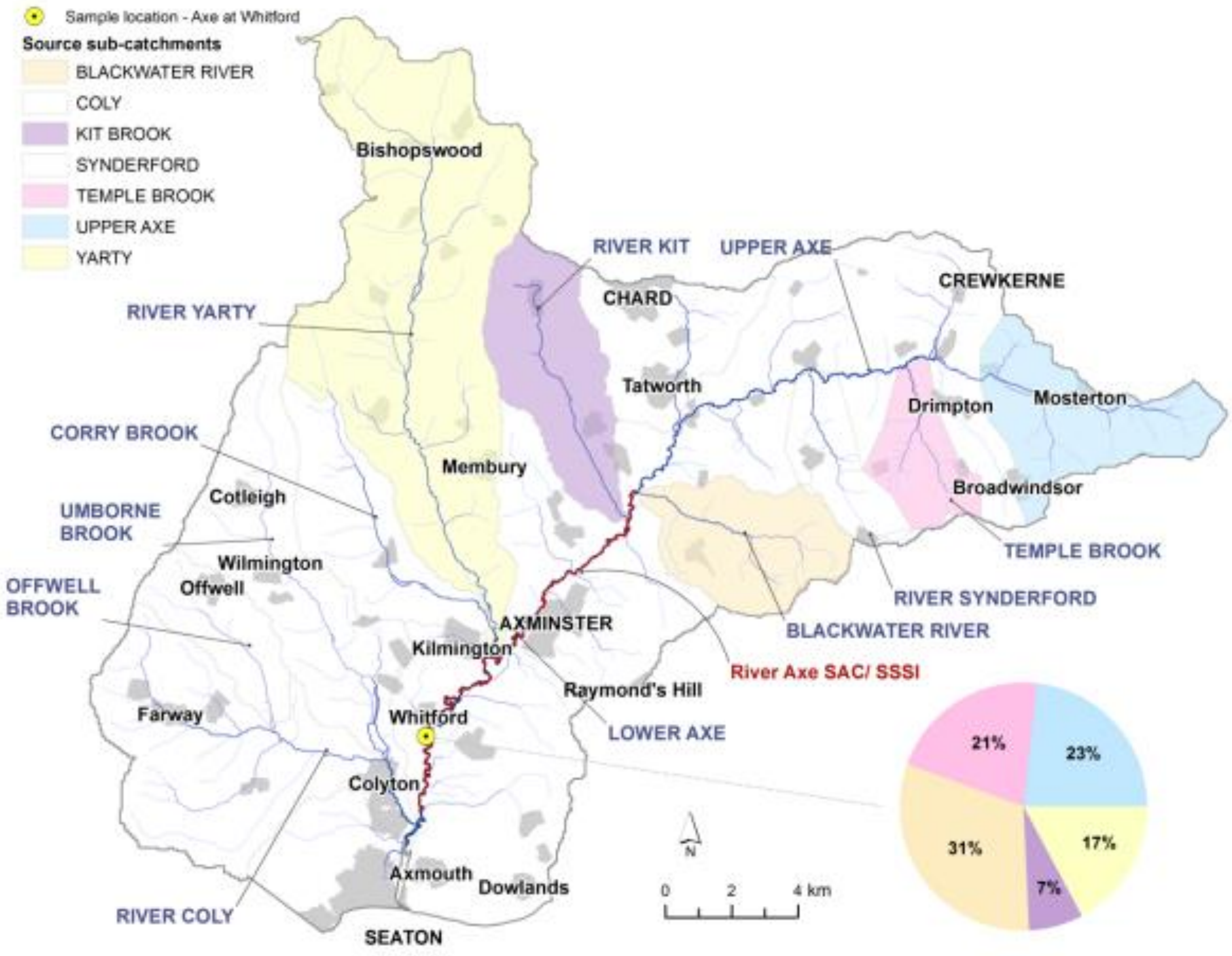
Appendix C Soil landscape map



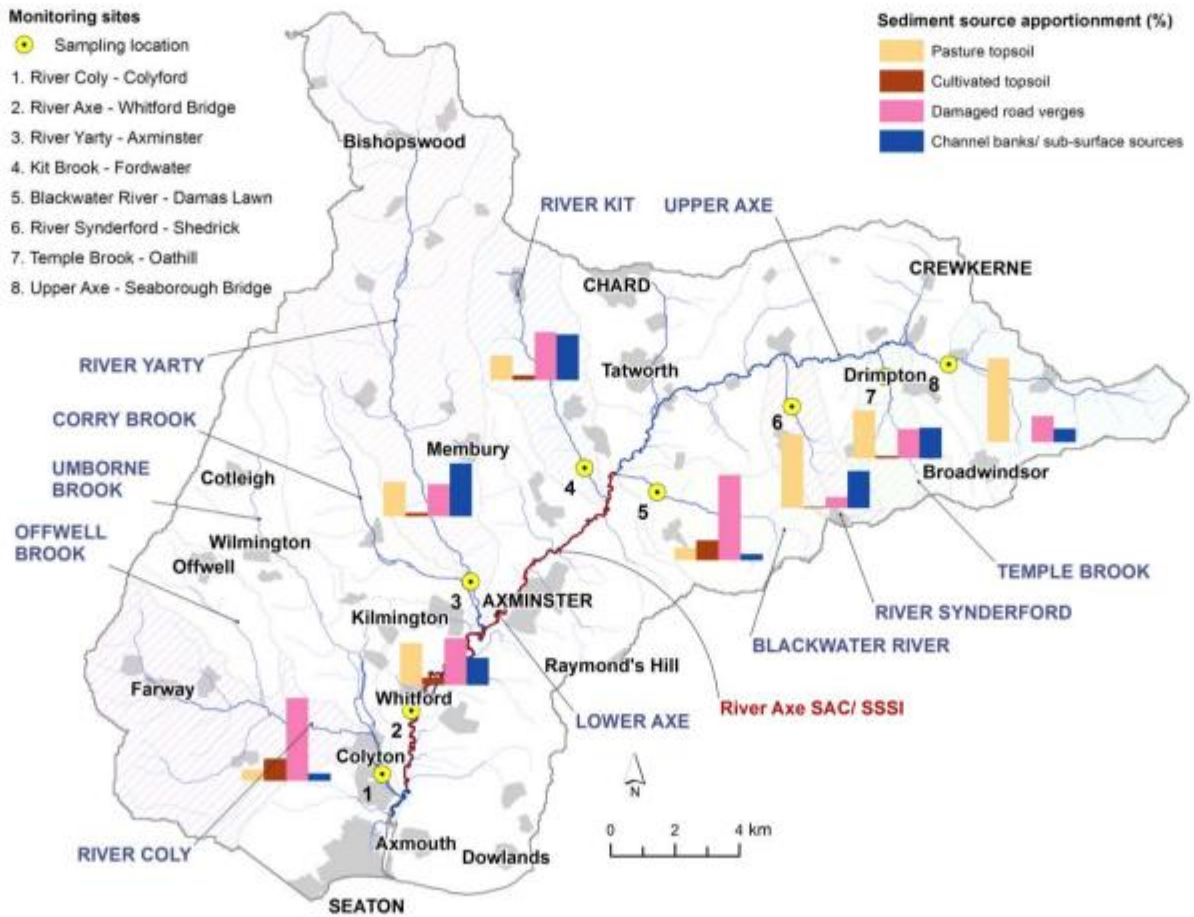
Appendix D Water quality monitoring points used for SSSI condition assessment



Appendix E Sediment source apportionment maps

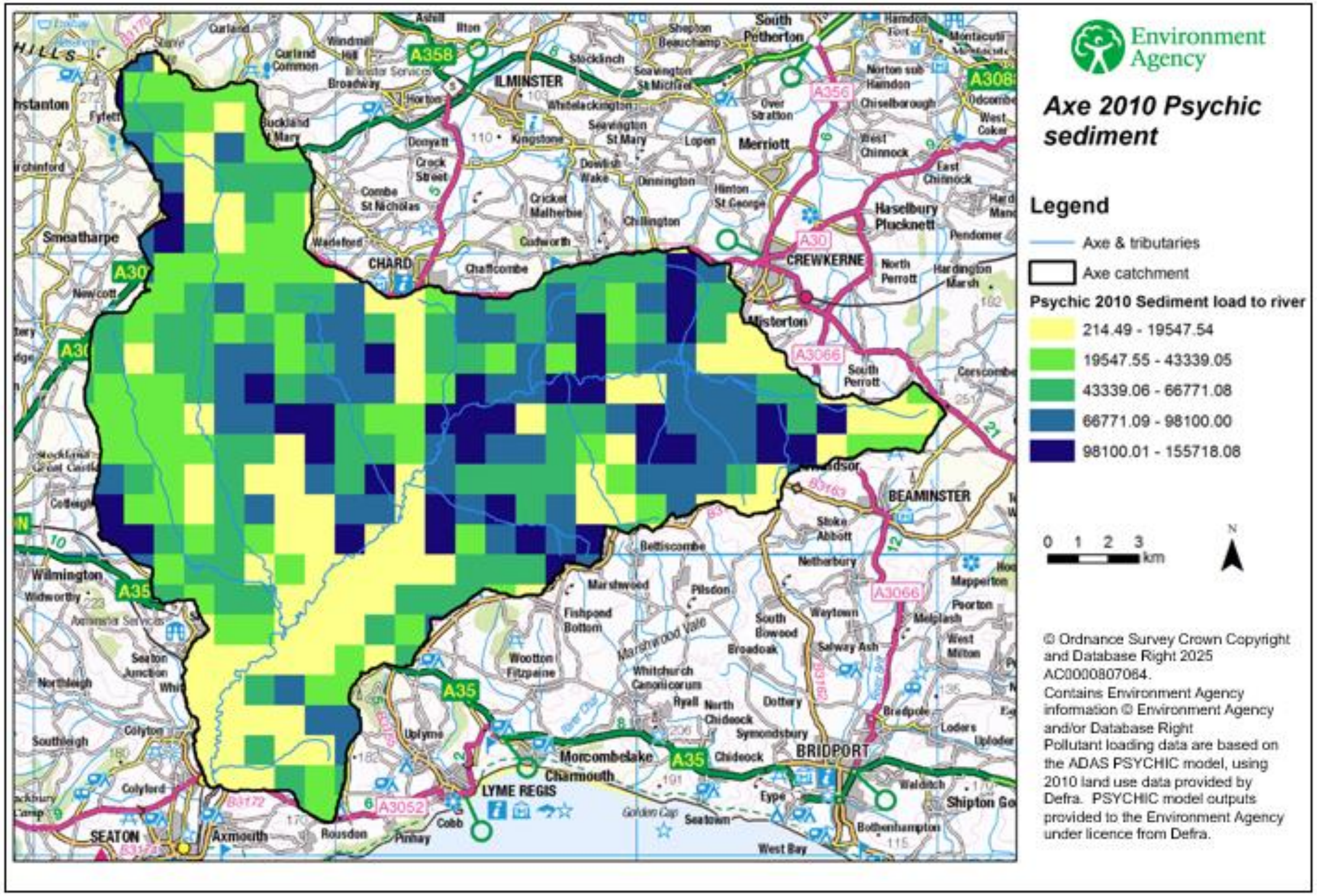


Source: Natural England (2015). Data derived from ADAS (2009). Contains public sector information licensed under the Open Government Licence v3.0.

