River Avon SAC Working Group

River Avon SAC - Phosphate Neutral Development

Interim Delivery Plan

Wood Environment & Infrastructure Solutions UK Limited – January 2019

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Report for

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Management systems

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Document revisions

No.	Details	Date
1	Draft Report	November 2018
2	Draft Final Report	December 2018
3	Final Report	January 2019

Executive summary

Purpose of this report

This report has been produced for the purpose of describing the interim plan developed by the River Avon SAC Working Group to achieve phosphorus neutral development over the period to 2025, and outlining in more detail how the plan can be delivered in the period to March 2020. It includes a calculation of the estimated additional phosphorus load that will be discharged in the catchment through increased volumes of sewage effluent, and sets out a suite of measures that could be deployed to mitigate that load.

Spatial data for the catchment to the River Avon SAC are included that illustrate where in the catchment measures are likely to be most effective at reducing diffuse phosphorus pollution. Recommendations are made as to which measures should be taken forward and how the plan can be delivered on the ground. It is shown that it is feasible to achieve the necessary reductions in diffuse phosphorus pollution to mitigate planned growth, both with and without the implementation of Wessex Water's Outcome Delivery Incentive.

Contents

1. Introduction

This report describes the interim approach to identifying and implementing measures to achieve phosphorus neutral development in the River Avon SAC.

1.1 Background

1.1.1 The Hampshire Avon is a groundwater fed Chalk river in the south of England. It rises in the Vale of Pewsey, Wiltshire, and flows south to the English Channel at Christchurch, Dorset, draining a total area of about 1,700 km^2. The whole river is a designated Special Area of Conservation (SAC), supporting a variety of important ecology.

1.1.2 Elevated levels of phosphorus can have a detrimental effect on the ecology and biodiversity of rivers, including eutrophication, and for this reason conservation objectives have been set for the SAC which include annual average and growing season average levels of phosphate in the river. There are two principal sources of phosphorus in rivers: effluent discharges from sewage treatment works, and diffuse phosphorus pollution, mainly in runoff from agricultural land. Wessex Water made significant investments in infrastructure during the period 2005-2015 in order to reduce phosphorus loads in sewage effluent. Nonetheless, objectives for growth in the catchment will result in new connections to sewage treatment works which, if not mitigated, will result in increased phosphorus loadings to the river in sewage effluent.

1.1.3 In 2015 the Environment Agency, Natural England and Wiltshire Council published a nutrient management plan (NMP) for the River Avon SAC which set out ambition targets to reduce the phosphate loading to the river from diffuse sources, in order to support compliance with conservation objectives, the requirements of the Habitats Directive and the Water Framework Directive, while still allowing some increase in point source (sewage) loadings from population growth. The NMP set out a suite of measures to reduce agricultural diffuse phosphorus pollution, to be delivered primarily through the Catchment Sensitive Farming (CSF) initiative. A Working Group (WG) was established to deliver the NMP, comprising members from Natural England, the Environment Agency, Local Planning Authorities and Water Utilities. The membership of the WG is as shown in Table 1.1.

Table 1.1 Membership of the River Avon SAC Working Group

Organisation	Role
Environment Agency	Regulatory body, responsible for the protection and enhancement of the natural environment. "Competent authority" under the Habitats Regulations
Natural England	Government adviser, with key role in implementation of Habitats Directive. "Statutory Nature Conservation Body"
Wiltshire Council	Local Planning Authority (LPA). "Competent authority" under the Habitats Regulations.
New Forest District Council	Local Planning Authority (LPA). "Competent authority" under the Habitats Regulations.
New Forest National Park Authority	Local Planning Authority (LPA). "Competent authority" under the Habitats Regulations.

Organisation	Role
Christchurch and East Dorset Council	Local Planning Authority (LPA). "Competent authority" under the Habitats Regulations.
Wessex Water	Water supply and sewerage undertaker. "Competent authority" under the Habitats Regulations.

1.1.4 Since 2015 it has become apparent that CSF is not achieving the reductions in phosphorus loading to the river required to meet the ambition targets. In 2018 the organisations of the WG (except East Dorset DC) signed a Memorandum of Understanding (MoU) that set out a more stringent approach to planning, requiring that new development in the catchment needs to be "phosphate-neutral, as requested in a joint statement from the Environment Agency and Natural England." The term "phosphate-neutral" is defined in the MoU ("Principles and Definitions", page 1), as follows:

"The additional phosphorus load generated by new development after controls at source, reduction by treatment and/or offsetting measures leads to no net increase in the total phosphorus load discharged to the River Avon SAC."

1.1.5 This "interim approach" will apply to all development in the catchment to the River Avon SAC, or that would connect to a sewage treatment works that discharges in the catchment, over the period 2018-2025. After this time, it is expected that this interim approach will be replaced by an approach that will take account of water company planning as well as government policy and legislation.

1.1.6 As part of their PR19 business plan, Wessex Water have made a performance commitment to support improvements to rivers (outside of their existing Water Industry National Environment Programme (WINEP) commitments).[1] This Outcome Delivery Incentive (ODI) commits to maintaining levels of phosphate discharge to the R Avon SAC to the average level of the last five years. This would operate over the years 2020-2025. The Business Plan has yet to be approved (due by Dec 2019), and, although the ODI is not a regulatory requirement Wessex Water clearly recognise the issue and intend to take action.

1.1.7 With an ODI in effect all new connections to Wessex Water sewage treatment works would be phosphate-neutral. However, the interim approach is required as a contingency to the ODI not being implemented in full, and also to cover new development in the period 2018-2025 that would not connect to Wessex Water's sewer network, and, as part of a precautionary approach, to cover all new development prior to 2020.

1.1.8 The MoU commits signatories to working cooperatively to set out and cost appropriate phosphate mitigation measures. The signatories have agreed to work together to develop the means for their delivery. An Annex to the NMP has been published has assessed a range of possible measures. This report develops these options further into an Interim Delivery Plan.

1.2 Structure of this report

1.2.1 This document sets out the interim approach agreed by the working group as follows. Section 2 sets out projections for the period to March 2025 of growth from residential and non-residential development, including an estimate of likely unsewered development, and estimates of the associated increase in phosphorus loads to the River Avon SAC. A sensitivity analysis is included to illustrate the possible variations from these calculations.

[1] https://www.wessexwater.co.uk/BP2020/Section%203/03.01.A%20-%20Performance%20commitment%20detail.pdf

1.2.2 Section 3 describes a suite of potential measures, as set out in Annex 2 to the River Avon SAC Nutrient Management Plan that could mitigate increases in phosphorus loads from this planned growth. Measures could apply on-site, in the wider catchment or through water company initiatives. Each measure is assessed in terms of challenges to implementation and wider benefits, and a high-level estimate of the reduction in P loads that it could achieve.

1.2.3 Section 4 describes the geographical setting of the River Avon SAC, and based on this, the applicability of various measures in different parts of the catchment.

1.2.4 Section 5 provides an Interim Delivery Plan (IDP) that shows how measures will achieve phosphate neutral development in the lead up to the implementation of the ODI, act as a contingency to Wessex Water measures and will achieve phosphate neutrality for new development that does not connect to the Wessex Water network.

2. Forecast Growth in the River Avon SAC

2.1 Increases in Phosphorus loads due to development

Residential growth

2.1.1 Housing development generates the largest proportion of the P loading to sewage treatment works (STWs) leading to increased volumes of sewage discharge. The method by which this additional loading is quantified is described in the MoU (Section 1.1). In summary, the calculation includes the following steps and assumptions:

- The phosphate load generated by new sewage connections associated with a proposed development is calculated on the basis of the number of planned dwellings;
- An average occupancy rate of 2.3 people per dwelling (the national average) is assumed, unless there is clear evidence that a higher or lower figure is appropriate;
- A rate of water use of 110 l/person/day is assumed (the "optional" lower figure set out in Building Regulations Part G, as opposed to the standard allowance of 125 l/person/day);
- It is assumed that the receiving STW discharges effluent with a phosphate concentration of 90% of the permitted concentration; and
- The total additional P load from increased sewage discharge is the product of the total number of new dwellings, the average occupancy rate, the daily water use per occupant and the sewage effluent quality (phosphate concentration).

2.1.2 Based on this method, the calculated additional phosphate loading from new connections from residential development over the period of the interim plan (March 2018- March 2025) is as shown in Table 2.1.

Table 2.1 Projected additional phosphorus loading from sewage produced by new residential development (based on Local Planning Authority Housing Land Supply Data, 2018).

Financial Year End	Potential growth (dwellings)	Additional population (persons)	Waste water discharge (l/day)	P after STW treatment (mg/day)	P per year (mg)	P Annual Total (kg)	P Cumulative Total (kg)
2019	1054	2424	266662	239995.8	87598467	87.60	87.60
2020	852	1960	215556	194000.4	70810146	70.81	158.41
2021	715	1645	180895	162805.5	59424008	59.42	217.83
2022	807	1856	204171	183753.9	67070174	67.07	284.90
2023	1155	2657	292215	262993.5	95992628	95.99	380.90
2024	790	1817	199870	179883.0	65657295	65.66	446.55
2025	842	1937	213026	191723.4	69979041	69.98	516.53

2.1.3 Over the 7-year period of the interim plan, this equates to a total of **2,092 kg P** for the catchment to the River Avon SAC.

2.1.4 It should be noted that if Wessex Water's ODI is adopted then all residential development after 2020 that connects to a Wessex Water sewage treatment works will be phosphate-neutral. In practice, most if not all residential development in the period 2018-2020 will also be phosphate-neutral, since developments granted planning permission during that period are unlikely to be occupied before 2020.

Non-residential growth

2.1.5 Based on Wessex Water's growth forecasts, and using the same methodology to estimate phosphorus loads as described above for residential growth, the additional phosphorus load arising from non-residential development has been estimated as shown in Table 2.2. It is noted that Wessex Water estimate lower phosphorus loads from non-residential growth, using a different method based on recent performance data from their assets. The estimates in Table 2.2 therefore represent a worst case precautionary approach.

Table 2.2 Projected additional phosphorus loading from non-residential development

Financial Year End	Additional population (persons)	Waste water discharge (l/day)	P after STW treatment (mg/day)	P per year (mg)	P Annual Total (kg)	P Cumulative Total (kg)
2019	270.4	29744	26770	9770904	9.77	9.77
2020	338	37180	33462	12213630	12.21	21.98
2021	396	43560	39204	14309460	14.31	36.29
2022	454	49940	44946	16405290	16.41	52.70
2023	512	56320	50688	18501120	18.50	71.20
2024	570	62700	56430	20596950	20.60	91.80
2025	628	69080	62172	22692780	22.69	114.49

2.1.6 Over the 7-year period of the interim plan, this equates to a total of **398 kg P**.

Unsewered development

2.1.7 Analysis by Wiltshire Council has previously shown that approximately 5% of recent building completions from residential development in the Avon catchment have been within unsewered areas. These developments are typically served by a septic tank and soakaway, which will infiltrate to groundwater and ultimately reach rivers in baseflow.

2.1.8 The phosphorus loading from such schemes is difficult to forecast, but accounting for the fact that the estimate is for the performance of new equipment it is estimated using similar assumptions to those described above.