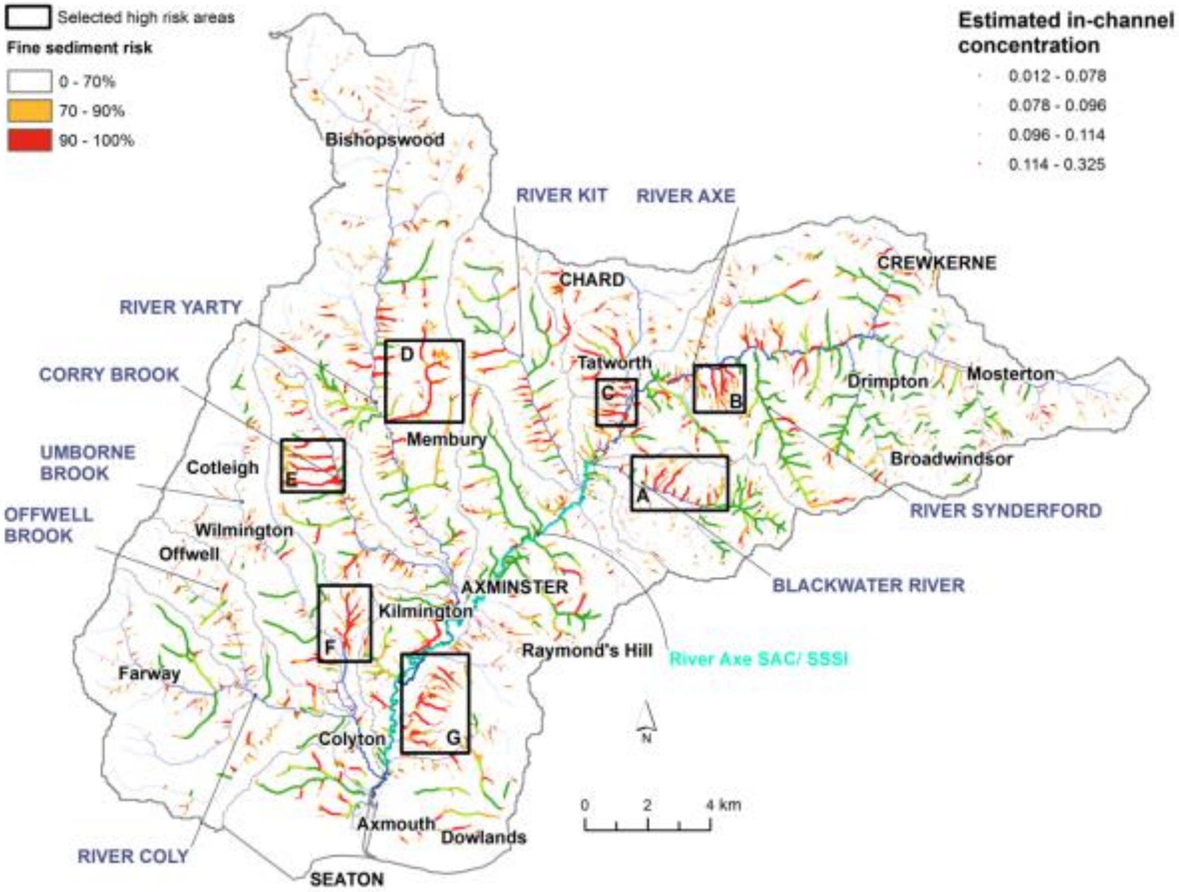


Source: Natural England (2015). Data derived from ADAS (2009). Contains public sector information licensed under the Open Government Licence v3.0.

Appendix F PSYCHIC sediment loads

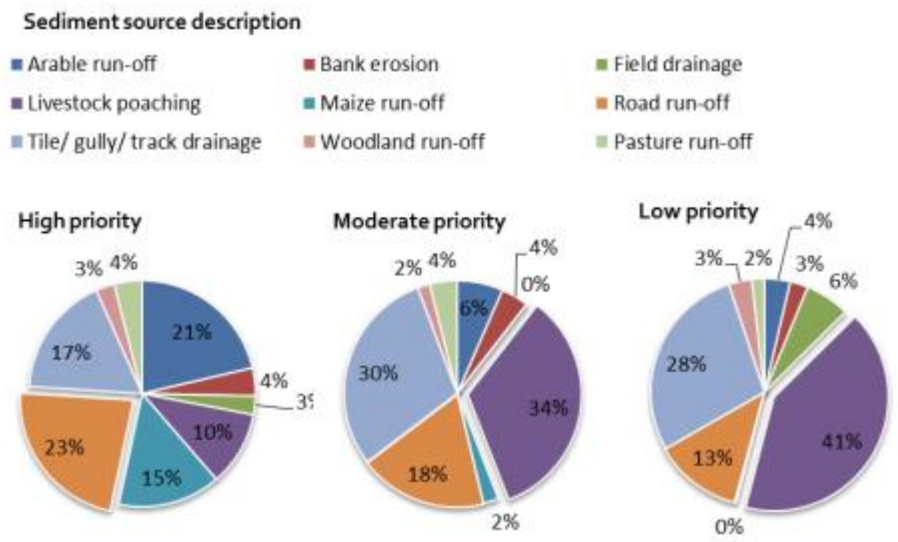


Appendix G SCIMAP in-channel fine sediment risk

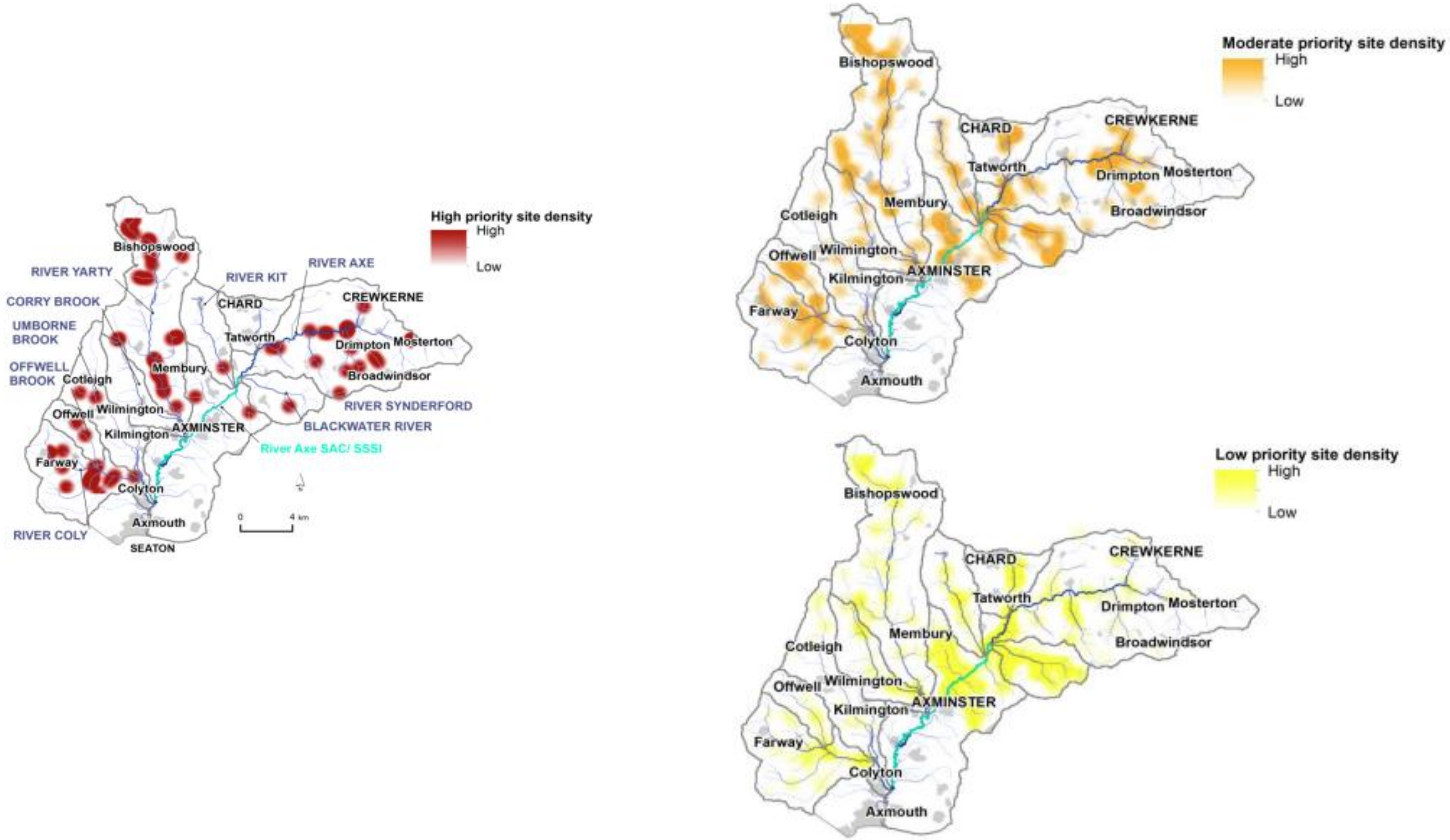


Source: Natural England (2015). Contains public sector information licensed under the Open Government Licence v3.0.

Appendix H Key sources of sediment identified in a catchment walkover survey and density mapping of high, medium and low priority sediment sources



Source: Natural England (2015). Data derived from Environment Agency (2010). Contains public sector information licensed under the Open Government Licence v3.0.



Source: Natural England (2015). Data derived from Environment Agency (2010). Contains public sector information licensed under the Open Government Licence v3.0.

Appendix I Options Appraisal

Diffuse Water Pollution Plan Options Appraisal

N2K/Ramsar/SSSI sites covered	River Axe SSSI, River Axe SAC
Diffuse Water Pollution Plan/Nutrient Management Plan Name	River Axe
EA Area Name	Devon, Cornwall, and Isles of Scilly
NE Area Name	Devon, Cornwall, and Isles of Scilly
Date	March 2024
Version	**1.1 April 2025** template update Version history: v0.1: March 2021 v0.2: January 2024 SAGIS-SIMCAT update v0.3: March 2024-comments addressed v1.0 Issued March 2024
Author(s)	Alex Taylor (EA) Kathryn McKendrick-Smith (NE) Fergus Mitchell (NE) Stuart Hunter (EA) Tom Beard (NE)

1. Define the objective

1.1. Water Quality Targets

Common Standards Monitoring (CSM) favourable condition targets for the River Axe SSSI/SAC are shown in Table 1. Targets for soluble reactive phosphorus (SRP) are not being met and consequently reducing phosphorus (P) inputs to the SSSI is a key objective. There are no quantified targets for suspended or stored (channel bed) sediment, only visual assessment of habitat siltation. Nevertheless, the impacts of excess sediment and its role in P transport and storage are widely recognised, hence sediment mitigation will also be considered here.

Table 1 *Favourable condition targets for river habitat function in the River Axe SSSI (Natural England, 2018)*

Parameter	Long-term Target	Interim Target	Notes
Phosphorus (soluble reactive phosphorus)	0.05 mg/L by 2027	0.082 mg/L by 2021	3yr annual mean and 3 yr growing season mean (01 April to 30 Sep).
Low flows (% deviation from naturalised flow)	5	5	Current CAMS assessment shows that there is water available
Low-moderate flows (% deviation from naturalised flow)	10	10	As above
Moderate – high flows (% deviation from naturalised flow)	10	10	As above
High flows (% deviation from naturalised flow)	10	10	As above
pH	N/A	N/A	
Acid Neutralising Capacity	N/A	N/A	
Un-ionised ammonia	0.025 mg/L	0.025 mg/L	As 95 percentile. Already achieved
Total ammonia	0.15 mg/L	0.15 mg/L	As 90 percentile. Already achieved
Mean biological oxygen demand	1.5 mg/L	4 mg/L	BOD is not monitored on a routine basis
Dissolved oxygen	85% saturation	85% saturation	As 10 percentile. Achieved at all sites except unit 3 (Colyton & Axe Bridge)

1.2. Reductions required to achieve water quality targets

This section provides a summary of the current reductions required to meet phosphorus targets by presenting recent monitoring (measured) data and modelling estimates. The latter draws upon measured data to provide an estimate of water quality throughout the SSSI river reach. Note that here, and in following sections, model results are discussed in terms of:

i. the fair share reductions required by the point and diffuse sectors, which have been calculated in line with the revised polluter pays principle, and
ii. the overall reductions required to achieve SRP targets.

<u>Phosphorus</u>

Monitoring Data

Environment Agency (EA) monitoring data show that the long-term target (LTT) of 0.05 mg/L SRP is not being met. Table 2 summarises monitoring data derived from the most recent condition assessment.

Table 2 *Orthophosphate reactive as P (OP) concentrations from the 2024 SSSI condition assessment (Natural England, 2024)*

Monitoring site	SSSI Unit	OP 3 yr mean (mg/L)	OP 3 yr growing season mean (mg/L)
River Axe at Broom	Unit 1	0.11	0.11
River Axe at Bow Bridge	Unit 2	0.09	0.08
River Axe at Slymlakes	Unit 3	0.10	0.09
River Axe at Whitford Bridge	Unit 3	0.10	0.09
River Axe above Colyton STW	Unit 3	0.12	0.09
River Axe at Axe Bridge	Unit 3	0.14	0.14

Modelling Outputs

i. Sector fair share reductions

To determine the phosphorus reductions required by the point and diffuse sectors, the fair share of the favourable condition target for each sector was calculated under the revised polluter pays principle. Source apportionment was calculated against the baseline year (2009) to align with the start of the river basin management planning cycle. This ensures that any sector reductions/improvements in pollutant load since 2009 are accounted for. Note that the fair share approach uses catchment average statistics (Table 3).

***Table 3** Diffuse and point sector share of the favourable condition target calculated under the revised polluter pays principle. Note that this approach uses catchment average concentrations*

	Diffuse	Point	Total
Baseline (2009) Sector Share (fixed)	78%	22%	100%
Baseline (2009) Catchment Average Concentrations (mg/L)	0.091	0.026	0.117
Baseline (2009) Sector Allocation of CSM target (mg/L)	0.033	0.017	0.05 (the site target)

ii. Overall reductions required to achieve the SSSI target

The SAGIS-SIMCAT modelling provided an estimate of current river SRP concentrations at various points along the SSSI reach. Current SRP concentrations (mg/L) modelled by SAGIS-SIMCAT are mapped in Figure 1, showing that the favourable condition target (0.05 mg/L) is exceeded across the SSSI. The overall percentage reductions required to meet the SRP target are shown in Figure 2, which indicates that the upper section of the SSSI is likely to require the greatest reductions, with >60% reduction required at the upper SSSI boundary.

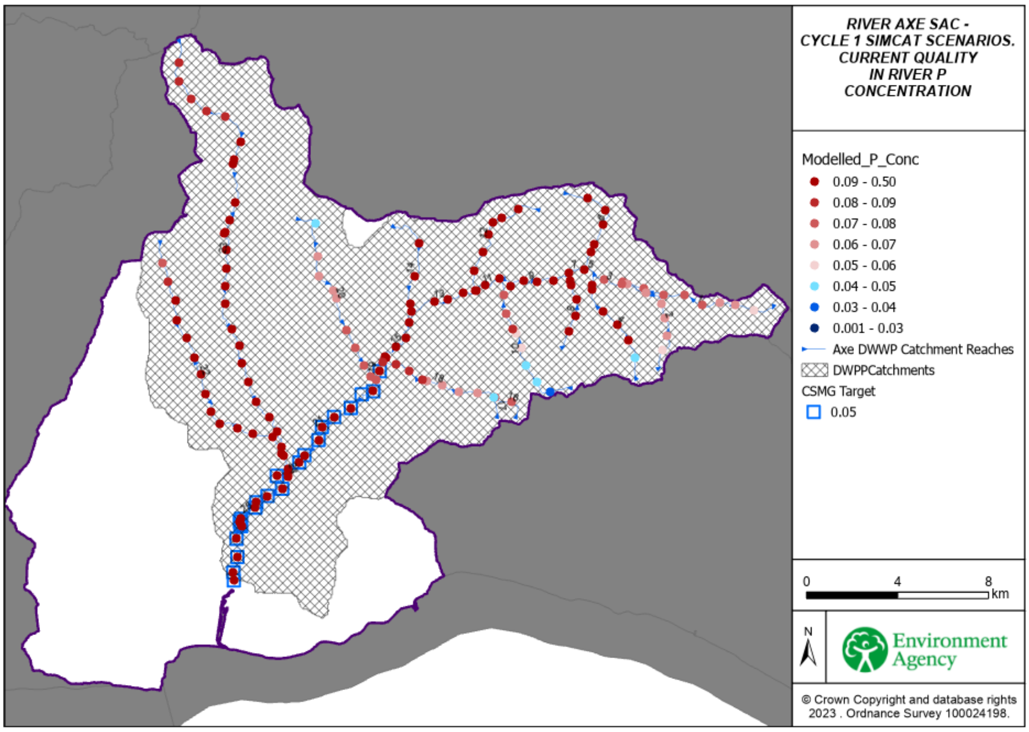


***Figure 1** SAGIS-SIMCAT modelled current soluble reactive phosphorus concentration in the River Axe catchment. The blue squares denote the SSSI/SAC reach with the Common Standards Monitoring (CSM) guideline favourable condition target of 0.05 mg/L soluble reactive phosphorus*

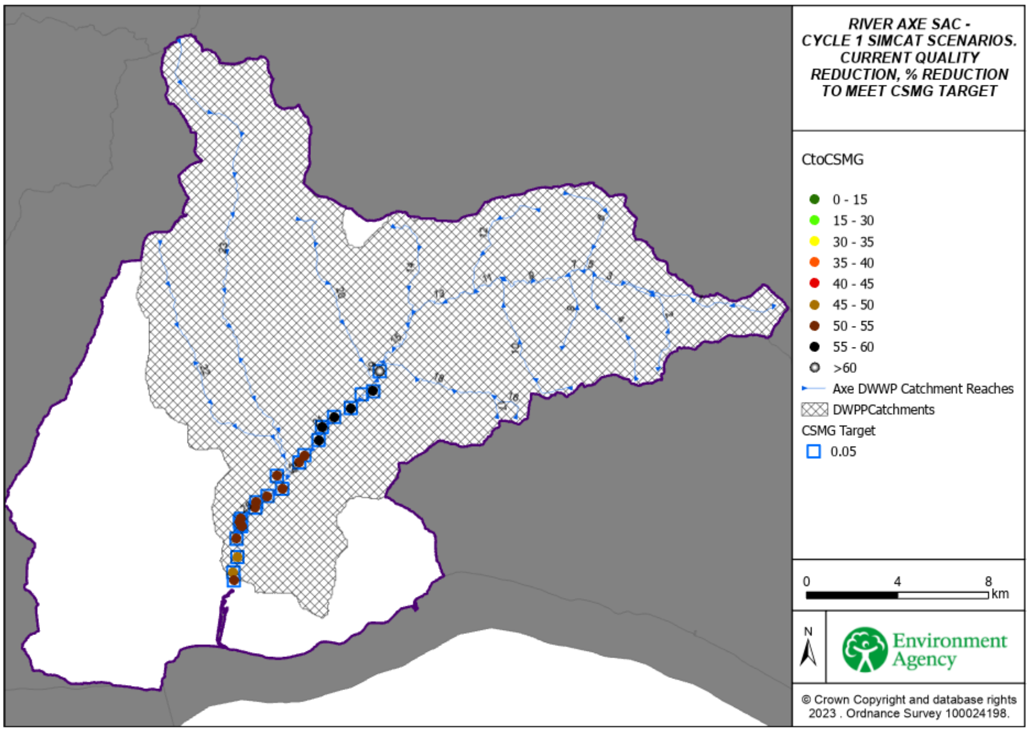


Figure 2 *Overall % reduction in current river soluble reactive phosphorus concentration required to achieve the favourable condition target of 0.05 mg/L*

Sediment

There is no specific target for suspended sediment and it is not monitored routinely. Recent qualitative assessment of the condition of river substrate (Natural England, 2024) showed no unnaturally high levels of siltation. However, the survey may not be appropriate for identifying the impacts of fine sediment upon biota and wider evidence suggests that sedimentation of gravels is a problem affecting invertebrates and the fishery. Numeric targets cannot be set to reduce sediment inputs to the river system, but the plan can focus on measures to prevent sediment reaching the river and promote bank stabilisation.

In 2016 (with the intention to repeat annually) the Environment Agency began specific monitoring for invertebrates at 12 reference sites which have a long-established data set. These data are analysed for proportion of sediment sensitive invertebrates (PSI). The survey now includes 30 sampling sites. Recent data (data up to and including 2022) indicate slight to moderate sedimentation across the sites.

Summary of key points:

- Sample data from monitoring stations in the SSSI reach show annual mean SRP concentrations exceed the favourable the condition target by up to around 0.06 mg/L
- Modelled outputs show exceedance of the SRP target across the whole SSSI reach
- SRP reductions required to achieve the SRP target are generally greater than 50% with the upper SSSI reach likely to require the greatest reductions

2. Reduction Strategies

This section provides:

i. an overview of phosphorus source apportionment at the waterbody scale, which has implications for spatial targeting of reduction strategies, and

ii. an assessment of the effect of mitigation measures on river phosphorus concentrations.

Phosphorus source apportionment

Source apportionment modelling showed 86% of P inputs to the River Axe are from diffuse sources, with the remaining 14% from point sources. Diffuse and point source inputs are dominated by rural land management (agriculture) and water company assets respectively (Figure 3). Note that several key tributaries input phosphorus to the upper reaches of the SSSI, with the highest mean concentrations apportioned to the Upper Axe waterbody. This corresponds with the larger SRP concentration reductions required for the upper SSSI as shown in Figure 2.