- Assuming that 5% of new development is unsewered, this equates to 32 dwellings per annum, or 224 dwellings over the interim period 2018-2025.
- At an occupancy rate of 2.3 people per dwelling, this is equal to 515 residents.
- Each person exports 0.44 kg P/year in sewage, generating a total P load of 227 kg P/year.
- Assuming 88% attenuation (see Annex 4 of the NMP), the loading to the River Avon SAC is calculated at **27 kg P/yr**.

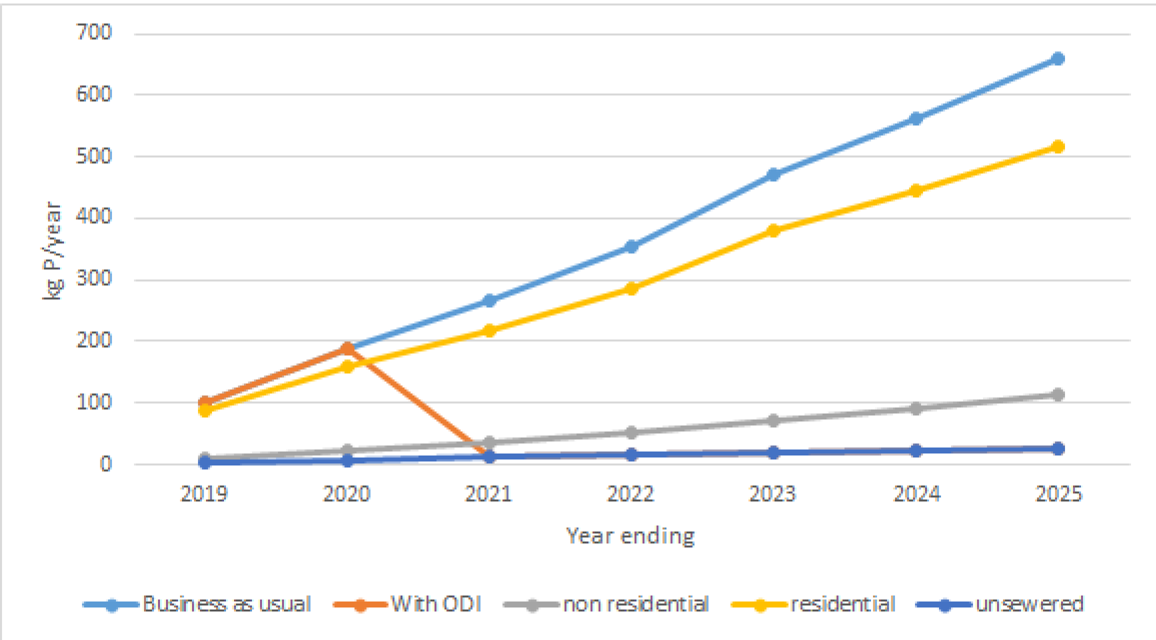
2.1.9 A more detailed breakdown is shown in Table 2.3. The locations of septic tanks, and in particular their proximity to watercourses and designated features such as SSSIs, can affect the degree of subsurface attenuation of phosphorus that occurs before the effluent reaches a sensitive site. Work commissioned by Natural England has produced risk maps for wetland sites, and it is noted that in some high-risk areas there may be less attenuation of phosphorus than has been assumed in the calculation presented here.

Table 2.3 Projected additional phosphorus loading from unsewered residential development

Financial Year End	Total new dwellings	Additional population (persons)	P export (kg/year)	P after attenuation (kg/year)	P Cumulative Total (kg)
2019	32	74	32.38	3.9	3.89
2020	32	74	32.38	3.9	7.77
2021	32	74	32.38	3.9	11.66
2022	32	74	32.38	3.9	15.54
2023	32	74	32.38	3.9	19.43
2024	32	74	32.38	3.9	23.32
2025	32	74	32.38	3.9	27.20

2.1.10 Over the 7-year period of the interim plan, this equates to a total of **109 kg P**. These figures are illustrated in Figure 2.1.

Figure 2.1 Estimated growth in phosphorus loads from development



2.2 Agricultural land taken out of production

2.2.1 Although housing development generates additional P loading through increased sewage flows from point sources, the cessation of intensive agriculture on greenfield sites can also reduce P loading from diffuse sources, helping to mitigate the net effect of development, and this can contribute to offsetting. The NMP assumes an average rate of phosphate export from the soil zone of agricultural land of 0.4 kg P/ha/year. Further detail on modelled P export from agricultural land is provided in Section 3.2.

2.2.2 However, phosphate can also be exported from these newly developed urban areas. Entec (2010)[2] reviewed urban sources of phosphorus loss, and found that the most significant urban diffuse P sources are mains water leakage (in areas where mains water is dosed for plumbosolvency) and sewer leakage, which between them typically accounted for around 90% of the total loading. Both these sources should be very low for new developments on greenfield, as lead pipes are no longer used, and sewer integrity should be very high.

2.2.3 Work carried out by HR Wallingford for Natural England, the Environment Agency and Wessex Water in 2018 assessed urban diffuse pollution from Nailsea, and the use of SuDS to mitigate pollutant loads to a nearby SSSI. The report states that

2.2.4 *"Any new development will increase pollution loads to the receiving waterbody unless appropriate water quality management is designed into the system within a SuDS approach. … For the purpose of this analysis it was assumed that SuDS treatment would be implemented effectively … therefore pollutant washoff from the new developments was assumed as not taking place."*

2.2.5 It is therefore not unreasonable to assume that, for greenfield sites previously in agricultural production, the increased P loading from new sewer connections will be offset by around 0.4 kg P/ha through a reduction in diffuse agricultural losses. Development is required to provide SUDs in accordance with technical best practice

2.2.6 The LPAs have indicated that the total area of land allocated for development in the Avon catchment in the period to 2025 is 84 ha (NFDC) and 202 ha (Wiltshire Council): a total of 286 ha[3]. Assuming that this land is all greenfield, and that it is taken out of agricultural production at a constant rate over the period of the IDP, this equates to a land take of 41 ha per year. This is equivalent to an offset of **16.3 kg P/year**.

2.3 What is the total phosphorus load to be mitigated?

2.3.1 On the basis of the calculations detailed in Section 2.1, the total P load from new development that could potentially need to be mitigated is the sum of the loads from residential growth (sewered and unsewered) and non-residential growth, which equates to **2,599 kg P** over the 7-year period of the interim plan, or an average of **371 kg P/year**.

2.3.2 However, once the ODI comes into operation in 2020, this would ensure that all sewered development connecting to Wessex Water networks (residential and non-residential) is phosphate-neutral. In this situation, mitigation would be required for all unsewered development, any development outside of the Wessex Water sewer network and potentially any development granted planning permission before 2020 (although as noted in Section 1, developments determined after 2018 are unlikely to be occupied before 2020). Potentially therefore, the total P load requiring mitigation is much smaller than the projected increase due to development.

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[2] Cumulative Nitrogen and Phosphorus Loadings to Groundwater, Final Report, November 2010. Ref 27510rr032i3, 178pp.

[3] Source: Local Planning Authorities, 2018. Includes undeveloped land with planning permission or allocated in Local Plans.

2.3.3 The total projected increase in P load from all sectors (residential, sewered and unsewered, and non-residential) in each year, including an allowance for a reduction in P export from land taken out of production due to development, is as shown in Table 2.4. This demonstrates that, once the ODI comes into operation, the reduction in P export from land take for new development will more than mitigate the growth in P loads from unsewered development, and no further mitigation will be required.

2.3.4 For the financial year ending 2019 the total reduction in phosphorus required is 85 kg. For financial year ending 2020 a further

Table 2.4 Projected additional phosphorus loading (kg P) requiring mitigation.

Financial year end	Sewered	Unsewered	Non-residential	Offset from land take	Total - without ODI	Total - with ODI
2019	87.6	3.9	9.8	-16.3	84.9	84.9
2020	158.4	7.8	22.0	-32.7	155.5	155.5
2021	217.8	11.7	36.3	-49.0	216.8	0.0
2022	284.9	15.5	52.7	-65.4	287.8	0.0
2023	380.9	19.4	71.2	-81.7	389.8	0.0
2024	446.6	23.3	91.8	-98.0	463.6	0.0
2025	516.5	27.2	114.5	-114.4	543.8	0.0

2.4 Sensitivity Analysis

2.4.1 The estimates of increases in P load arising from new development rely on a number of assumptions (as described in Section 2.1). In order to understand how the estimated P loads may vary in response to changing assumptions underpinning them, the calculation of increased P loads from residential development, which is by far the largest of the three sectors, have been repeated with differing assumptions around water use, total housing growth and sewage effluent quality.

2.4.2 Three additional calculations were carried out:

- Housing growth at a rate of 10% above the baseline projection;
- Increased per capita water use of 150 l/person/day (the standard figure from Flows and Loads[4], reflecting national average consumption); and
- Improved effluent quality of 0.5 mg-P/l (noting that many Wessex Water works currently treat to a standard close to this quality).

2.4.3 The results are as shown in Table 2.5.

[4] https://www.britishwater.co.uk/code-of-practise-flows-and-loads-4-on-sizing-criteria-treatm.aspx

Table 2.5 Results of sensitivity calculations on predicted increases in P loads

Assumption	Housing growth (dwellings)	Water use (l/person/day)	Effluent quality (mg-P/l)	Predicted increase in P load 2018-2025 (kg)
Baseline	6,215	110	0.9	2,092
Increased housing growth	6,837	110	0.9	2,302
Increased water use	6,215	150	0.9	2,854
Improved effluent quality	6,215	110	0.5	1,163

2.4.4 It is evident that there are considerable differences in the predicted increases in P loads using different assumptions with a range of 1,691 kg P between the best and worst case. Since the calculation of increase in P load is linear, being simply the product of the input variables, an increase of X% in one of the input variables will result in an increase of X% in the predicted P loads.

2.4.5 The ODI, when approved, will result in no net increase in P loads discharged from Wessex Water assets compared with the average load over the 5 years 2013-2017. Data from Wessex Water indicate that many of their works currently out-perform their permits and treat to a higher effluent quality than the baseline assumption of 0.9 mg-P/l, typically 0.5 mg-P/l to 0.7 mg-P/l. On the advice of Natural England, a precautionary approach uses a worst-case scenario. The baseline assumption of effluent quality of 0.9 mg-P/l is therefore conservative, by a significant margin. The estimated increase in P load assuming an occupancy rate of 2.3, per capita water use of 150 l/person/day and effluent treatment to 0.5 mg P/l is 1,585 kg P.

2.4.6 The baseline figure for the increase in P loading from residential development (0.9 mp-P/l) is an overestimate, therefore, even if the ODI is not adopted, particularly if Wessex Water continue to operate their treatment works to the same quality as in recent years as this would still represent a higher quality than 0.9 mg-P/l.

3. Options for mitigating increases in Phosphorus Loads

3.1 Introduction

3.1.1 This section sets out an appraisal of measures that could be implemented to mitigate increases in phosphorus loads to the River Avon SAC due to development. This builds on the measures appraisal included in Annex 2 of the River Avon NMP, and provides an indication of the approximate costs and effectiveness of measures.

3.1.2 Estimates of costs and potential effectiveness are necessarily based on a number of assumptions, since the actual costs and effectiveness of measures will depend on the local setting, particularly for those measures targeting agricultural diffuse pollution. Measures are divided into those that would be applied at the development site (on-site), those that would be applied within the wider catchment (which are principally targeted at agricultural diffuse pollution) and those that fall within the remit of the water company.