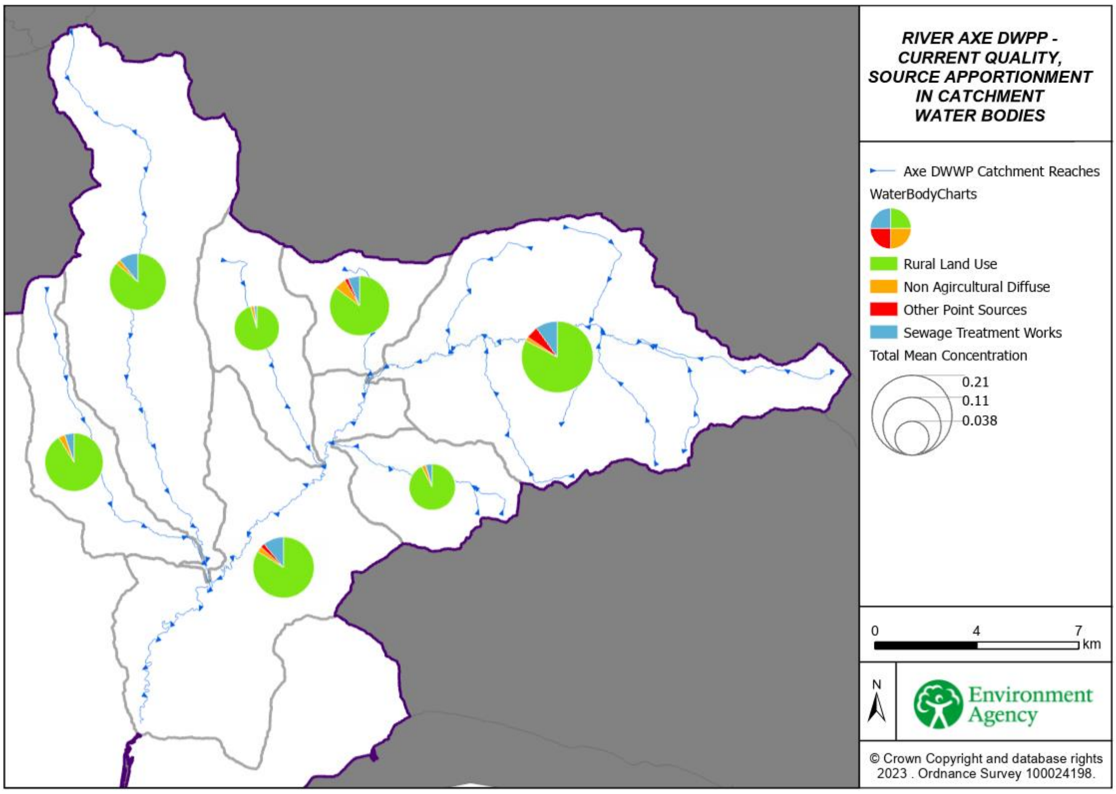


Figure 3 *Phosphorus source apportionment in the River Axe catchment*

Diffuse source inputs

As the dominant source, the reduction strategy should focus on reducing P inputs from agricultural land by targeting key sources and pathways. Phosphorus can be transported in dissolved and particulate forms and reduction strategies in the River Axe catchment must focus on mitigating soil erosion and P transport via overland flow pathways. This is particularly pertinent in the Axe catchment wherein soil compaction and associated overland flow is widespread. Elevated risk occurs in the wet winter months when most animals are housed, and dirty water systems can fail or be overloaded. Spreading slurry in wet weather compacts soils and increases the risk of nutrient and sediment transfer from fields and tracks to drains and roads and into rivers. Phosphorus that is bound to sediments can be released into the river over prolonged periods. Out-wintering of stock can compact and poach the soil causing sediment and associated nutrients to be transported to surface waters in high-risk areas. Tracks and roads used for moving stock from fields to milking sheds can be a significant source of P in summer months, as can stock accessing rivers directly.

Intensive wet weather monitoring by the EA of the Kit Brook, Temple Brook and Blackwater River showed how rainfall washes organic pollutants and P into rivers (EA, 2005). The focus on tackling diffuse pollution from farms should be seen in the context of how land use has changed in the catchment. The change in Agricultural Census returns between 2000 and 2010 illustrated how land use had intensified with increased numbers of cattle and sheep and increased extent of maize and temporary grassland (Natural England, 2015). More slurry is produced in these intensive systems, and this puts pressure on infrastructure and storage facilities, which in turn increases the frequency of spreading to land. Inputs of manufactured fertiliser are also likely to increase in these systems.

Dairying remains the dominant farming type, but as farms have amalgamated and intensified, they have moved from a mixed system based on permanent pasture and hay making to silage and maize, while stocking densities have also risen. More land is cultivated, and cultivations are more frequent, exerting pressure on the soil system. The late harvest of maize for example, when the soil is often wet, presents a particular risk by compacting the soil and impeding drainage over the wet winter months, increasing overland flow and transport of nutrients and sediment. Recent work by the East Devon Catchment Partnership revealed the extent of diffuse pollution risks in maize-based systems. Every farm in a sample of 27 that voluntarily agreed to be audited, showed signs of runoff. Most (19) of these had ineffective mitigation measures after the maize harvest and five were having a serious impact. A key finding from the study was how widespread the risk of runoff was in the East Devon landscape. In the holdings sampled, less than 19% of the land used for maize production was naturally free draining and, therefore, unlikely to be suitable for harvesting during autumn. When all factors were considered, 93% of the land used for maize production was at high risk of runoff. In practice, every farm growing maize presents a risk and the scale of risk correlates positively with farm size.

Intensively managed grassland is also vulnerable to compaction from livestock and machinery, with repeated slurry applications to compacted ground a significant problem. Risks can vary field by field and year by year and presents a problematic 'moving target' for those trying to address field-scale runoff problems.

Point source inputs

The input from point sources has been reduced by the water company (South West Water (SWW)) and remains under review through the asset management plan (AMP) process. An investigation into the options available to the water company to further reduce its contribution to P load in the SSSI is detailed in a recent report (SWW, 2022). At present SWW does not achieve an adequate Environmental Performance Assessment rating to be eligible for nutrient balancing via catchment management schemes.

The large single source of P from the dairy business at Chard junction has ceased and the consent to discharge surrendered. The contribution from small sewage discharges (e.g., septic tanks) is estimated to represent a small proportion (2%) of the total load.

Assessing phosphorus and sediment reduction strategies

Description of the modelling approach

Phosphorus

The effect of mitigation measures on SRP concentrations was modelled by Environment Agency Operations Catchment Services using SAGIS-SIMCAT. Point sector improvements were captured using details derived from the asset management plan (AMP) process. For diffuse inputs from agriculture, the Environment Agency Agriculture Risk and Evaluation team carried out an assessment of pollutant load reductions for the River Axe catchment using Farmscoper (v.5) (Gooday et al., 2015). Farmscoper modelled the reductions in total phosphorus loads (kg) from agricultural land in response to mitigation measures, which were then incorporated into SAGIS-SIMCAT as percentage reductions from livestock and arable land uses. Mitigation scenarios were set according to the uptake rate of regulatory and non-regulatory measures (see Appendix A for full list of measures). Note that CSM targets are for soluble reactive phosphorus (SRP) whereas the default values used by

Farmscoper are for total phosphorus (TP). Percentage load reductions derived from Farmscoper are used in SAGIS-SIMCAT rather than absolute loads (kg), with an underlying assumption that the difference in percentage reduction between total phosphorus and dissolved phosphorus is small.

The following management scenarios were used in the modelling process:

- **Current Quality:** Catchment-wide current water quality.
- **Current Regulation 2025:** Assumed 100% compliance with regulatory measures. Point discharges fully permitted (AMP7). Diffuse agricultural inputs assume full (100%) compliance with required regulatory measures, 25% for Farming Rules for Water 'reasonable' measures and current uptake rates for voluntary and other measures
- **Current Planned 2030:** Assumed 100% compliance with regulatory measures. As Scenario 2 but with current planned AMP8 permits applied to water company discharges.
- **Theoretical Maximum:** Assumed 100% compliance with all measures. AMP8 delivery for water company assets and 100% uptake of all relevant land management measures. Note that this scenario is included for benchmarking only since 100% uptake of land management measures is not achievable in practice.

Note on model uncertainties: The models are valuable decision support tools but do carry inherent assumptions and uncertainties. It is important to acknowledge this, particularly in relation to the complexities of diffuse water pollution and model assumptions relating to e.g., current measures uptake, land management practice and contaminant behaviour. There is, however, high confidence in the census data used in Farmscoper for the River Axe catchment. Unless otherwise stated, values referred to below are mean modelled values.

Sediment

There are no quantitative suspended sediment thresholds for the SSSI/SAC. Sediment reduction strategies were assessed using model outputs from Farmscoper and compared to literature values for background sediment loss in UK catchments.

Modelling Results

Phosphorus

Figure 4 shows the predicted effect of each management scenario on SRP concentrations apportioned to point and diffuse sectors. None of the scenarios is predicted to achieve the sector share for agricultural inputs. Even under a theoretical maximum, the long-term target (LTT) for SRP would not be achieved in the SSSI (Figure 5). If all water company assets were operating at the technically achievable limit (TAL) for P reduction, it would not offset the excess input from agriculture.

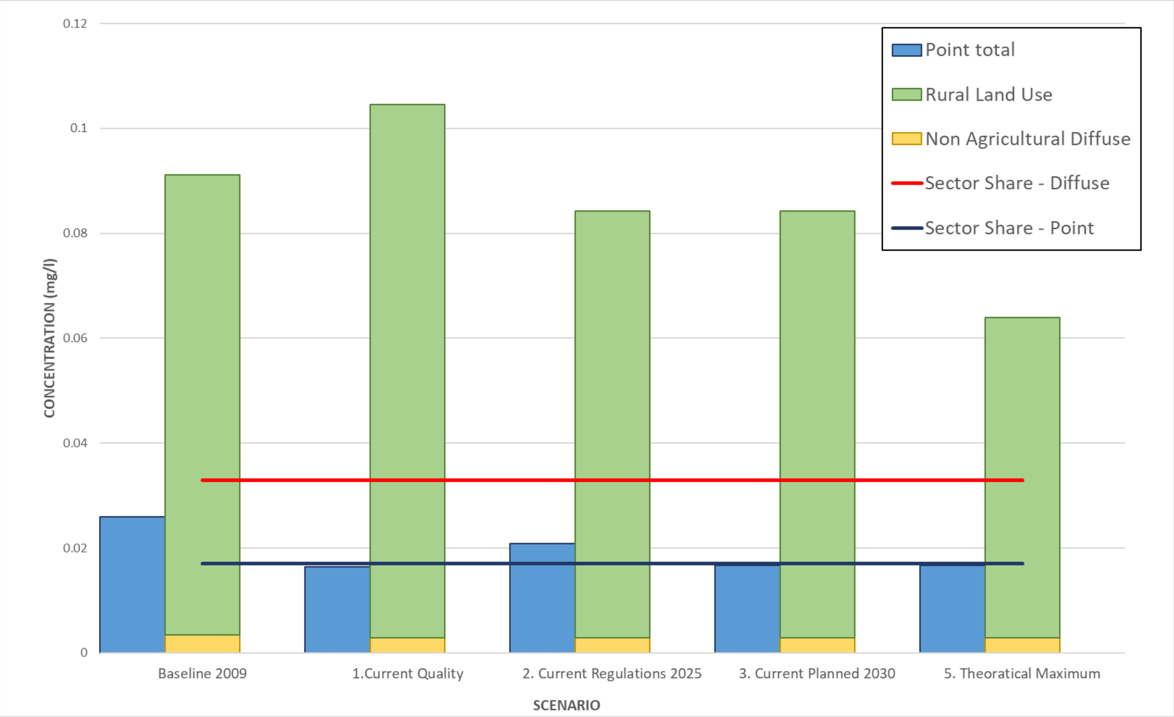


Figure 4 *River Axe soluble reactive phosphorus concentrations (mg/L) apportioned to diffuse and point sources. Sector share benchmarks denote the fair share proportion of the favourable condition target (0.05mg/L) attributed to each sector using the revised polluter pays approach.*
Scenarios:
Baseline 2009 *shows apportionment derived from the PR19 baseline model;*
Current quality *denotes apportionment based on the PR24 calibration model;*
Current regulations 2025 *modelled point inputs at AMP7 permits with diffuse measures at 100% compliance for regulatory measures, 25% uptake for Farming Rules for Water 'reasonable' measures and current uptake for voluntary and other measures;*
Current planned 2030 *as per the 2025 model but with AMP8 permits applied;*
Theoretical maximum *current planned 2030 plus 100% uptake of all agricultural measures*

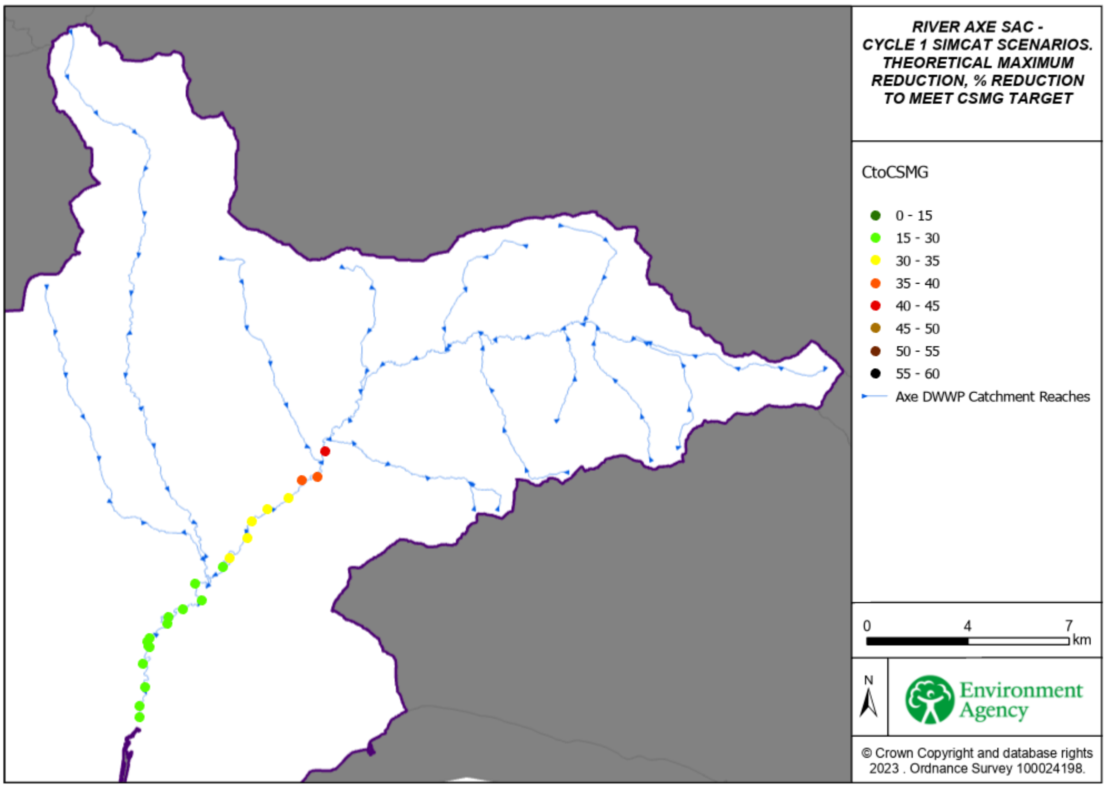


Figure 5 *Overall remaining percentage reduction required to meet the Common Standards Monitoring target for soluble reactive phosphorus under the theoretical maximum scenario*

Agricultural load reductions modelled by Farmscoper showed a 41% reduction in TP load under the theoretical maximum scenario, which was not sufficient to meet the sector share target for river SRP concentrations (Figure 4). A point compliance forecast was carried out to determine the TP load reductions required by the agricultural sector to achieve the SRP concentration target across the SSSI reach. Agricultural load reductions of 53% and 72% were predicted to achieve the interim (0.082 mg/L) and long term (0.05 mg/L) SRP targets respectively. These load reductions are greater than those predicted under the theoretical maximum scenario in Farmscoper (41%). Maximum implementation of measures is not feasible in practice, and Table 3 shows a more realistic TP load reduction under a high compliance scenario (27%).

*Table 3 Farmscoper derived phosphorus loads under different land management scenarios and loads predicted to achieve CSM targets**

Scenario	P load kg/yr	% P reduction from current	Load reduction from current kg
Current uptake[a]	19,528	-	-
High compliance[b]	14,191	27	5,337
Theoretical max.[c]	11,563	41	7,965
Achieving interim target[d]	9,178	53	10,350
Achieving long-term target[d]	5,468	72	14,060

[a] Based on national average uptake of mitigation measures
[b] Uptake rates: All regulatory measures 85%; Farming Rules for Water 'reasonable' 70%; voluntary measures 70%; all other measures at current level. Note this scenario differs from the National Once programme by increasing the uptake of Farming Rules for Water 'reasonable' based upon targets specific to the River Axe catchment
[c] 100% uptake of all appropriate measures
[d] Estimated load reductions based on a point compliance forecast. These are the estimated reductions required to achieve the agricultural sector share of the CSM target shown in Figure 4

* Farmscoper derived loads do not translate directly to SAGIS-SIMCAT i.e., 1kg/d P load in Farmscoper is not equal to 1kg/d P load in SAGIS-SIMCAT. Percentage reductions calculated by Farmscoper are therefore used by SAGIS-SIMCAT instead of mass (kg) reductions. The load reductions required to meet targets[d] are based upon estimated percentage reductions and should be treated as indicative only.

Phosphorus source apportionment across farm types is dominated by the dairy sector (Figure 6). Table 4 shows the estimated TP load reductions required by farm type to achieve the CSM target. Note that areal loads shown in Table 4 assume an even load distribution across all land for each broad farm category. This is indicative only and, in practice, areal loads would vary across the landscape depending upon several risk factors. Further scrutiny of Farmscoper data showed drained arable and grassland farm types are likely to contribute the greatest TP loads within the dairy sector, requiring areal load reductions >1 kg/ha/yr.

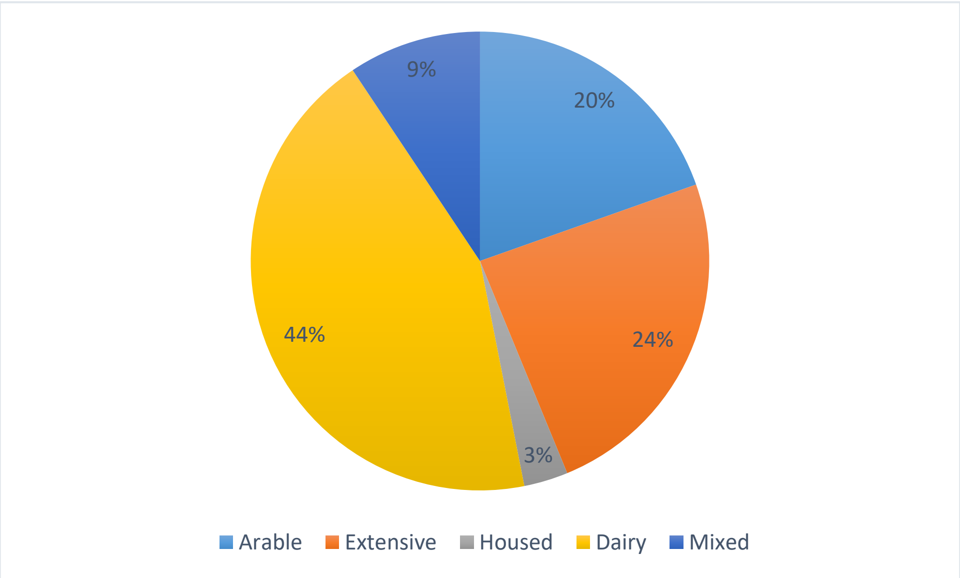


Figure 6 Farmscoper output showing phosphorus apportionment to farm type based on current inputs. 'Housed' refers to pig/poultry farms

***Table 4** Estimated phosphorus load reductions required by farm type to achieve the sector share of the interim and long-term target (LTT) for soluble reactive phosphorus concentration. Areal loads are based upon the total farmed area across the catchment. Farmscoper apportionment (Figure 6) has been applied to the predicted load reductions required to meet the diffuse sector share (Table 3). Values are indicative only*

Sector	Proportion of P load %	Proportion of load reduction to achieve interim target kg/yr	Proportion of load reduction to achieve LTT kg/yr	Sector area ha	Areal load reduction to achieve interim kg/ha/yr	Areal load reduction to achieve LTT kg/ha/yr
Arable	20	2,070	2,812	4,654	0.44	0.60
Extensive	24	2,484	3,375	8,463	0.29	0.40
Housed	3	311	422	568	0.55	0.74
Dairy	44	4,554	6,186	9,238	0.49	0.67
Mixed	9	931	1,265	2,037	0.46	0.62
	Total	**10,350**	**14,060**			

Sediment

There are no quantitative suspended sediment thresholds for the SSSI/SAC. For reference only, Table 5 summarises the sediment load predicted by Farmscoper for three scenarios. Sediment load apportionment by farm type is shown in Figure 7. Foster et al. (2011) estimated guideline values for sediment delivery to rivers in England and Wales, suggesting a target modern background value of 0.2 t/ha/yr for high erosion risk agricultural catchments. A maximum modern background delivery of 0.35 t/ha/yr was estimated, and values above this indicate an urgent need for mitigation. Areal loads in Table 5 show that, currently, sediment delivery is likely to be beyond the maximum target suggested by Foster et al. (2011), and a high compliance scenario could reduce sediment delivery below this maximum threshold. Foster et al. (2011) suggested that where delivery values lie between the target and maximum thresholds (as shown here for high compliance and theoretical maximum), further assessment is required to underpin effective mitigation.

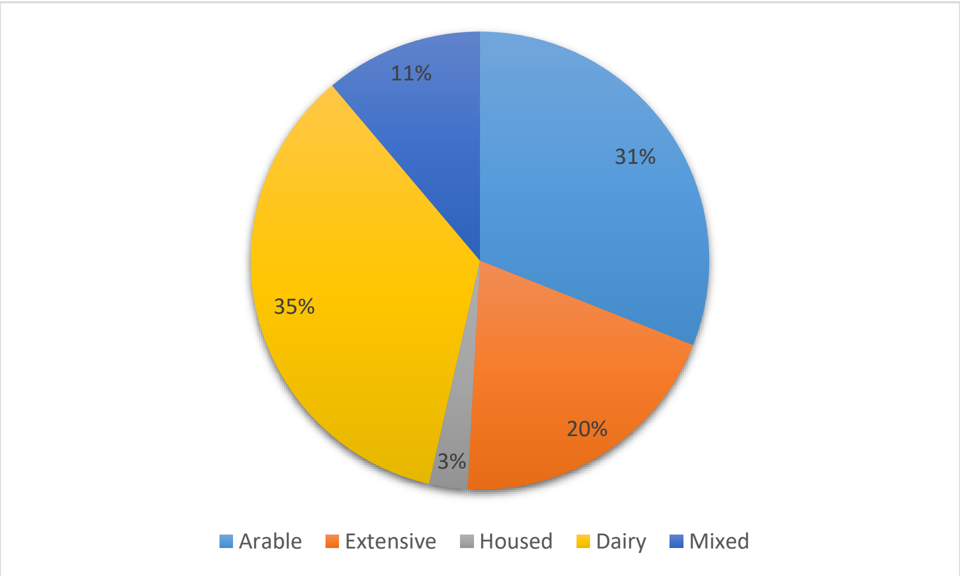


***Figure 7** Farmscoper output showing sediment loads apportioned to farm type based on current inputs. 'Housed' refers to pig/poultry farms*

***Table 5** Farmscoper derived sediment loads under three scenarios*

Scenario	Sediment load t/yr	Areal load t/ha/yr
Current uptake	9,268	0.371
High compliance[a]	6,727	0.270
Theoretical maximum	5,314	0.213

[a] Uptake rates: All regulatory measures 85%; Farming Rules for Water 'reasonable' 70%; voluntary measures 70%; all other measures at current level

Summary of key points:

- Source apportionment modelling showed phosphorus inputs to the River Axe are dominated by agricultural sources (86% catchment average)
- Farmscoper modelling estimated a 41% reduction in phosphorus loss from agricultural land under theoretical maximum uptake of land based measures
- Theoretical maximum uptake of land based measures is not predicted to achieve SSSI targets for phosphorus

3. Identification of *measures* needed to achieve the protected area objectives

Summary of measures applied in the reduction strategies

- Point source measures achieve the sector share under the planned AMP 8 scenario. This scenario accounts for the improvements to treatment at Colyton STW, Kilmington WwTW and Tatworth WwTW required by the phosphorus sensitive catchment area designation under the Water Industry Act 1991. This proposes upgrades to the technically achievable limit (0.25 mg/L) by 1st April 2030

- The agricultural measures modelled in Farmscoper (Appendix A) cover those required for compliance in the catchment, and those which may be adopted on a voluntary basis. Numerous measures are applicable to mitigating erosion and overland flow pathways common to the Axe catchment, and which are deemed effective for P reduction. Examples include establishing cover crops in autumn and use of riparian buffer strips. Both options are predicted to be effective for reducing particle bound phosphorus and sediment loads (typical impacts 80% and 50% respectively). Measures required under Farming Rules for Water (FRfW), such as avoiding slurry spreading at high-risk times and use of manufactured fertiliser on high-risk areas, are highly relevant to the Axe catchment and mitigating P transport; the latter is particularly relevant to transfer of dissolved P.