3.1.3 In practice, the derivation of suitable mitigation measures will need to be determined on a case-by-case basis as individual applications come forward for consideration. This is because the effectiveness of measures, particularly those to mitigate agricultural diffuse pollution, require detailed information on the "baseline" for each farm on which intervention is planned, and hence the level of reduction that can be achieved. The next section sets out estimates of baseline (i.e. pre-mitigation) agricultural pollutant losses from a variety of generic farm types, to assist in understanding the scale of reduction that can be achieved through measures, and which farm types are likely to present the greatest risk of diffuse agricultural pollution. The remainder of this section then provides further details of a range of potential measures to reduce P loads to the catchment.

3.1.4 It should be noted that all the estimates of cost and effectiveness have some uncertainty, hence many are expressed as a range. Further work will be required during the delivery of the IDP to refine these estimates as a part of monitoring the performance of implemented schemes and so ensure phosphate neutrality is being achieved over the interim period.

3.2 Baseline agricultural pollutant losses

3.2.1 The reductions in phosphorus export from agricultural land that can be achieved through implementation of measures will depend on the estimated current "baseline" losses. This section sets out estimated present-day P losses from a variety of different farm types, prior to any mitigation being put in place. Farms with the greatest baseline P losses offer the greatest potential for mitigation.

3.2.2 Baseline estimates of P export from agricultural land are based on outputs from the ADAS Farmscoper 4[5] model. These figures reflect estimated losses from "model" generic farm types, which assume typical land areas and livestock numbers. In reality, farms in the River Avon catchment will not match these assumptions precisely, and as the interim plan is delivered it will be necessary to carry out more detailed assessments of actual nutrient losses from individual farms based on more precise data. These figures should thus be considered as illustrative only, and are included here as they form the basis for estimates of the reductions in P loads that could be achieved through catchment mitigation measures. Tables 3.1 and 3.2, and Figure 3.1, show baseline

[5] http://www.adas.uk/Service/farmscoper

losses from each Farmscoper farm type for situations typical of the Hants Avon: 700-900 mm annual rainfall, and for free draining soil (over the Chalk, for example) and for other soils, which are assumed to be drained for arable use (more typical of the Tertiary deposits in the lower catchment), respectively. It is evident that predicted P losses are significantly greater from farms with less free-draining soils. If the assumption is made that agricultural grassland is also drained, then predicted P losses increase further still (although it is unlikely that this would apply to much land in the Avon catchment). This suggests that there will be greatest benefit in targeting farms on heavier soils that are more likely to have assisted drainage in place (likely to be found more in the lower catchment, south of Fordingbridge, and in parts of the Nadder). This will not, however, protect the upper part of the catchment.

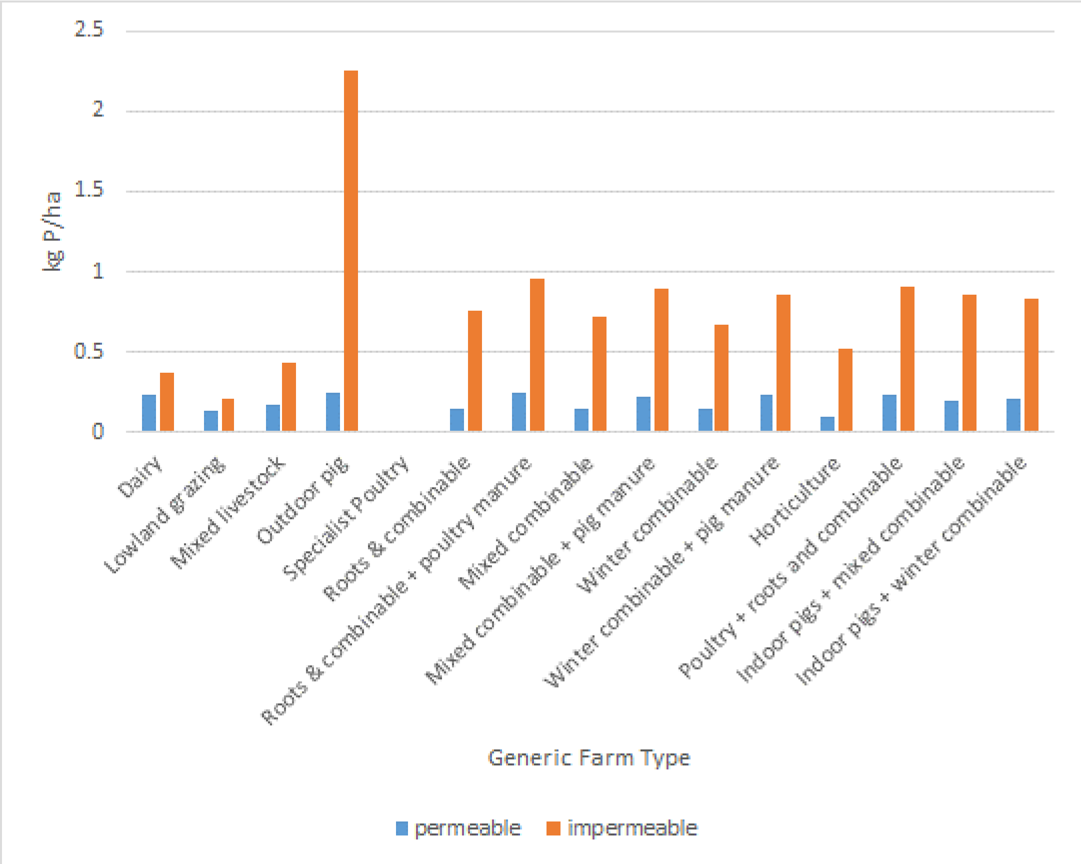
Table 3.1 Farmscoper baseline P export by farm type, free draining soil, 700-900mm annual average rainfall

Farm type	Land area (ha)	Baseline P export (kg)	Baseline P export (kg/ha)
Dairy	114	25.91	0.23
Lowland grazing	101	13.2	0.13
Mixed livestock	156	27.10	0.17
Outdoor pig	57	14.46	0.25
Specialist Poultry	No land for livestock	0.05	
Roots & combinable	180	26.35	0.15
Roots & combinable + poultry manure	180	45.38	0.25
Mixed combinable	197	28.39	0.14
Mixed combinable + pig manure	197	43.56	0.22
Winter combinable	159	22.33	0.14
Winter combinable + pig manure	159	37.16	0.23
Horticulture	18	1.81	0.10
Poultry + roots and combinable	350	79.15	0.23
Indoor pigs + mixed combinable	197	39.07	0.20
Indoor pigs + winter combinable	159	32.79	0.21

Table 3.2 Farmscoper baseline P export by farm type, impermeable soil drained for arable, 700-900mm annual average rainfall

Farm type	Land area (ha)	Baseline P export (kg)	Baseline P export (kg/ha)
Dairy	114	42.07	0.37
Lowland grazing	101	21.07	0.21
Mixed livestock	156	67.20	0.43
Outdoor pig	57	128.50	2.25
Specialist Poultry	No land for livestock	0.09	
Roots & combinable	180	137.08	0.76
Roots & combinable + poultry manure	180	170.30	0.95
Mixed combinable	197	141.96	0.72
Mixed combinable + pig manure	197	174.73	0.89
Winter combinable	159	106.89	0.67
Winter combinable + pig manure	159	136.15	0.86
Horticulture	18	9.40	0.52
Poultry + roots and combinable	350	313.98	0.90
Indoor pigs + mixed combinable	197	168.71	0.86
Indoor pigs + winter combinable	159	131.31	0.83

Figure 3.1 Estimated baseline phosphorus export from generic farm types (Farmscoper 4)



Landscape Connectivity

3.2.3 A further consideration in estimating baseline phosphorus losses is the connectivity between the farm and watercourses. Fields adjacent to watercourses or on steep slopes will present a higher risk of phosphorus export than fields that are very distant from rivers or on shallow slopes. Roads and tracks can also provide pathways connecting fields to the river. This can be allowed for in the Farmscoper model.

Estimation of costs

3.2.4 Sources are provided in Section 3.3 of the information used to estimate costs of implementation of agricultural measures. In many cases, information is taken from the Defra 2012 report: An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture. User Guide[6]. This is referred to as "DPI User Manual" for brevity.

3.2.5 Note that a 12% uplift has been applied to these cost estimates to allow for increases in costs from 2011 to 2018.

3.2.6 For measures which carry a one-off capital cost, an Equivalent Annualised Cost (EAC) is also provided, based on a discount rate of 3.5% (Green Book).

[6] http://randd.defra.gov.uk/Document.aspx?Document=MitigationMethods-UserGuideDecember2011FINAL.pdf

3.3 Description and appraisal of potential measures

3.3.1 This section presents a variety of measures that could be employed to reduce P loads to the River Avon SAC. For each measure, a description of the mechanism by which it would reduce P loads is provided, followed by an estimate of the reduction in P loads that the measure could achieve, details of the basis of the estimate and assumptions on which it is based, the timescale of operation and a broad estimate of the cost of implementation.

3.3.2 Measures are divided into those that would be applied on-site (i.e. at the point of development), those that would be applied in the catchment and those that fall within the remit of the water company or sewerage undertaker.

Measures applicable on-site

Reducing Flows to the Foul Sewage Network through Water Efficiency Measures

Details

3.3.3 Reducing total foul flow to STWs through implementation of water efficiency measures at new dwellings.

Benefits

3.3.4 Improvement in sustainability as well as water quality.

Challenges

3.3.5 The effectiveness of this measures is difficult to measure and would be affected by individual household decisions as dwellings are adapted and equipped according to different choices. Local Planning Authority signatories to the MoU are already requiring new homes to be built to the higher efficiency Building Regulation standards. This requirement is a condition of planning permission for all new dwellings.

3.3.6 In addition, further improvements in water efficiency are often associated not with a reduction in overall consumption but with measures such as rainwater harvesting and water re-use, thus while the quantity of mains water consumed is reduced, overall flow to the sewer network does not reduce in proportion.

Basis of estimated P reduction

3.3.7 The MoU method assumes an occupancy rate of 2.3 people per dwelling and a rate of water use of 110l/person/day, treated to 0.9 mg-P/l. A 10% reduction in water use (to 99l/person/day) would reduce P loads by 23 mg-P/day per dwelling, or 0.008 kg-P/year.

3.3.8 Waterwise (2018)[7] estimate that the cost of achieving water use of 110l/person/day is £9 per dwelling, but that "the costs of building homes at 80 lpd would be higher, but more research is required on the current costs and benefits of rainwater harvesting and water reuse." For the purposes of this report, a cost of £18 per dwelling to achieve 99l/person/day has been assumed.

3.3.9 EAC is calculated on the basis of no operational costs over a lifetime of 10 years. It is recognised that the basis of this figure is very uncertain.

Approximate reduction in P load	Timescale	Cost
0.008 kg-P/year per dwelling	Intermediate (post 2021)	£18 per dwelling (one off cost) EAC £2/year.

[7] https://drive.google.com/file/d/1UMdkjjOZNm1QmR-a8POoL_VBIaYEC3CK/view

On-site sewage treatment and disposal systems

Details

3.3.10 Large scale proposals may support on-site investment in systems that are more efficient at managing phosphates than existing STWs.

Benefits

3.3.11 Reduction in P export to rivers, and where used in combination with constructed wetlands could provide wider synergistic benefits for wildlife.