- The measures list used in Farmscoper is extensive but not exhaustive and may not adequately represent new measures under the emerging Environmental Land Management scheme. Whilst there is high confidence in the catchment census data applied in the model, default values (e.g., farm systems and soils) have been used. Farmscoper is a robust decision support tool and values shown here represent a best estimate based on available data. Refinements to these estimates can be made in future assessment using catchment-specific data and a revised measures suite when available.

Note on Nutrient Neutrality

The River Axe catchment has been identified by Natural England as a nutrient neutrality catchment. This DWPP identifies the sector share of nutrient reductions required to support the recovery of the SSSI/SAC to favourable condition. It also identifies the measures required to secure or work towards the reductions identified. If any measure identified in the DWPP actions is used for other purposes, such as providing mitigation to allow housing development, then this measure would no longer be able to be included in the DWPP or be implemented for site recovery to favourable condition. Any nutrient mitigation measures for nutrient neutrality should not compromise the restoration of the site to favourable condition.

4. Identification of *mechanisms* needed to achieve the protected area objectives

Summary of mechanisms currently in place

Voluntary

- The Catchment Sensitive Farming (CSF) initiative has been active in the Axe catchment since 2006, promoting the Code of Good Agricultural Practice and providing advice and support for farmers via one-to-one visits and group events. CSF offers tailored support for farms either directly or via free of charge specialist advice visits (e.g., nutrient management planning) through external suppliers
- Farmer participation in farm clusters, peer learning groups and local-level pilot schemes offering advice on land management with potential benefits for the water environment. An example is the Farm Transition Plan approach trialled by the Triple Axe Partnership. The Triple Axe Partnership was launched in 2021 and, led by the Blackdown Hills AONB, is a collective which includes the land managers, the EA, Natural England, voluntary groups, and NGOs. The farm advice component of the partnership is designed to complement the existing regulatory and agri-environment scheme delivery by the EA and CSF, whilst remaining distinct with its key focus on tailored farm plans. Funded by WEIF and FiPL, a pilot scheme involving six dairy farms was rolled out between 2021-22, with a second phase planned to work with 12 farms in three farm clusters. The premise is to employ specialist farm business advisors to scrutinise the existing farm business models, and to develop a road map for change to a more sustainable approach, which has economic benefits for the farmer whilst reducing impacts on the River Axe and surrounding landscape. The second phase will build on the lessons learned from phase 1. Promoting transformational farming practice in the Axe catchment through greater investment in farm business model assessment is crucial for achieving long-term change in the catchment. The process is well designed to dovetail with the existing delivery by the EA and CSF, and fostering shared learning using exemplar farm cases will help with upscaling across the catchment.

Incentive-based

- CSF provides advice on best practice and is instrumental in delivery of key financial support mechanisms available through e.g., Countryside Stewardship and Sustainable Farming Incentive (SFI). In the period 2022-2024 alone, CSF has visited around 200 farms in the Axe catchment, assisting with 41 Countryside Stewardship Mid-Tier and 34 Capital Grant agreements. This support focuses on items, which have the potential to reduce phosphorus and sediment sources and transfer to the River Axe SAC by improving farmyard infrastructure and field management practice. For example, agreements include incentivised items and options which implement:
- separation of clean and dirty waters, reducing pressure on slurry systems and minimising frequency of spreading to land
- removal of livestock from high-risk land over winter
- low input arable practices
- installation of buffer strips in high-risk areas
- hedge management and installation of new hedgerows
- winter cover cropping
- herbal leys (reducing fertiliser inputs with potential soil structure benefits)
- organic rotational land
- low input grassland

- More recently CSF has been offering advice regarding applications under the Slurry Infrastructure Grant (SIG) scheme. This is designed to help farmers improve their slurry handling facilities to meet compliance, with £74 million available nationally in the 2023 round of funding. In addition, smaller parcels of funding are available through the Farming Equipment and Technology Fund for items, which could also benefit nutrient management.

Regulatory

The key regulatory mechanisms currently in place, which have potential to mitigate phosphorus and sediment contamination in the SAC are:

- The Environmental Permitting (England and Wales) Regulations 2016

- The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018 (Farming Rules for Water (FRfW))

- Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (England) Regulations 2010 (SSAFO)

The Environment Agency farm regulation campaign has visited c.300 dairy farms in the Axe catchment between 2016-2024 to assess compliance. Around £350k of EA officer time has been invested in the catchment in this period and, working closely with CSF, an estimated £12-14 million has been invested via grant funding and farmer input. A substantial number of new slurry lagoons (around 95) have been or will be constructed because of this input, enhancing around 45km of surface waters discharging to the SAC.

Best estimates of the effect agricultural measures implemented under these mechanisms suggest a 27% reduction in P load could be achieved under a high compliance scenario (Table 3). Unlike point source mitigation, it is difficult to determine a timeframe for downstream improvements relating to diffuse water pollution from agriculture.

5. With the current (or proposed) mechanisms in place, will all the measures needed to ensure protected area objectives be in place to meet river basin planning timetables? **YES OR NO**
NO

6. If NO, what are the options (alternative or additional mechanisms) to get all the required measures in place?
The Farmscoper/SAGIS-SIMCAT modelling findings detailed in section 2 highlight that achieving the SRP target in the SSSI is likely to remain challenging. The theoretical maximum scenario has been modelled for benchmarking purposes only, given that 100% uptake of all relevant farm measures (Appendix A) is not possible in practice. Mean model outputs suggest that even this scenario will not achieve long-term or interim SRP targets in the SSSI. The list of modelled measures is extensive, but not exhaustive and further Farmscoper analyses may be required to assess the effectiveness of an updated suite of measures, which better represents new and emerging land management schemes. It is currently, therefore, difficult to ascertain what realistic measures could be implemented to achieve the targets and the mechanisms which could be used. Further work is required to gather and assess evidence bases to underpin an improvement strategy. An effective mechanism for achieving the SRP target could be voluntary, incentivised, or regulatory. Regulatory changes could be through a Water Protection Zone (WPZ) or a change to the existing Farming Rules for Water. Incentives-based schemes are evolving in the catchment under the national ELM framework, via SFI and the Upper Axe Landscape Recovery Project. The latter is in the project development phase and, working with 32 farms across 2767ha, provides an opportunity for an alternative approach to land management, which could benefit the water environment. Further discussion of preferred options is provided in the sections below.

7. What reductions will each of the options identified above achieve and by when?
Details of the modelled scenarios are provided in section 2, with agricultural load reductions shown in Table 3. To achieve favourable condition targets, it is predicted that the diffuse (agricultural) loads would need to reduce by ~53% or 72% to meet the interim and long-term sector share targets respectively. As stated above, the high compliance uptake rate represents a realistic scenario and under this scenario agricultural P loads would need to reduce by a further 45% to meet long-term targets. Even a theoretical maximum uptake is predicted to fall short of the required reductions. Against this background, it is difficult to ascertain what further measures are viable. An update to the Farmscoper measures suite to account for land use change under the ELM scheme may alter this outcome, but to date this is not available.

Unlike point source reductions, it is not possible to identify a timeframe within which diffuse pollution measures will lead to reductions in river SRP concentrations. This is due to the rate of measures implementation and contaminant behaviour in the catchment. Regarding the former, implementing measures can depend upon the level of engagement in the catchment, which in turn is dependent on the delivery capacity within EA and CSF area teams. In addition, even when measures agreements are in place, there may be a time period for implementation, such is the case for capital items under Countryside Stewardship wherein the recipient has three years to conduct the works and claim the funding.

Another crucial factor to consider is the storage of legacy P in the catchment, which could continue to impact upon surface waters even when mitigation measures are in place. This could lead to a considerable delay between land use changes and water quality improvements downstream. This legacy effect may relate to P storage and behaviour in soils or sediment stored in riparian and channel zones. The extent to which this is occurring in the Axe catchment is unknown although it is well established that catchment improvements should be considered across long-term (several years) timescales. Furthermore, the impact of climate change on weather patterns contributes to uncertainty regarding contaminant behaviour in catchment systems. This also highlights the importance of continued investment in robust long-term monitoring strategies to adequately assess effectiveness of land use change (Davy et al., 2020; Holden et al., 2017; Koch et al., 2023).

8. Cost effectiveness and cost benefit of appropriate options

What are the monetary costs of each of the options considered?

Considering the model findings, it is not possible to undertake full cost-benefit analyses of options. For reference only, estimated economic costs of implementing a high compliance scenario are shown in Table 6. Note that these values are estimates derived from Farmscoper.

This section can be updated in line with selection of options in future appraisals.

Table 6 *Farmscoper derived economic costs of implementing the high compliance scenario[a] across all holdings in the catchment*

Capital Cost (£)	Operational Cost (£)	Total Cost (£)	Environ. Benefit (£)
5,820,481	4,806,596	10,627,077	5,938,455

[a] Uptake rates: All regulatory measures 85%; Farming Rules for Water 'reasonable' 70%; voluntary measures 70%; all other measures at current level

9. Summarise the potential positive and negative impacts on ecosystem services for each option

Considering the model findings, a full appraisal has not been undertaken.

An appraisal summary table is included in Appendix B, which can be revisited and updated as required in line with future planned measures.

For reference, Farmscoper modelling showed an improvement in soil quality and biodiversity scores for the high compliance scenario, which in turn will improve the delivery of ecosystem services across the catchment. Supporting services, such as soil formation and nutrient cycling are likely to improve, underpinning provisioning services (e.g., food supply) and regulatory services (e.g., pest and disease regulation; water regulation). An indication of the effects of agri-environment scheme measures upon ecosystem services has been taken from Natural England (2012) and is shown in Appendix B.

10. What is the preferred option?

Summarise the preferred options to take forward based on the cost effectiveness assessment above

Considering the model findings, it is not possible to undertake full cost-benefit analyses of options.

The modelled scenarios detailed in preceding sections do not achieve the interim or long-term favourable condition targets for the SSSI. Based upon mean modelled values, significant further P reduction is required from the diffuse sector. With available evidence, it is difficult to ascertain viable additional options given the shortfall shown by a theoretical maximum benchmark, which itself is not achievable in practice.