Challenges

3.3.12 Only likely to be viable in larger developments of >10 dwellings and levels of treatment that can be achieved with on-site treatment vary. Likely to be most effective when combined with appropriately designed wetlands, which will require identification of suitable sites (see later section on wetlands). They will not be suitable for sites where groundwater levels are high, or for sites within source protection zones.

3.3.13 Wessex Water will not adopt sewer networks which connect to private treatment works. This will significantly increase the yearly maintenance charge and lead to complexities with ownership and responsibilities.

3.3.14 Issues with policing potential new connections to on site private works – meaning future adjacent developments could be forced into private treatment themselves or a lengthier offsite connection to the public sewer network.

3.3.15 On site space will be required for the private sewage treatment works.

Basis of estimated P reduction

3.3.16 Literature review (Entec 2010) suggests that Package Treatment Plants (PTPs) can typically achieve around 10mg P/l in final effluent, which is similar to the effluent strength from a STW with secondary treatment (i.e. no P stripping). Concentrations in discharges from septic tanks tend to be a little higher. Considerable attenuation would be expected if the discharge is to ground (as most septic tanks will be), but PTPs may discharge directly to watercourses (subject to permitting). Since this effluent quality is lower (higher P concentration) than is typically achieved by Wessex Water STWs, use of on-site STWs is unlikely to be viable unless an additional stage of treatment to reduce P levels in the effluent is provided.

3.3.17 On-site sewage treatment combined with suitably designed and constructed wetlands could potentially produce final effluent of a much higher quality[8]. An Environment Agency permit to discharge is likely to be required. Wildlife and Wetlands Trust (WWT) guidance indicates that more complex systems are capable of treating and retaining nearly all influent phosphorus, achieving final effluent quality of around 1 mg-P/l from an influent concentration of around 20 mg-P/l (i.e. a 95% reduction). Whilst this will not achieve phosphate neutrality, it could greatly reduce the amount of mitigation required.

3.3.18 A PTP with capacity to treat waste from a population equivalent of up to 50 (approximately 22 dwellings) typically costs around £10,000[9], or £500 per dwelling. There will also be ongoing

[8] http://www.wwt.org.uk/uploads/documents/1429707026_WWTConstructedFarmWetlands150422.pdf
[9] https://www.uksepticktanks.co.uk/sewage-treatment-plants/extra-large-treatment-plants

operational costs, although these are estimated to be low. Given the difficulty of retro-fitting improved technology to such systems, it will be important that only the highest-performing systems (with respect to phosphorus discharge) are installed.

3.3.19 At a water usage rate of 110 l/day the PTP would discharge 5,500 l/day. At an effluent concentration of 10 mg-P/l this equates to a P loading of about 20 kg-P/year. A 95% reduction in this loading is 19 kg P/year, or a P reduction of about 0.9 kg-P/dwelling/year.

3.3.20 WWT estimated costs for a simple system treating the effluent from a single septic tank to be typically £5,000 - £10,000. Costs to treat a high volume of high strength effluent could be as high as £100,000. For illustration, a figure of £20,000 has been taken forward, or £870 per dwelling.

3.3.21 EAC is calculated on the basis of £1,370 (£500 for the PTP + £870 for the wetland) per dwelling capital cost, plus £100/dwelling/year operational cost, over a lifetime of 20 years.

Approximate reduction in P load	Timescale	Cost
0.9 kg-P/dwelling/year	Intermediate (post 2021)	£1,370 per dwelling (one off cost) EAC £196/dwelling/year

Increasing the proportion of green infrastructure within new developments

Details

3.3.22 Where technically feasible, increase the delivery of green infrastructure (e.g. Sustainable Drainage Systems [SuDS], swales, permeable surfaces, green rooftops) in new developments with particular focus on attenuating phosphorus discharge.

Benefits

3.3.23 Whilst this may have a small knock-on effect on the cost of developments, it provides an option that is readily within the gift of developers. The impact of any additional costs may nevertheless impact upon commercial viability and this would need to be assessed on a site by site basis. Wider benefits of more greenspace include more attractive, healthier places to live with space for people, birds and insects, plus water retention can have a positive impact on managing flood risk. SuDS can also reduce loads of other pollutants such as Polycyclic Aromatic Hydrocarbons (PAHs).

Challenges

3.3.24 Possible reduction in overall capacity for housing growth.

Basis of estimated P reduction

3.3.25 Would not act to reduce P loads, assuming no overall reduction in housing provision (new dwellings) other than through reduction in urban diffuse loads (which are expected to be small for new developments). Changes in land management on existing green infrastructure could realise some reduction in P loads (for example, avoiding compaction of grassland; siting gateways so as to avoid poaching in high risk areas, in order to reduce the risk of soil erosion and runoff).

3.3.26 Assuming 80% reduction in urban diffuse P export by SuDS (after CIRIA SuDS Manual, version 3), and a baseline diffuse P loss (excluding sewer leakage and mains water leakage) of around 0.1 kg-P/ha and 30 dwellings per hectare, the estimated reduction in P load is 0.08 kg-P/ha, or 0.003 kg-P/dwelling.

3.3.27 Costs are estimated on the basis of Environment Agency (2015)[10]. Simple rainwater harvesting: £100-£243 per dwelling; advanced rainwater harvesting: £2,000-£6,000 per dwelling; greywater reuse: £1,900-£3,500 per dwelling. For the purposes of this report, a figure of £3,000 per dwelling has been assumed.

3.3.28 EAC is calculated on the basis of £3,000 per dwelling capital cost, no operational cost and a lifetime of 20 years.

Approximate reduction in P load	Timescale	Cost
0.003 kg P/dwelling	Intermediate (post 2021)	£3,000 per dwelling EAC £211/dwelling/year

[10] http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/SC080039_cost_SUDS.sflb.ashx

Measures applicable in-catchment

On-Farm Wetland Creation and Restoration Details

3.3.29 Establishment of constructed on-farm wetlands (or silt traps) to reduce diffuse pollution from e.g. agricultural yards and dairy cattle movements (but first having taken measures to reduce it at source). Constructed wetlands consist of man-made systems that treat wastewater through a range of natural processes including sedimentation and uptake of nutrients by plants.

Benefits

3.3.30 Considerable potential for multiple benefits aside from water quality improvements, such as enhanced flood risk management, enhanced recharge, biodiversity and habitats, and community health.

Challenges

3.3.31 Removal efficiency depends on a range of factors - hydraulic load, nutrient load, pre-existing land use, size of wetland basin, retention time, vegetation structure, and long-term management. Schemes would need to be carefully designed and placed to achieve maximum benefits.

3.3.32 Agreements with landowners will be necessary. Good access will be necessary to enable maintenance and removal of captured sediment.

Basis of estimated P reduction

3.3.33 Information from Wildfowl and Wetlands Trust (WWT) guidance on on-farm wetlands[11].

3.3.34 Wetland options range in size, scale, cost and effectiveness from swales (cheap and simple), through sediment traps to constructed wetlands. The WWT guidance distinguishes between them using a star system, with the simplest, lower cost options to treat low strength effluent being 1-star systems and the most complex, higher cost systems capable of treating high strength effluents being 5-star systems.

3.3.35 Typical costs range from £10-15/m^2 for a 1-star swale treating a single track or field, through to £5-100/m^2 for a 5-star constructed wetland that could treat runoff from farmyards and fields to a high quality.

3.3.36 For the most complex (and effective) types an Environment Agency permit to discharge is likely to be required. Case studies include an in-ditch wetland with a cost of about £2,700, achieving reductions in total phosphorus (TP) loads of 0.1-0.2 kg P/ha/year, and a constructed wetland with P-specific crushed stone treatment that could achieve effluent quality of around 1mg-P/l at a cost of £10-18k.

3.3.37 Baseline farm P loads from farms range from 0.1 kg/ha to over 2 kg/ha (Tables 3.1 and 3.2).

3.3.38 The case studies described in the WWT guidance suggest the effectiveness of wetlands at removing phosphorus can be as high as 95%. Assuming 95% effectiveness, farm wetlands could reduce P loads by 0.09 – 1.9 kg/ha. Based on the Farmscoper model farms, this equates to 1.7 – 300 kg P per farm per year, with central estimate 69 kg-P per farm per year (average over all farm types). However, typical effectiveness is likely to be lower than this.

[11] http://www.wwt.org.uk/uploads/documents/1429707026_WWTConstructedFarmWetlands150422.pdf

3.3.39 For the purposes of illustration, a constructed wetland on an arable farm on the Chalk might cost around £10,000 and achieve a reduction in P loading from the baseline figure of 22 kg-P/year (0.14 kg P/ha) to around 50% of that, a reduction of 11 kg-P/year (although there is very large variability between farm types and wetland systems). It is noted that there is evidence that greater reductions than this could be achieved, and this estimate is therefore precautionary.

3.3.40 EAC is calculated on the basis of £10,000 capital cost, operational costs of £200/year over a lifetime of 10 years. No cost is included for land purchase since it is assumed that the wetland will be constructed on land already owned by the farm. Compensation for the loss of productive farmland might be in the region of £640 per hectare (based on a milling wheat crop of average yield[12]) although in practice much less productive land would be likely to be utilised, and compensation would be significantly lower. No allowance has been included in the cost estimate for compensation.

Approximate reduction in P load	Timescale	Cost
69 kg P per farm per year (central estimate) with range 1.7 – 300 kg P per farm per year. 11 kg P per farm per year used for illustration.	Medium	£10,000 (one off cost), £200/year operational cost. EAC £1,402/farm/year

[12] John Nix Farm Management Pocketbook, 46th edition, 2016.

In-Catchment Wetland Creation and Restoration

Details

3.3.41 Establishment of constructed wetlands to reduce diffuse pollution, at strategic locations within the catchment, for example alongside the river (so that some or all river flow is diverted through the wetland), on or at the back of the floodplain of the river, or intercepting drainage ditches or smaller tributaries that ultimately flow into the river. Constructed wetlands consist of man-made systems that treat wastewater through a range of natural processes including sedimentation and uptake of nutrients by plants.

Benefits

3.3.42 Considerable potential for multiple benefits aside from water quality improvements, such as enhanced flood risk management, enhanced recharge, biodiversity and habitats, and community health.

Challenges

3.3.43 Removal efficiency depends on a range of factors - hydraulic load, nutrient load, pre-existing land use, size of wetland basin, retention time, vegetation structure, and long-term management. Schemes would need to be carefully designed and placed to achieve maximum benefits.

3.3.44 Agreements with landowners will be necessary. Permits are likely to be required for any scheme that alters flow (from the Lead Local Flood Authority) or that includes a discharge to a watercourse (from the Environment Agency).

Basis of estimated P reduction

3.3.45 Information from Wildfowl and Wetlands Trust (WWT) guidance on on-farm wetlands[13], although it is noted that some of the case studies describe larger systems that may be more applicable in-catchment.

3.3.46 Typical costs for larger schemes are given as £5-100/m^2 for a 5-star constructed wetland that could treat runoff to a high quality. Case studies include a large Integrated Catchment Wetland, reported as capable of treating to very low Total Phosphorus concentrations and covering an area of about 1.3ha.

3.3.47 For the most complex (and effective) types an Environment Agency permit to discharge is likely to be required.

3.3.48 Further work is required to identify suitable locations for larger schemes, and to understand the levels of treatment and phosphorus removal that could be achieved. It is recommended that a study is commissioned to further investigate the feasibility of this option. Given the likely timescale for this to be completed, implementation of any such schemes is unlikely to occur before the latter half of the interim delivery plan period, at the earliest.

3.3.49 At this stage no further estimate can be provided of the likely costs or effectiveness of in-catchment wetland schemes, as they will be bespoke to each scheme.

[13] http://www.wwt.org.uk/uploads/documents/1429707026_WWTConstructedFarmWetlands150422.pdf

Taking Land Out of Agricultural (arable or grass) Production through Offsetting

Details

3.3.50 Includes:

- Ensuring that greenfield land in new developments is taken out of production (or at least that CSF measures or equivalent are in place to minimise P export);
- Taking publicly owned land (estate) out of production;
- Purchase of land by Local Authorities or charities and taking it out of production; and
- Paying farmers to take their land out of production.

3.3.51 Land could be converted to parks, wetland or woodland (for example).

Benefits

3.3.52 Effective measure that could potentially realise significant reductions in P export to rivers. Wider benefits through habitat creation and reduction in other diffuse pollutants (such as pesticides).

Challenges

3.3.53 Likely to be prohibitively expensive for Local Authorities to purchase agricultural land, or to pay farmers to take land out of production. It would be significantly cheaper to rent land than to buy it, although this would provide less security that the reduction in P export would be in perpetuity.

Basis of estimated P reduction

3.3.54 Reversion to woodland would provide some long-term income while reducing P loads, but on a very long timescale (typically 75 years for a hard timber crop to mature, soft timber is up to 30 years). Reduction in P load assumed to be around 0.4 kg P/ha (as per NMP), but could be in the range 0.1 kg P/ha to >2 kg P/ha (Farmscoper modelling results), depending on farm type and location (soil type). Central estimate (average over all farm types) 0.5 kg P/ha. Based on the Farmscoper model farms this equates to up to 314 kg P per farm per year, with a central estimate of 73 kg P/farm/year.

3.3.55 Savills farmland value survey (2017[14]) suggests land values as follows: Prime arable land £21,600 per ha, grade 3 land £18,000 per ha and grazing land £12,000 per ha. For the purposes of this comparison, a farm size of 100 ha has been assumed, which at £18,000/ha equates to £1,800,000

3.3.56 This cost is likely to prohibit purchase of land by Local Authorities, but this measure could be applied to any publicly owned land that is currently put to agricultural use. Wiltshire Council own 270 ha of agricultural land, which, assuming current P export of 0.4 kg P/ha, would equate to a reduction of 108 kg P/yr if taken out of production. In this case, the cost of implementation would equate to the loss of rental income from the land. The Agriculture and Horticulture Development Board (AHDB)[15] indicate that the average rental price of arable land in 2018 is £356/ha, which would equate to a rental income of £96,120/year.

[14] https://www.savills.co.uk/research_articles/229130/228020-0

[15] https://dairy.ahdb.org.uk/market-information/farm-expenses/land-prices/rent-prices/#.XAFM1tv7QnQ

Approximate reduction in P load	Timescale	Cost
108 kg P/year	Medium to Long	£96,120/year

Change land-use from Intensive to Less Intensive

Details

3.3.57 Change intensive land use to low intensity management, for example by reducing overall stocking rates on livestock farms. Low tillage methods on arable fields to reduce sediment run-off.

Benefits

3.3.58 Effective measure that could potentially realise significant reductions in P export to rivers. Wider benefits through potential reduction in other diffuse pollutants (such as pesticides) and carbon/ methane emissions.

Challenges

3.3.59 Degree of mitigation provided depends on the location of the site and the 'replacement' land use. Relies on securing long term agreements with landowners. Securing change for the medium-long term is key.

Basis of estimated P reduction

3.3.60 Diffuse Pollution Inventory User Manual (2011) data: Method 41, reduce overall stocking rates on livestock farms. This suggests that P and sediment losses would be decreased by ca 30%. Applying this to the baseline Farmscoper predictions of P export suggests an average reduction of 0.14 kg P/ha across all farm types (range 0.04 – 0.7 kg P/ha), or 23 kg P per farm per year (range 0.5 – 94 kg P/farm/year). The DPI User Manual notes that this measure would have a serious impact on farm profitability (up to £33,000 per farm per year). The figure for a dairy farm is £11,000 per year. With a 12% uplift to allow for increases in costs from 2011 to 2018 this figure rises to £12,320.

Approximate reduction in P load	Timescale	Cost
23 kg P/farm/year (range 0.5 – 94 kg P/farm/year)	Short	£12,320 per dairy farm per year.

River restoration measures

Details

3.3.61 Measures such as removal of weirs and re-profiling of banks all help to reduce the amount of phosphate laden silt depositing in the river, and help restore more natural river hydrodynamics, while increased riparian vegetation will assimilate greater nutrients from the water itself. This measure could also include the creation of in-catchment wetlands (see previous section).

Benefits

3.3.62 This has considerable wider benefits for the river ecology and could provide greater access.

Challenges

3.3.63 Difficult to quantify improvements in nutrients that can be realised. Requires engagement with multiple stakeholders, landowners, angling groups etc. and consents from Environment Agency/Natural England.

Basis of estimated P reduction

3.3.64 A River Restoration Plan for the Avon is already in place, which has identified and costed restoration actions for each reach. This measure is considered to be expensive to implement and unlikely to result in the required reductions in P loads on timescales compatible with the interim approach. For these reasons, it is not further considered.

Storing and transporting excess P from dairy farms to arable farms as a means of nutrient balancing across farm type

Details

3.3.65 Livestock farms apply only such manure to land as is necessary to maintain nutrient levels, with the excess being transported to arable farms nearby. The receiving farm uses a recognised fertiliser recommendation system and other supplementary guidance to make full allowance of the nutrients applied in organic manures and reduce manufactured fertiliser inputs accordingly, such that overall nutrient inputs are at or below recommended rates.

Benefits

3.3.66 Wider benefits to the farming community.

Challenges

3.3.67 Ongoing costs of subsidising infrastructure for storage, transport and fuel costs. For example, the receiving farm may need infrastructure improvements to accommodate manure heaps or slurry stores.

3.3.68 Applicability will vary depending on scale of manure and availability of nearby arable land to receive it (see Section 4.4). Applicability may also be limited by the Nitrate Vulnerable Zone (NVZ) regulations, which limit the rate at which nitrogen may be applied to land, and hence the rate at which manure may be applied. This measure may help livestock farmers meet the New Farming Rules for Water, however.

Basis of estimated P reduction

3.3.69 The measure is evaluated on the basis that it is similar to the mitigation Method 23 Integrate fertiliser and manure nutrient supply, described in the DPI User Manual (Defra, 2012)[16] (see Section 3.2: Estimating costs of agricultural measures). This measure assumes that farmers will use manure analysis data to quantify the nutrients in manure applications to land, and reduce mineral fertiliser applications accordingly.

3.3.70 That measure is estimated to achieve a potential reduction in P losses of up to 10%. Based on Farmscoper modelling this equates to an average reduction of 0.05 kg P/ha, or 7.8 kg P per farm per year, with a range of 0.01 – 0.23 kg P/ha (0.2 – 31 kg P/farm/year). Costs of transporting manure would be partially offset by reduction in fertiliser costs on receiving farms.

3.3.71 See also DPI User Manual Method 12: Maintain and enhance soil organic matter levels. Based on the receiving farm paying the transport costs this is estimated to cost £800 per farm per year if manure transported 10km, or a net saving of £6,500 per farm per year if transported 3km. The former figure is taken forward for illustration, with a 12% uplift applied, giving a cost of £896. Note that the levels of P reduction achieved will vary and there is increased risk of incidental P losses from manure applications.

[16] DEFRA, 2012. An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture. User Guide. http://randd.defra.gov.uk/Document.aspx?Document=MitigationMethods-UserGuideDecember2011FINAL.pdf

Approximate reduction in P load	Timescale	Cost
7.8 kg P/farm/year (range 0.2 – 31 kg P/farm/year)	Short to medium	Up to £896 per farm per year.

Make available compost to improve soil condition

Details

3.3.72 Make available compost to improve soil condition to improve soil structure, water and nutrient holding capacity.

Benefits

3.3.73 Wider benefits to the farming community.

Challenges

3.3.74 It is not clear what level of reduction in phosphorus export can be achieved.

Basis of estimated P reduction

3.3.75 This is essentially the same as the previous measure (storing and transporting P from dairy farms), and the costs and P reductions are estimated on the same basis.

Approximate reduction in P load	Timescale	Cost
7.8 kg P/farm/year (range 0.2 – 31 kg P/farm/year)	Short to medium	Up to £896 per farm per year.

Regulatory controls on agricultural phosphorus

Details

3.3.76 Direct regulatory controls on agricultural phosphorus input that limits the accumulation of surplus phosphorus in soils and prevents phosphorus losses to water from agricultural activities, for example, regulations requiring regular soil testing and adherence to phosphorus fertiliser rates from a recognised fertiliser recommendation system.

Benefits

3.3.77 An understanding of the scope for, prospects and possible impact of such measures would help to inform the pursuit of other land use/management measures involving agriculture.

Challenges

3.3.78 High levels of regulatory compliance may already exist, i.e. most arable and dairy farmers will already match fertiliser requirement to soil P status.

Basis of estimated P reduction

3.3.79 This is similar to DPI User Manual Method 32 Do not apply P fertiliser to high P index soils (except it would be implemented through regulatory controls rather than voluntary uptake). The DPI manual states that this measure could reduce soluble P export by up to 50% and particulate P by up to 30%, over the long term. Based on Farmscoper baseline predictions of P export, this equates to 0.05 – 1.1 kg P/ha, or 0.25 kg P/ha on average across all farm types (39 kg P/farm/year, range 1 – 157 kg P/farm/year). Saving per farm is £100 to £500 per annum (assuming no loss of yield). There would be an additional cost of employing an officer to carry out compliance visits, which could be funded via Local Authorities. For the purposes of comparison, this is estimated at twice the estimated salary of such an officer, or £50,000/year. If their remit were to include 250 farms, this would equate to £200/farm/year. As a worst-case scenario, the potential saving to each farm is ignored and the cost of implementation considered to be the cost of employing an officer.

Approximate reduction in P load	Timescale	Cost
39 kg P/farm/year (range 1 – 157 kg P/farm/year)	Medium to long	£200/farm/year.

Measures within the remit of Water Companies

Diverting surface water flows and groundwater ingress away from the Foul Sewage Network

Details

3.3.80 This measure includes:

- Separation of storm runoff and foul sewage in existing developments, with storm runoff being directed to (for example) SuDS or highway drains;
- Sewer lining to reduce groundwater ingress and hence foul flow to STWs.

Benefits

3.3.81 Reduction in the total flow to STWs and hence reductions in storm tank discharges and Combined Sewer Overflow (CSO) discharges. Improvements in sewer network capacity and reduced risk of sewer flooding.

Challenges

3.3.82 Needs a fuller understanding of land from which storm runoff currently drains to the foul sewer network. Depends upon the levels of improvement in performance at STWs that can be achieved. Potentially high level of disruptive work on highways.

3.3.83 Customers' private lateral drains and connections can also be responsible for the ingress of surface and groundwater into foul sewer networks.

Basis of estimated P reduction

3.3.84 Would act to reduce storm tank discharges and CSO flows. It is difficult to quantify the effect this would have on P loads without knowing how frequently ST discharges occur. Based on figures for another STW, PE 54,000, spilling 14,000m^3 from storm tanks in a typical year at P concentration of 1.5 mg/l equates to a P loading discharged of 21 kg P/yr.