The Diffuse Water Pollution Plan and preceding sections in this appraisal demonstrate the increased resource allocated to land-based measures in recent years via the EA, CSF, and catchment partnerships. Evidence needs to be reviewed and gathered to scrutinise existing approaches and explore alternative options, whether voluntary, incentivised, or regulatory. This will allow a sound case to be developed wherein the effectiveness, practicality and economic viability of the different options can be explored and a decision made regarding the best route to achieving the required P reductions. This will be an adaptive process guided by the evidence.

Developing effective management strategies requires a review of current approaches and available data, alongside addressing evidence gaps. Discussion of the evidence base has highlighted several areas for attention, which are described below and captured as actions in section 5 of the DWPP. A summary table is also provided in this appraisal (Table 7).

Areas of the evidence base highlighted as requiring attention:

- The measures list used in the Farmscoper modelling is extensive and provides best estimates to date but may not adequately capture all options available under the emerging ELM framework. Refinements to the model should be explored in line with current available options under ELM, and future planned options, including those implemented under Landscape Recovery

- Exploring the use/availability of up-to-date risk assessment tools:

  The catchment risk assessment approach detailed by Natural England (2015) provided a resource for spatial targeting and an update of this approach using more recent land use data could be considered for targeting at the waterbody and sub-waterbody scales. The use of available GIS tools for identifying overland flow risk at the farm and field scales should be reviewed to identify opportunities to further support delivery. For example, the development of new erosion and runoff risk layers in the ALERT tool will provide a valuable resource for field-scale targeting based upon hydrological connectivity to surface waters

- A review of the current water quality monitoring programme would be beneficial to ensure it continues to deliver against environmental priorities in the catchment. It is important to identify any shortfalls and opportunities for improving understanding of phosphorus and sediment dynamics in the catchment, which in turn can improve model estimates, spatial targeting, and assessment of measures effectiveness

- An appraisal of spatial targeting of delivery should be undertaken in line with best estimates of key sources derived from modelling/mapping tools

- A review of uptake of measures would be beneficial to explore potential barriers to uptake in the catchment

- Measures for mitigating P (particulate and dissolved) transfer to surface waters should be assessed in the context of catchment conditions to determine their effectiveness i.e., ensuring the right measures are in the right place

- There is a lack of knowledge regarding the extent and impact of legacy P storage in the catchment. Calculation of a P budget in the catchment. (i.e., modelling phosphorus inputs, uptake, and outputs across the catchment system) would help to determine the P surplus and quantify the draw down needed in catchment soils. This would support more effective nutrient management and estimates of timescale for recovery. It is also important to consider this surplus in the context of climate change wherein changes to weather patterns will increase P delivery to surface waters (Ockenden et al., 2017). In that regard, drawing down any P surplus in catchment soils should be a key management focus alongside mitigation measures which target transfer pathways. Without considering this surplus there is a risk that the effects of mitigation measures could be offset by changing weather patterns

***Table 7** Evidence gaps and actions required to identify/develop preferred management options. Actions are included in section 5 of the DWPP*

Category	Component	Evidence Gap	Actions
Data & Evidence	Modelling	Does the current Farmscoper measures suite adequately reflect management options under the ELM framework? What is the effect of land use change under SFI and Landscape Recovery on P and sediment load estimates?	Updated Farmscoper analyses to include catchment-specific data and updated measures suite when available
	Monitoring	Understanding of monitoring needs in the catchment regarding assessment of key source areas and measures effectiveness	Review of current monitoring programme in line with environmental objectives. Enhanced monitoring is currently in place, this includes sonde deployments (2021, 2022, 2023 and planned for 2024), annual proportion of sediment sensitive invertebrates (PSI) assessment, and targeted satellite image assessment of annual changes in over winter bare ground. The results of the enhanced monitoring programme require review to inform management planning
	Risk Assessment	The effect of recent Agricultural Census data on catchment risk assessment outcomes	Initial mapping exercise to determine the extent of land use change since 2007. Consider an update to the catchment risk assessment approach (Natural England (2015)) if deemed necessary
	Legacy P	The extent of phosphorus surplus in catchment soils and internal loading in river channels	Develop a substance flow analysis (SFA) to quantity the stores and flows of P (P budget, imports versus exports) for the catchment and to improve our understanding of legacy soil P (surplus P), its

			vulnerability to loss and its contribution to P transfer to surface waters. Explore management opportunities and barriers to address P 'draw down' in soils (the exploitable P resource) and the adaptive capacity of farmers to implement P stewardship solutions. Attention to timescales for recovery considering soil P surplus, internal loading and climate change factors. Likely desk-based review
Delivery	Spatial Targeting	Alignment of delivery with knowledge of key source areas in the catchment based on available evidence	Mapping on the ground delivery against high-risk areas. Exploring opportunities to improve spatial targeting using GIS tools
	Measures Implementation	Rate of implementation of measures (i.e., conversion of visits to implementation) and barriers to uptake	Review of available audit and farmer feedback data
	Measures effectiveness	Factors impacting the effectiveness of implemented measures on catchment P and sediment delivery	Review of: Suitability of measures for catchment conditions; Measures placement i.e., right measure in the right place and alignment with field-scale spatial targeting tools; Quality of implementation (i.e., following best practice and guidance to ensure effective implementation)

11. If a Water Protection Zone is being considered, summarise the potential positive and negative impacts on ecosystem services for each option required to achieve WFD protected area objectives

A review of available evidence and evidence gaps identified above needs to be undertaken prior to defining an effective alternative mechanism whether voluntary, incentivised, or regulatory.

12. Has a Statement of Intent been agreed between catchment partners?

A panel of Natural England and Environment Agency staff met on 30 Nov 2016 to review the situation in the Axe catchment and consider future compliance based on current performance and monitoring information. The meeting concluded:

- Too much phosphorus is escaping from poorly managed or insufficiently equipped farms.
- This is a year-round problem linked to slurry and soil condition but is most acute during wet weather and most evident where maize is grown.
- Further regulation of water company discharges will not achieve water quality targets without reduction in the diffuse load.
- There was no prospect of compliance with the phosphorus standard for the SAC based on the pattern and intensity of advice from CSF and enforcement by the Environment Agency.

Subsequent work by the Environment Agency during the winter of 2017/18 and further consideration of the impacts of soil compaction concluded that the following are required:

- More effective and more high-profile enforcement of pollution control legislation, including the Farming Rules for Water, is required of the Environment Agency
- More funded capital investment in farm infrastructure
- Increased uptake of CSF advice with more return visits and surveillance of soil management
- Better professional engagement by the maize supply chain on the pollution risks from maize cultivation and the measures required to manage these risks.

The outcomes of the review led to the increased resource allocation described in section 5.

During 2020 the National Farmers Union, the Farming and Wildlife Advisory Group SW and the Environment Agency began developing a programme of technical advice and holistic business planning to support the farming community to reduce diffuse pollution in the Axe catchment. At the same time related discussions were taking place across the wider East Devon Catchment Partnership, which included farmer interviews and feedback. Consultants were commissioned to bring these strands together and develop a single proposal for a funded programme of work around three themes of farming, nature, and people in the emerging Triple Axe Action Plan (East Devon Catchment Partnership, 2021).

A meeting between Environment Agency and Natural England personnel in February 2024, reviewed the progress of mitigation as part of the DWPP update process. Considerable effort has been made to ensure compliance since 2016, alongside significant capital investments. It was agreed that a thorough review of the evidence base needs to be

undertaken to inform future management approaches as part of an adaptive process. A steering group will be established to prioritise and implement the actions listed in the DWPP, and to review and act upon the findings within the adaptive framework.

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Appendix A Farmscoper measures list

ID	Method Name	FRfW (Required)	FRfW (Reasonable)	SSAFO	NVZ	CS	CSF
4	Establish cover crops in the autumn		Y			Y	Y
5	Early harvesting and establishment of crops in the autumn		Y				Y
6	Cultivate land for crops in spring rather than autumn, retaining over-winter stubbles		Y				Y
7	Adopt reduced cultivation systems						Y
8	Cultivate compacted tillage soils		Y				Y
9	Cultivate and drill across the slope						Y
10	Leave autumn seedbeds rough		Y				Y
11	Manage over-winter tramlines		Y				Y
13	Establish in-field grass buffer strips					Y	Y
14	Establish riparian buffer strips		Y			Y	Y
15	Loosen compacted soil layers in grassland fields		Y				Y
16	Allow grassland field drainage systems to deteriorate						Y
180	Ditch management on arable land					Y	Y
181	Ditch management on grassland						
19	Improved livestock through breeding						
20	Use plants with improved nitrogen use efficiency						Y
21	Fertiliser spreader calibration		Y		Y		Y
22	Use a fertiliser recommendation system	Y			Y		Y
23	Integrate fertiliser and manure nutrient supply	Y			Y	Y	Y
25	Do not apply manufactured fertiliser to high-risk areas	Y			Y		Y
26	Avoid spreading manufactured fertiliser to fields at high-risk times	Y			Y		Y
27	Use manufactured fertiliser placement technologies						Y
28	Use nitrification inhibitors						Y
290	Replace urea fertiliser to grassland with another form						Y
291	Replace urea fertiliser to arable land with another form						
300	Incorporate a urease inhibitor into urea fertilisers for grassland						Y
301	Incorporate a urease inhibitor into urea fertilisers for arable land						Y
31	Use clover in place of fertiliser nitrogen						Y
32	Do not apply P fertilisers to high P index soils	Y					Y
331	Reduce dietary N and P intakes: Dairy						Y
332	Reduce dietary N and P intakes: Pigs						Y
333	Reduce dietary N and P intakes: Poultry						Y
341	Adopt phase feeding of livestock: Dairy						Y
342	Adopt phase feeding of livestock: Pigs						Y
35	Reduce the length of the grazing day/grazing season					Y	Y
36	Extend the grazing season for cattle						Y

ID	Method Name	FRfW (Required)	FRfW (Reasonable)	SSAFO	NVZ	CS	CSF
37	Reduce field stocking rates when soils are wet		Y			Y	Y
38	Move feeders at regular intervals		Y				Y
39	Construct troughs with concrete base					Y	Y
42	Increase scraping frequency in dairy cow cubicle housing						Y
43	Additional targeted bedding for straw-bedded cattle housing						Y
44	Washing down of dairy cow collecting yards						Y
46	Frequent removal of slurry from beneath-slat storage in pig housing						Y
481	Install air-scrubbers: mechanically ventilated pig housing						
482	Install air-scrubbers: mechanically ventilated poultry housing						
50	More frequent manure removal from laying hen housing with manure belt systems						
51	In-house poultry manure drying						
52	Increase the capacity of farm slurry stores to improve timing of slurry applications						Y
53	Adopt batch storage of slurry						Y
54	Install covers to slurry stores					Y	Y
55	Allow cattle slurry stores to develop a natural crust						Y
56	Anaerobic digestion of livestock manures						Y
570	Minimise the volume of dirty water produced (sent to dirty water store)				Y	Y	Y
571	Minimise the volume of dirty water produced (sent to slurry store)				Y	Y	
59	Compost solid manure						Y
60	Site solid manure heaps away from watercourses/field drains	Y			Y		Y
61	Store solid manure heaps on an impermeable base and collect effluent					Y	Y
62	Cover solid manure stores with sheeting						Y
63	Use liquid/solid manure separation techniques						Y
64	Use poultry litter additives						
67	Manure Spreader Calibration				Y		Y
68	Do not apply manure to high-risk areas	Y			Y		Y
69	Do not spread slurry or poultry manure at high-risk times	Y			Y		Y
70	Use slurry band spreading application techniques						Y
71	Use slurry injection application techniques						Y
72	Do not spread FYM to fields at high-risk times	Y			Y		Y
73	Incorporate manure into the soil		Y		Y		Y
76	Fence off rivers and streams from livestock		Y			Y	Y
77	Construct bridges for livestock crossing rivers/streams					Y	Y
78	Re-site gateways away from high-risk areas					Y	Y
79	Farm track management					Y	Y
80	Establish new hedges						Y
81	Establish and maintain artificial wetlands - steading runoff					Y	Y
82	Irrigate crops to achieve maximum yield						Y