3.3.85 Assuming that reduced flow to the works causes a 10% reduction in storm tank discharges, this equates a P reduction of 2kg/yr.

3.3.86 It is noted that Wessex Water will have detailed data on actual storm tank discharges.

3.3.87 Wessex Water have provided a broad indication of the cost of implementation. It is not possible to provide a precise figure.

Approximate reduction in P load	Timescale	Cost
2 kg P/year (but highly uncertain)	Medium	Medium

Addressing sewer misconnections

Details

3.3.88 Identifying and correcting instances where foul drains have been incorrectly connected to storm drains. WWT[17] suggests 0.6-2% of households have some sort of misconnection, most commonly washing machines (35%), sinks (20%) and dishwashers (10%), but 5% involve a toilet.

Benefits

3.3.89 General improvement in water quality.

Challenges

3.3.90 Survey work would be needed to properly understand the scale of problem and reduction in P loading that could be achieved. Difficulties in identifying mis-connections, reliance on public to know where these occur.

3.3.91 Generally, only cost effective in larger urban conurbations (the Avon is a largely rural catchment).

Basis of estimated P reduction

3.3.92 Assuming a per capita P export of 0.44kg P/person/year (e.g. Entec, 2010) and 2.3 persons per household, if 5% of this load is directed to storm drains instead of foul sewer (that being the estimated proportion of mis-connections that involve a toilet) that would equate to 0.05 kg P/year.

3.3.93 P reductions will be realised in urban areas (e.g. Salisbury, Ringwood, Fordingbridge, Warminster). Note that these will be one-off reductions, although it is likely that new misconnections will continue to arise as existing properties are altered or extended.

3.3.94 If 1% of the sewered population of 140,000 people in the catchment are mis-connected, this would suggest a potential P reduction of up to 70 kg P/year.

3.3.95 Wessex Water have provided a broad indication of the cost of implementation. It is not possible to provide a precise figure.

Approximate reduction in P load	Timescale	Cost
Up to 70 kg P/year.	Short to medium	Low to medium

[17] https://wwtonline.co.uk/features/the-rights-and-wrongs-of-misconnections

Reduce leakage from foul sewerage system

Details

3.3.96 Reduce sewer leakage, and hence ingress of phosphorus to the catchment. Leakage of raw sewage from the sewer network into the subsurface introduces a source of phosphorus to the environment. Reducing leakage rates will reduce this source of phosphorus. Leakage in this context can refer to inadequate hydraulic capacity of the network, sewage pumping station failures and rising main bursts / sewer damage.

Benefits

3.3.97 General improvement in environmental quality.

Challenges

3.3.98 Further work would be needed to understand the scale of the problem and improvement in water quality that could be achieved. It is likely that a high degree of attenuation of phosphorus from sewer leakage will limit the impact of sewer leakage on river water quality.

Basis of estimated P reduction

3.3.99 Estimates of rates of leakage vary. This estimate is based on the figures quoted in Entec (2010). Taking a value of 2% leakage and water usage of 230 l/person/day (which is high but includes other water uses), and an effluent strength of 9 mg/l as P, yields an estimated loading of 0.015 kg P/person/year. For the sewered population of the Hants Avon of 140,000 people, this is 2,100 kg P.

3.3.100 Significant attenuation would be expected to occur in the subsurface. 88% attenuation, as assumed in the NMP, would result in a P loading of 252 kg P/year. (Note this is a one-off reduction rather than an ongoing reduction).

Wessex Water have provided a broad indication of the cost of implementation. It is not possible to provide a precise figure.

Approximate reduction in P load	Timescale	Cost
Up to 252 kg P	Short to medium	Medium

Reduce leakage from potable water supply

Details

3.3.101 Reduce leakage from potable supply (where P dosing of drinking water to address lead issues in the private pipe network represents a viable P source).

Benefits

3.3.102 Improvement in sustainability and reduction in OPEX.

Challenges

3.3.103 Uncertainty in scale of problem and improvement in water quality that could be achieved.

Basis of estimated P reduction

3.3.104 Information from Wessex Water (G. Sanders, Pers. Comm.) indicates that only Middle Camp WTW (Salisbury) doses for plumbosolvency. The WTW releases 7.5 Ml/d of treated water, containing an estimated 5.6 kg/d of phosphorus. With leakage estimated at 20%, this equates to a release of 410 kg-P/year.

3.3.105 Leakage reduction is targeted to be reduced from 20% to 15% by 2025, which will reduce this release to 349 kg-P/year by 2025, or 12 kg-P/year on average.

3.3.106 There will be substantial attenuation of this load in the subsurface. Assuming an attenuation rate of 88% (as per the NMP) the resulting reduction in P load would be 1.44 kg-P/year.

Wessex Water have provided a broad indication of the cost of implementation. It is not possible to provide a precise figure.

Approximate reduction in P load	Timescale	Cost
1.44 kg P/year on average.	Medium	Medium

Increased treatment of the effluent by the water company

Details

3.3.107 Apply improved treatment technology at STWs to further improve effluent quality. This option is effectively being taken forward by Wessex Water as their ODI. If this is adopted, it will make all new mains-sewered development from 2020 phosphate neutral.

Benefits

3.3.108 General improvement in water quality.

Challenges

3.3.109 Would need to be implemented via the Price Review process.

Basis of estimated P reduction

3.3.110 It is difficult to estimate accurately the reduction in P loading that could be achieved through improved treatment, since the reduction will clearly depend on the level of treatment applied. Wessex Water's growth forecasts indicate that the total P load from their assets in year 2017/18 was around 11.3 tonnes (based on measured flows from each works and assuming effluent quality equal to the average for the period 2013-2017). They further estimate that improving all works to treat to a quality of 0.5 mg-P/l would reduce this load to 10.0 tonnes.

3.3.111 The Technically Achievable Limit (TAL) for phosphorus treatment is currently considered to be 0.25 mg-P/l. Hypothetically, therefore, if all works treated to the TAL, the total load would decrease by a further 5.0 tonnes. This is, however, an extreme example included only to illustrate what is theoretically achievable.

3.3.112 A reduction of 1,300 kg-P/year is a reasonable estimate of the reduction in loading that could be achieved.

3.3.113 Wessex Water have provided a broad indication of the cost of implementation. It is not possible to provide a precise figure.

Approximate reduction in P load	**Timescale**	**Cost**
Up to 1300 kg P/year (but very uncertain)	Medium	High

3.4 Summary of measures

3.4.1 Table 3.3 presents a summary of the estimated costs and effectiveness of the measures described in Section 3.3. Note that where costs have been taken from the DPI User Manual a 12% uplift has been applied to account for increases from 2011 to 2018.

Table 3.3 Summary of estimated costs and effectiveness of measures

Measure	Estimated effectiveness	Estimated cost	Cost-effectiveness (£/kg-P)
Measures applicable on-site			
Reducing Flows to the Foul Sewage Network through Water Efficiency Measures	0.008 kg-P/year per dwelling	£2/dwelling (EAC)	£250/kg
On-site sewage treatment and disposal systems (with wetlands)	0.9 kg-P/year per dwelling	£196/dwelling (EAC)	£218/kg
Increasing the proportion of green infrastructure within new developments	0.003 kg-P/year per dwelling	£211/dwelling (EAC)	£70,000/kg
Measures applicable in-catchment			
Wetlands	11 kg P per farm per year 38 kg-P/year (for a PTP serving 100 people)	£1,402/farm (EAC)	£127/kg
Taking Land Out of Agricultural (arable or grass) Production through Offsetting	108 kg P/year	£96,120/year	£890/kg
Change land-use from Intensive to Less Intensive Grass Production.	23 kg P/farm/year	£12,320/farm/year	£536/kg
Storing and transporting excess P from dairy farms to arable farms	7.8 kg P/farm/year	£896/farm/year	£115/kg
Make available compost to improve soil condition	7.8 kg P/farm/year	£896/farm/year	£115/kg
Regulatory controls on agricultural phosphorus	39 kg P/farm/year	£200/farm/year	£5/kg
Measures within the remit of the Water Company			
Diverting Surface Water Flows and groundwater ingress away from the Foul Sewage Network	2 kg P/year	Medium	
Addressing Misconnections	Up to 70 kg P/year	Low to Medium	
Reduce leakage from foul sewerage system	Up to 252 kg P/year	Medium	

Measure	Estimated effectiveness	Estimated cost	Cost-effectiveness (£/kg-P)
Reduce leakage from potable supply	1.44 kg P/year	Medium	
Increased treatment of effluent.	Up to 1300 kg P/year	High	

4. Feasibility of measures

4.1 Introduction

4.1.1 This section discusses the feasibility of measures, both in terms of their requirements for effective implementation, and (at a high level) the areas within the River Avon SAC in which they are most likely to be applicable.

4.2 Requirements for implementation of measures

4.2.1 This section provides a summary of the requirements for the implementation of each of the measures described in Section 3. This applies in particular to the catchment measures, which may not be applicable in all parts of the River Avon SAC catchment. For example, measures which target manure use will not apply in arable catchments where little or no manure is used.

4.2.2 A summary of the constraints on the application of each measure is provided in Table 4.1.

Table 4.1 Restrictions or requirements for the implementation of measures

Measure	Applicable areas
Measures applicable on-site	
Reducing Flows to the Foul Sewage Network through Water Efficiency Measures	Any new development
On-site sewage treatment and disposal systems	Any new development (but likely to be supported only for large scale developments).
Increasing the proportion of green infrastructure within new developments	Any new development
Measures applicable in-catchment	
On-Farm Wetlands	Farms with available land for schemes. Some schemes may require Environment Agency permits. Also, small STWs or package treatment plants.
In-Catchment Wetlands	Likely to be most effective adjacent to the river corridor or on or near the floodplain. Schemes that alter flow will require Lead Local Flood Authority permits.
Taking Land Out of Agricultural (arable or grass) Production through Offsetting	Available arable or grazed land.
Change land-use from Intensive to Less Intensive Grass Production.	Intensive livestock farms.
Storing and transporting excess P from dairy farms to arable farms	Livestock farms with nearby available arable land to receive manure.
Make available compost to improve soil condition	Livestock farms with nearby available arable land to receive manure/compost. Particularly applicable to heavier soils more prone to runoff.

Measure	Applicable areas
Regulatory controls on agricultural phosphorus	All farms.
Measures within the remit of the Water Company	
Diverting Surface Water Flows and groundwater ingress away from the Foul Sewage Network	All sewer catchments, particularly areas with older infrastructure.
Addressing Misconnections	Mainly in urban areas including rural villages and towns.
Reduce leakage from foul sewerage system	Mainly in urban areas with older infrastructure and rural villages.
Reduce leakage from potable supply	Mainly in urban areas with older infrastructure.
Increased treatment of effluent.	All sewer catchments.

4.3 Catchment and sub-catchment spatial data

4.3.1 Appendix A presents a series of maps and Appendix B a series of tables that illustrate where in the Hampshire Avon catchment the various measures previously described are most likely to be applicable. For example, the measure "Change land-use from Intensive to Less Intensive Grass Production" is applicable to intensive grassland agriculture. Appendix A includes a map that shows, at Water Framework Directive (WFD) waterbody level, the numbers of livestock farms in the catchment, and where, therefore, the measure is most likely to be successfully put in place.

4.3.2 Table 4.2 provides a list of figures for reference. A list of data sources and references is also provided at Appendix A.

Table 4.2 Figure list

Figure	Content
1	WFD waterbody boundaries
2	Numbers of proposed dwellings
3	Land cover
4	Topsoil Olsen P[1] (mg/kg)
5	Manure applications – beef manure and slurry
6	Manure applications – poultry manure
7	Manure applications – dairy manure and slurry
8	Manure applications – outdoor pigs
9	Manure applications – other pigs
10	Manure applications – sheep
11	Risk of soil erosion by water
12	Population density
13	Crop data

Figure	Content
14	Farm numbers by sub-catchment - Arable
15	Farm numbers by sub-catchment – Extensive grazing
16	Farm numbers by sub-catchment – Intensive grazing
17	Farm numbers by sub-catchment – Pigs and poultry
18	Modelled phosphorus loads to watercourses – Agricultural sources – Total phosphorus - unmitigated
19	Modelled phosphorus loads to watercourses – Agricultural sources – Dissolved phosphorus - unmitigated
20	Modelled phosphorus loads to watercourses – Agricultural sources – Total phosphorus - mitigated
21	Modelled phosphorus loads to watercourses – Agricultural sources – Dissolved phosphorus - mitigated
22	Modelled phosphorus loads to watercourses – Bank erosion – Total phosphorus
23	Modelled phosphorus loads to watercourses – Bank erosion – Dissolved phosphorus
24	Modelled phosphorus loads to watercourses – Urban diffuse – Total phosphorus
25	Modelled phosphorus loads to watercourses – Urban diffuse – Dissolved phosphorus
26	Modelled phosphorus loads to watercourses – Sewage treatment works – Total phosphorus
27	Modelled phosphorus loads to watercourses – Sewage treatment works – Dissolved phosphorus
28	Modelled phosphorus loads to watercourses – Storm tank discharges – Total phosphorus
29	Modelled phosphorus loads to watercourses – Storm tank discharges – Dissolved phosphorus
30	Modelled phosphorus loads to watercourses – Septic tanks – Total phosphorus
31	Modelled phosphorus loads to watercourses – Septic tanks – Dissolved phosphorus
32	Modelled phosphorus loads to watercourses – Combined sewer overflows – Total phosphorus
33	Modelled phosphorus loads to watercourses – Combined sewer overflows – Dissolved phosphorus
34	Modelled phosphorus loads to watercourses – Direct deposition – Total phosphorus
35	Modelled phosphorus loads to watercourses – Direct deposition – Dissolved phosphorus
36	Modelled phosphorus loads to watercourses – Waterbody total – Total phosphorus
37	Modelled phosphorus loads to watercourses – Waterbody total – Dissolved phosphorus
38	Solid geology
39	Superficial geology

1. Olsen P is a measure of the bio-available phosphorus content of topsoil.

4.4 Applicability of measures

4.4.1 From the maps and tables in Appendices A and B it is possible to make some preliminary observations about the potential applicability of measures in sub-catchments of the Hants Avon.

4.4.2 In general, to afford maximum protection to the river, it would be preferable to provide mitigation measures close to, or upstream of, the point of discharge of the relevant sewage treatment works to which the associated development will connect. The SAC extends along the length of the river, so whilst implementing mitigation measures near the bottom of the catchment could, technically, achieve phosphorus-neutrality, this would not protect the majority of the SAC.

4.4.3 The distribution of projected housing growth indicates that larger developments are likely to occur in the Lower Nadder, west of Salisbury, and the Upper Avon downstream of the Nine Mile confluence, north of Salisbury.

- Figure 7 suggests a significant source of pig manure in the Upper Avon, which could represent a significant source of phosphorus, offering opportunities for potential improvements in manure management or measures to reduce diffuse pollution in runoff and soil erosion.
- Figure 10 indicates a relatively high risk of soil erosion in the Bourne, and measures to mitigate runoff and soil erosion (e.g. wetlands or silt traps) are likely to be applicable. This also applies to some extent to the Wylye and the Ebble.
- Cropping data (Figure 12) indicates areas of potato crops in the Upper Avon. Potatoes typically receive high applications of P fertiliser, or are grown on soils that are high in P, suggesting opportunities to reduce diffuse P loss associated with runoff and soil erosion.
- Measures involving transporting manure from livestock farms to receiving arable farms are likely to be most applicable in predominantly arable or mixed arable and livestock areas. The largest number of arable holdings in any sub-catchment of the Avon is in the Bourne (Figure 13). There are also significant numbers of arable holdings in the Ebble, the Lower Avon and Upper Avon (d/s Nine Mile confluence), the Middle Nadder and the Wylye (headwaters and middle). The Bourne and Wylye also contain significant numbers of intensive livestock enterprises (Figure 15).
- Pig and poultry units present a relatively high risk of diffuse phosphorus export. There are, however, relatively few of these, located mainly in Ditchend Brook, Dockens Water, Huckles Brook and Linford Brook, all in the lower part of the catchment (Figure 16).

5. Recommendations

5.1 Applying measures

5.1.1 It is estimated that mitigation will be required for around 85 kg P in financial year 2018/19 and 155 kg P in Financial Year 2019/2020 from new development which would otherwise reach the River Avon SAC (Table 2.4). Of this, the majority (around 85%) is due to mains-sewered residential development, and as noted these are likely to represent overestimates as developments granted permissions now are unlikely to be occupied much before 2020.

5.1.2 This section presents the practical measures that could be put in place to mitigate these increases in P loading, bearing in mind the need for short lead-in times.

5.1.3 It is evident from Table 3.3 that some of the largest reductions in P loadings can be achieved through measures within the remit of the water company. However, whilst these measures should remain under consideration going forward, the nature of the regulatory process precludes them on this short timescale. At this stage, therefore, consideration is limited to catchment measures and on-site measures.

5.1.4 On-site measures alone are not predicted to be able to achieve the levels of reductions in P loading required to achieve phosphorus neutrality. Measures aimed at reducing P loads to foul sewers (for example through water efficiency measures) are helpful and should be pursued, but outside of the implementation of Wessex Water's ODI, any new connection to their network will cause an increase in P loads to the catchment that will need to be mitigated by some other means. On-site measures can achieve a reduction in the level of mitigation that will be required, however.

5.1.5 Of the catchment measures, those predicted to achieve the greatest potential reductions in P loadings are wetland sites. These are predicted to achieve significant reductions in diffuse P export from farms (provided they are appropriately designed to capture and treat the majority of the effluent from the farm). They can also be used to provide a form of tertiary treatment for on-site sewage treatment plants, usually involving reed bed systems and require a good deal of management. The predicted reductions in P loads that can be achieved by on-farm wetlands suggest that they will play a key part in achieving P-neutrality.

5.1.6 Of the other catchment measures applicable at farm-level, land use change is predicted to be most effective at reducing P loads. Taking land out of production is predicted to be very effective, but is likely to be very expensive. However, as noted in Section 3.3, Wiltshire Council owns sufficient land that, if it is all currently in agricultural production and were taken out of production, could achieve sufficient reductions in P load to mitigate the estimated increase due to growth in 2018/2019.

5.1.7 The less extreme option of changing land use from intensive to extensive is predicted to achieve smaller reductions in P loads, but has the advantage of being potentially applicable to a larger area of land. Based on the estimates provided in Table 3.3, this measure would need to be implemented on about 4 farms in 2018/2019, and 8 farms in 2019/2020 (although the number will depend on the farm type and location; there is significant variability as shown in Tables 3.1 and 3.2).

5.2 Estimating the effectiveness of agricultural measures on the ground

5.2.1 Section 3.2 provides estimates of baseline phosphorus losses from various "model" farm types, on free-draining and less permeable soils. However, actual farms in the catchment are unlikely to exactly match these model farms in terms of livestock numbers, land area or nutrient management practices. In assessing the effectiveness of measures as implemented it will be necessary to consider the characteristics of the candidate farms, and in the case of measures such as wetlands, the detailed design of the scheme to ensure that maximum benefits are achieved (e.g. a ditch silt trap will have limited effectiveness if the majority of the P export from a farm is in yard runoff). This relies on more detailed local knowledge, and it is recommended that existing schemes and partnerships such as the Hants Avon Catchment Based Approach (CaBA) and Catchment Sensitive Farming are engaged during delivery of the interim plan to provide that knowledge.

5.2.2 Farmscoper modelling can be tailored to individual farms to produce farm-level estimates of P loss by sector (soil, manure etc.) and pathway (runoff, drainflow) and can help to inform detailed designs to maximise the effectiveness of measures.

5.2.3 This report cannot therefore provide quantified estimates of the reduction in P loads that could be achieved across the catchment through implementation of measures, since this will depend on detailed assessment of individual farms and schemes. However high-level estimates of the reductions which could achieve the required 155 kg-P are given in Section 5.5.

5.3 Monitoring

5.3.1 Once measures are put in place to provide mitigation, or reduce P discharges to the environment, it will be necessary to put in place monitoring in order to ensure that the estimated reductions in P loads are being achieved. The nature of the monitoring will vary according to the nature of the measure being monitored, and will require further consideration at site-level.

5.3.2 For wetland sites, it is recommended that specialist advice be sought at the design stage in order to design an appropriate monitoring plan for the site. Samples should be analysed by an accredited laboratory. Monitoring should be carried out for at least 12 months.

5.3.3 Monitoring of on-site wastewater treatment works should comprise inline monitoring of effluent flow and quality for larger plants. For smaller plants, monthly grab samples may be sufficient.

5.3.4 The Working Group has a continuing role to monitor the implementation of the Interim Delivery Plan to ensure it achieves the objective that additional P load generated by new development leads to no net increase in the total load discharged to the River Avon SAC (see section 5.5 below)

5.4 Delivery mechanisms and other catchment initiatives

Catchment Sensitive Farming

5.4.1 Implementation of on-farm mitigation measures will require the identification of suitable candidate sites and the long-term cooperation of landowners. This will rely on good relationships between stakeholders.

5.4.2 Catchment Sensitive Farming (CSF) officers will have those relationships, and would be well placed to support the delivery of the interim plan. CSF is a partnership between Defra, the Environment Agency and Natural England. It brings together farmers and other catchment stakeholders to deliver improvements in air and water quality, through the provision of free training and advice covering manure and nutrient management, soil condition, cross compliance and other subjects. CSF also jointly run a number of long term catchment partnerships with local partners, and support other short-term collaborative projects. Training and advice is delivered by a team of officers, each with a remit to cover a particular area.

5.4.3 Success of the plan will be helped by the provision of financial compensation to farmers for any loss of income. Whilst CSF alone has not delivered the levels of P reductions required by the Nutrient Management Plan, it should be noted that CSF is essentially a vehicle for the delivery of advice and is voluntary with limited incentive for many of the measures actually required in practice. To achieve greater uptake of measures would appear to require this, possibly alongside an enhanced regulatory framework.

5.4.4 Planning authorities could support the delivery of the interim plan through, for example, the provision of an officer (see section 5.5. below) to work with CSF staff, to oversee the delivery of the plan through utilising existing relationships between CSF officers and farmers (see Section 5.5). A crucial first step will be early engagement with CSF staff; they will have local knowledge of where in the catchment measures are likely to be most effective, and which farmers are likely to be receptive to engagement with the interim plan.

5.4.5 It is possible that provisions could be agreed to develop the CSF project in ways that help to deliver measures in the IDP. Further discussion on funding and the scope of this work would be required to take this option forward.