ID	Method Name	FRfW (Required)	FRfW (Reasonable)	SSAFO	NVZ	CS	CSF
83	Establish tree shelter belts around livestock housing						Y
90	Calibration of sprayer						Y
91	Fill/Mix/Clean sprayer in field						Y
92	Avoid PPP application at high-risk timings						Y
94	Drift reduction methods						Y
95	PPP substitution						Y
96	Construct bunded impermeable PPP filling/mixing/cleaning area					Y	Y
97	Treatment of PPP washings through disposal, activated carbon or biobeds					Y	Y
101	Protection of in-field trees						
102	Management of woodland edges						
103	Management of in-field ponds					Y	
105	Management of arable field corners						
106	Plant areas of farm with wild bird seed / nectar flower mixtures					Y	
107	Beetle banks					Y	
108	Uncropped cultivated margins						
109	Skylark plots						
110	Uncropped cultivated areas					Y	
111	Unfertilised cereal headlands						
112	Unharvested cereal headlands						
113	Undersown spring cereals		Y				
114	Management of grassland field corners					Y	
116	Leave residual levels of non-aggressive weeds in crops					Y	
117	Use correctly inflated low ground pressure tyres on machinery		Y				Y
118	Locate out-wintered stock away from watercourses		Y				
119	Use dry-cleaning techniques to remove solid waste from yards prior to cleaning						
120	Capture of dirty water in a dirty water store			Y			Y
121	Irrigation/water supply equipment is maintained and leaks repaired						
122	Avoid irrigating at high-risk times						
123	Use efficient irrigation techniques (boom trickle, self-closing nozzles)						
124	Use high sugar grasses						
125	Monitor and amend soil pH status for grassland						
126	Increased use of maize silage						
131	Improved crop health						
132	Better health planning: dairy						
133	Better health planning: beef						
134	Better health planning: sheep						
135	Improve livestock through genetic modification						
136	Slurry acidification during storage						
137	Slurry acidification at spreading						
138	Install covers to slurry stores and burn off methane						
139	Use feed additives to reduce enteric methane emissions						

Appendix B Assessment of ecosystems services from agri-environment scheme example measures. Source: Natural England, 2012.

Green = positive, red = negative, amber = positive and negative

	Soil, Nutrients, water[2]	Genetic resources	Pest regulation	Pollination
Boundary features				
• Hedgerows	Green		Amber	Green
• Stone-faced hedgebanks	Green		Amber	Green
• Ditches	Green		Red	
• Hedges and ditches combined (basic hedge management)	Green		Amber	Green
• Stone walls	Green			
Trees and woodland				
• In-field trees (general)	Green			Green
• Woodland fences	Green			
• Woodland edges	Green		Amber	
• Wood pasture and parkland	Green			Green
• Woodland	Green			Green
• Scrub	Green		Amber	Green
• Orchards	Green	Green	Amber	Green
Historic and landscape features				
• Archaeology under grassland	Green			
• Archaeology under cultivated soils				
• Archaeology and high water levels	Green		Amber	
• Designed water bodies	Green		Red	

[2] Over all categories. Can separate these if necessary or more convenient

	Soil, Nutrients, water[2]	Genetic resources	Pest regulation	Pollination
• Water meadows				
• Traditional farm buildings				
Buffer strips, field margins and corners				
• Buffer strips (2m & 4m)				
• Enhanced buffer strips (6m)				
• Enhanced buffer strips (without grazing)				
• Enhanced buffer strips (with grazing)				
• Buffer strips beside ponds and streams				
• Uncropped cultivated margins				
• Conservation headlands				
• Conservation headlands (no fertiliser or harvesting)				
• Field corners				
Arable land				
• Seed mixtures sown for birds or insects				
• Fallow plots for ground nesting birds and arable flora				
• Low input cereals				
• Undersown spring cereals				
• Over-wintered stubbles				
• Whole crop silage and over-wintered stubbles				
• Fodder crops and over-wintered stubbles				
• Beetle banks				
Grassland				
• Low input grassland				
• Species rich grassland				

	Soil, Nutrients, water[2]	Genetic resources	Pest regulation	Pollination
• Rough grazing (basic)				
• Rough grazing (enhanced)				
• Rush pastures				
• Wet grassland				
• Mixed stocking				
• Rare breeds (supplement)				
Moorland and heath				
• Moorland				
• Shepherding (supplement)				
• Lowland heathland				
The coast				
• Coastal saltmarsh				
• Sand dunes				
Wetland				
• Ponds				
• Reedbeds				
• Fen				
• Lowland raised bog				
Soils				
• Maize crops and resource protection (without cover crop)				
• Maize crops and resource protection (with cover crop)				
• Arable reversion to grassland (no fertiliser)				
• Arable reversion to grassland (low input)				
• Infield grass areas				

	Soil, Nutrients, water[2]	Genetic resources	Pest regulation	Pollination
• Intensively managed grassland and soils (low input)				
• Seasonal livestock removal on intensive grassland)				
• Watercourses and erosion				

Natural Capital Appraisal Summary Table:

Establishing a baseline and forecasting change in Ecosystem Services

Option 1	Option 2	Option 3	Option 4
Current measures uptake	High Compliance scenario		

Ecosystem Service Category	Current (what is there now)	Change in these services				
		Initial Project/Plan ideas				
	Baseline	Option 1	Option 2	Option 3	Option 4	Beneficiaries
Provisioning services						
Water supply	No DWPAs. Some small private abstraction	o	o	Choose an item.	Choose an item.	
Food	>400 farms	o	o	Choose an item.	Choose an item.	
Fibre and fuel	Forestry	o	o	Choose an item.	Choose an item.	
Genetic resource	Priority Orchards	?	o	Choose an item.	Choose an item.	
Biochemicals, natural medicines, pharmaceuticals		?	o	Choose an item.	Choose an item.	

Ecosystem Service Category	Current (what is there now)	Change in these services				
		Initial Project/Plan ideas				
	Baseline	Option 1	Option 2	Option 3	Option 4	Beneficiaries
Ornamental resources		?	o	Choose an item.	Choose an item.	
Renewable energy	Small scale solar/wind	o	o	Choose an item.	Choose an item.	
Energy		?	o	Choose an item.	Choose an item.	
Minerals	Up to four active quarries in catchment Sand and gravel extraction at Chard Junction and Kilmington	o	o	Choose an item.	Choose an item.	
Regulatory services						
Air quality regulation	Ancient woodland; priority grassland; priority wetland	o	o	Choose an item.	Choose an item.	
Climate regulation	Ancient woodland; priority grassland; priority wetland	o	^	Choose an item.	Choose an item.	Wider community. Soil structure/carbon sequestration improvements
Water flow regulation	Ancient woodland; priority grassland; priority wetland; current agri-env measures e.g., buffer strips; swales	o	^	Choose an item.	Choose an item.	Wider community downstream of measures
Hazard regulation	Ancient woodland; priority grassland;	o	^	Choose an item.	Choose an item.	Wider community downstream of measures

Ecosystem Service Category	Current (what is there now)	Change in these services				
		Initial Project/Plan ideas				
	Baseline	Option 1	Option 2	Option 3	Option 4	Beneficiaries
	priority wetland; current agri-env measures e.g., buffer strips; swales					
Disease & pest control	Some integrated pest management (IPM)	o	^	Choose an item.	Choose an item.	Farming community
Water quality regulation	Ancient woodland; priority grassland; priority wetland; current agri-env measures e.g., buffer strips; swales	o	^	Choose an item.	Choose an item.	Wider community downstream environments
Pollination	Ancient woodland; priority grassland; priority wetland; wood pasture; some pollinator option in agri-env schemes	o	^	Choose an item.	Choose an item.	Farming community; wider community
Noise mitigation		?	o	Choose an item.	Choose an item.	
Light reduction		?	o	Choose an item.	Choose an item.	
Cultural services						
Cultural heritage	Woodland; parks; heritage museum	o	o	Choose an item.	Choose an item.	
Aesthetic value & sense of place	SSSI/SAC	o	^	Choose an item.	Choose an item.	Wider community

Ecosystem Service Category	Current (what is there now)	Change in these services				
		Initial Project/Plan ideas				
	Baseline	Option 1	Option 2	Option 3	Option 4	Beneficiaries
Spiritual and religious value	Church	o	o	Choose an item.	Choose an item.	
Inspiration of art, folklore, architecture, etc		?	o	Choose an item.	Choose an item.	
Education	Heritage Centre; Farm school	?	o	Choose an item.	Choose an item.	
Volunteering		?	o	Choose an item.	Choose an item.	
Recreation	Parks, public paths; beach	o	^	Choose an item.	Choose an item.	Wider community e.g., benefits from pollution and flow regulation upon bathing waters
Amenity	Parks, public paths; beach	o	^	Choose an item.	Choose an item.	Wider community e.g., benefits from pollution and flow regulation upon bathing waters
Physical health	Parks, public paths; beach	o	^	Choose an item.	Choose an item.	Wider community e.g., benefits from pollution and flow regulation upon bathing waters
Mental health	Parks; woodland; public paths; beach; SSSI/SAC surroundings	o	^	Choose an item.	Choose an item.	Wider community
	Supporting services					
Soil quality	Woodland; low input, low intensity grazing; herbal leys	^	^^	Choose an item.	Choose an item.	Farming community directly. Indirect benefits to wider community via improved regulatory services

Ecosystem Service Category	Current (what is there now)	Change in these services				
		Initial Project/Plan ideas				
	Baseline	Option 1	Option 2	Option 3	Option 4	Beneficiaries
Primary production	Freshwater plants/algae; priority habitats	o	^	Choose an item.	Choose an item.	Wider community via feedback of improved regulatory services
Nutrient cycling	Ancient woodland; priority grassland; priority wetland; wood pasture;	o	^	Choose an item.	Choose an item.	Wider community via feedback of improved regulatory services
Water cycling	Ancient woodland; priority grassland; priority wetland; wood pasture	o	^	Choose an item.	Choose an item.	Wider community via feedback of improved regulatory services
Photosynthesis	Ancient woodland; priority grassland; priority wetland; wood pasture; aquatic plants/algae	o	^	Choose an item.	Choose an item.	Wider community
Habitats	Ancient woodland; priority grassland; priority wetland; wood pasture; floodplain marsh; lowland meadows; semi-improved grassland of good quality	o	^	Choose an item.	Choose an item.	Wider community
	Bundled services					
Quality of water	Bathing waters; marine SAC	o	^	Choose an item.	Choose an item.	Wider community via feedback of improved regulatory services

Ecosystem Service Category	Current (what is there now)	Change in these services				
		Initial Project/Plan ideas				
	Baseline	Option 1	Option 2	Option 3	Option 4	Beneficiaries
Biodiversity	SSSI/SAC habitats; Priority Habitats and associated biodiversity	o	^	Choose an item.	Choose an item.	Wider community via feedback of improved regulatory services