Natural England work

5.4.6 Natural England are engaged in a number of initiatives either in the Avon catchment, or potentially of relevance to ongoing work in the catchment. Of particular note is a natural capital opportunity mapping project (including the use of SciMap modelling, the flow pathway tool, Lidar, and outputs from Hampshire Avon Model) that would help to improve the targeting of mitigation and to identify a mosaic of semi-natural wetland habitats in the catchment.

Wessex Chalk Stream and Rivers Trust

5.4.7 Wessex Chalk Stream and Rivers Trust are pursuing an initiative to provide CSF-type advice in the Nadder sub-catchment. This will not necessarily focus on agricultural mitigation, but on sediment and nutrient enrichment, and is therefore relevant to initiatives to reduce phosphorus in the wider Avon. The intention is to work with Farming Wildlife Action Group South West (FWAG-SW) , who could be a delivery partner for the IDP in their own right.

Landscape Enterprise Networks (LENs)

5.4.8 The Landscape Enterprise Networks (LENs) initiative will bring businesses in the catchment together, to identify risks and assets to their business, find areas of common ground and work together to find solutions. LENs are currently working in the catchment with Wessex Water, Frontier Agriculture, Qinetiq and other businesses, with an initial focus on reducing phosphorus loads to the catchment. Natural England, the Blacksheep Consultancy and the Game and Wildlife Conservation Trust are engaged with the initiative to facilitate a pilot scheme, working with groups of farmers, “Cluster Farms”, to define ‘Whole Landscape Plans that can identify opportunities to increase the environmental health of the landscape (including biodiversity, water quality and access) but with a focus on finding solutions to reducing phosphorous.

5.4.9 The initiative has the potential to facilitate farmer-led action to invest in phosphorus reduction in the Avon, but is at an early stage.

Offset trading

5.4.10 ‘Off-set trading’ by collaboration between Wessex Water and Local Authorities is potentially a very effective means to deliver land use/management measures, developing the model of the Poole Harbour nitrogen offset project.

5.4.11 Wessex Water are investigating the feasibility of a phosphorus trading scheme, and will be running a pilot scheme in 2019, followed by roll-out in the Tone, Parrett and Stour in AMP7. Options for the remainder of the Wessex region (including the Hants Avon) are still being considered.

5.4.12 Such a scheme offers significant benefits through wider stakeholder engagement and efficiencies in determining the most appropriate and cost-effective combinations of measures.

Developer unilateral undertakings

5.4.13 Use of s106 funding to bring forward STW improvements ahead of the AMP process could enable treatment to a higher quality than at present. Although this measure will be largely superseded by the ODI (if adopted), it can also act as a contingency measure should the ODI not be adopted. It would require support from developers willing to support forward funding, and would require an approval process outside the Price Review.

Infrastructure charge discount

5.4.14 To incentivise measures within development, the Water Company provides a 100% environmental discount on infrastructure charge for development that is phosphate neutral at source or meets high standards of on-site measures.

5.5 Interim Delivery Plan

Achieving phosphorus neutrality – to March 2020

5.5.1 The Interim Delivery Plan (IDP) should deliver on-site measures to reduce the phosphorus loading to the River Avon SAC arising from housing development, and catchment measures to mitigate the residual loading from development.

5.5.2 The analysis presented in Sections 3 and 4 demonstrate that the level of mitigation required to achieve P-neutrality in FY2018/19 and FY2019/20 can be achieved through a combination of on-site and catchment measures, although the interim delivery plan cannot specify exactly which measures should be implemented and where (this will need to form the basis of further work – see 'delivering the plan' below.). Annual monitoring will refine the P load reductions that need to be achieved. Sensitivity analysis shows how forecasts may vary and has helped to estimate the likely impacts of the likeliest factors anticipated as an influence.

5.5.3 Based on the high level figures presented here, those measures that seem the most promising and provide mitigation for 155 kg-P/year would be :

Wetlands

5.5.4 Installing wetlands on 12 dairy farms, each achieving a reduction in P export from 26 kg-P/farm/year, to 13 kg-P/farm/year (i.e. 50% reduction) would yield a total reduction in loading of 156 kg-P/year. There are an estimated 100 intensive grazing holdings in the Avon catchment. Estimated cost would be £120,000 (one-off) plus ongoing maintenance costs. Amortised over 10 years, and assuming £2000/year operational costs yields an EAC of £16,400/year. As noted in Section 3, the actual reduction in P load that wetlands can achieve could be greater than 50%, so this represents a conservative estimate.

Changing land use

5.5.5 Changing land use from intensive grazing to extensive grass production on 7 farms would yield a reduction in catchment P load of 23 kg/farm/year, or 161 kg-P/year. Estimated cost would be £86,240 per year.

On-site wastewater treatment

5.5.6 A combination of on-site wastewater treatment works with additional treatment by wetlands to reduce the requirement to mitigate P loads from growth, and in-catchment measures to provide the required level of mitigation.

5.5.7 As an illustration, on-site treatment to an effluent quality of 0.1 mg-P/l for a population of 5000 people (the estimated population growth to March 2020) would generate a need to mitigate 20 kg-P/year. Installing farm wetlands on 2 dairy farms would achieve an estimated reduction in catchment P load of 26 kg-P/year. The approximate cost might be 25 Package Treatment Plants each serving 200 people at £30k each, plus 25 large wetland installations at £20k each, giving a total capital cost of £1,250,000. This would be a one-off cost, with an Equivalent Annualised Cost (EAC) over 20 years of £88,000/year. There would also be some ongoing maintenance costs.

Achieving phosphorus neutrality – to 2025

5.5.8 It is shown in Section 2 that reductions in diffuse P export from development on greenfield sites will mitigate the increase in P loads from unsewered development, and no further mitigation would be required beyond 2020.

5.5.9 This Outcome Delivery Incentive (ODI) commits Wessex Water to maintaining levels of phosphate discharge to the R Avon SAC to the average level of the last five years. This would operate over the years 2020-2025. If the ODI is not put fully into place, there will be a need to mitigate up to approximately 220 kg-P/year in 2021, rising to 545 kg-P/year in 2025.

5.5.10 The most effective means of achieving these large reductions would be through reducing the amount of mitigation required elsewhere, either through on-site treatment with tertiary treatment to reduce the P load discharged to the environment, or through connection to a Wessex Water STW, with improvements to treatment funded via one of the delivery mechanisms identified above (e.g. developer unilateral undertakings).

5.5.11 By 2020 it will be necessary to review the calculated P load from new development taking into account the actual performance of Wessex Water STWs, bearing in mind that some assets already perform to a higher standard than the 0.9 mg-P/l assumed in the MoU methodology. Depending on to which STW the new developments will be connected, the load requiring mitigation could be lower than estimated here.

5.5.12 In-catchment measures with prospects for achieving mitigation of 545 kg-P/year include:

Wetlands on farms

5.5.13 Wetlands on farms in the lower catchment (on heavier soils). Using the baseline figure of 136 kg-P/year diffuse export (winter combinable + pig manure farms) and assuming wetlands can reduce this by 50%, yields a reduction of 68 kg-P/farm/year. Wetlands would be required on 8 farms (based on the Farmscoper generic farms). Agricultural census data indicates that there are 17 arable holdings in the Lower Avon waterbody, and also some pig farms in the lower catchment. Assuming capital costs of £20,000 per wetland (costs will be higher because a higher level of treatment is required) and £2000/year maintenance costs yields an EAC over 10 years of £21,200/year.

Changing land use

5.5.14 Changing land use from intensive grazing to extensive grass production on 24 farms would yield a reduction in catchment P load of 23 kg/farm/year, or 552 kg-P/year. Estimated cost would be £295,680 per year. Agricultural census data identifies 100 intensive grazing holdings in the Avon, mainly in the upper catchment (Bourne and Wylye).

Delivering the plan

5.5.15 Delivering the plan will involve the following actions to be over seen by the working group:

5.5.16 Agreement to a 'implementation plan' setting work objectives and task for the year ahead. This would investigate and deliver measures identified in the IDP and involve:

- Identifying and gaining access to suitable locations
- Testing feasibility of measures
- Detailed design and construction
- Agreements for ongoing management
- Specifying a monitoring programme
- Co-ordination of funding and resources
- Liaison and co-ordination of the IDP with other delivery mechanisms and catchment initiatives (see above)

5.5.17 It is recommended that the working group engage an officer with responsibility for delivering the IDP and its implementation. The tasks of the IDP Officer would be:

- To engage with developers to make them aware of the requirements of the IDP;
- To provide assurance that calculations of P loads that will need to be mitigate from each development are accurate and follow the correct methodology;
- To engage with catchment stakeholders such as CSF officers and LENS, in order to identify suitable sites for agricultural mitigation measures, where there are opportunities for reductions in diffuse pollution and willing landowners;
- To work with developers to identify options for mitigation, or to reduce the degree of mitigation required through on-site measures;
- To carry out site-specific calculations of the reductions in catchment P loads that can be achieved through measures. This will be likely to involve modelling to estimate the effectiveness of agricultural measures (e.g. Farmscoper) and site-specific calculations of P loads from development sites taking into account any local mitigation;
- To gather specialist advice to design and implement a monitoring programme to quantify the reductions in P loads that have been achieved by measures and ensure that developments have achieved P-neutrality.

5.5.18 In addition, the Working Group should continue to oversee the delivery of the IDP. The Working Group should annually review rates of housing growth in the catchment against the projections described in this report, and ensure that any significant deviations from the projections are accounted for by the IDP. There are a number of studies planned or underway to establish constructed wetlands to protect sites in the south of England, and the Working Group should review the outcomes of these projects in order to build the evidence base that wetlands can achieve the reductions in phosphorus required to achieve phosphorus-neutral growth in the River Avon SAC. The Working Group should also continue to monitor emerging science, and review the suites of measures implemented through the IDP to ensure that the most effective measures are considered.

5.6 Summary

- It is estimated that a P load of around 85 kg P/year will need to be mitigated in FY 2018/2019, and a P load of 155 kg P/year mitigated in FY 2019/2020;
- On-site measures, especially if they include combinations of on-site sewage treatment and wetlands, can significantly reduce the degree of mitigation required, but not eliminate the need for mitigation;
- Catchment measures targeted at diffuse agricultural sources can provide significant reductions in P export. There will be a great deal of variability in P export between farms, however, depending on farm type, soil type and nutrient management practices, and further work is required to identify suitable sites for intervention;
- The largest reductions are predicted to involve land use change. Taking land out of production is predicted to result in large reductions in phosphorus loads, but is likely to be viable only if the land is already owned by the LPA (i.e. public estate);
- Changing from intensive to extensive land use can also result in significant reductions in P export;
- Farm scale constructed wetlands offer very significant potential reductions in agricultural P export, but the detailed design and placement of the schemes will be important to maximise effectiveness;
- Similarly, large-scale, in-catchment wetlands could potentially offer significant reductions in phosphorus in the catchment, although further work is required to explore the feasibility of this option, and it is recommended that a study is commissioned to that end;
- The estimated costs and reductions in P loads presented here are based on many assumptions and generic farm types, and will be refined as the IDP as further work is carried out;
- It will be important to capture local knowledge of the catchment when determining suitable schemes to mitigate P increases from housing growth and the predicted reductions in agricultural P loads that can be achieved with combinations of measures, particularly including constructed wetlands. The analysis presented here suggests that delivery of the interim plan to achieve phosphorus-neutrality is technically feasible.