Payments for Ecosystem Services – Round 3: Winford Brook PES Pilot Research Project

Final Report for Defra

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Disclaimer

Eunomia Research & Consulting has taken due care in the preparation of this report to ensure that all facts and analysis presented are as accurate as possible within the scope of the project. However no guarantee is provided in respect of the information presented, and Eunomia Research & Consulting is not responsible for decisions or actions taken on the basis of the content of this report.
Executive Summary

This report presents the findings of the Winford Brook Pilot Payments for Ecosystem Services (PES) Project, one of the Round 3 PES Pilots funded by Defra in 2014/15. The project partners for the work were Eunomia Research & Consulting Ltd. (Eunomia), Avon Wildlife Trust Consultancy (AWT), Wessex Water, Bristol Water and TLT Solicitors. The project gained the support of the West of England Local Enterprise Partnership. Several of the partners are involved in the West of England Nature Partnership: the project partners worked closely with the Environment Agency, Natural England, Bath & North East Somerset Council, and North Somerset Council.

E.1.0 Approach

The project was centred on the 17km$^2$ Winford Brook catchment, south of Bristol, identified by the Environment Agency as a Rapid Response Catchment. There has been flood-related loss of life in the area in recent years, and there are now frequent flood surgeries in Chew Magna involving local residents, the Environment Agency, Bristol Water and other stakeholders.

Bristol Water also owns a reservoir in the catchment, the Chew Magna Reservoir, which lies upstream of Chew Magna itself. It has to remove silt, periodically, due to erosion in the catchment. To date, the silt has been stored on site, but due to space constraints, any that is removed in future will have to be removed from the site, most probably being sent for landfill (or other forms of management). Accordingly, the expense attributable to the accumulation of silt is expected to increase, so Bristol Water was keen to explore cost-effective measures to reduce the amount of silt entering the reservoir.

Bristol Water was also seeking to reduce the likelihood of algal blooms due to elevated nutrient levels in Chew Valley Lake, which receives input from Chew Magna Reservoir.

Wessex Water, with local responsibility for sewerage, was keen to explore the potential for a catchment-based approach to reduce or avoid costs associated with removing nutrients from wastewater at their local wastewater treatment works. The presence of nutrient was closely linked to the soil erosion problem.

Other organisations with an interest in the catchment included the Environment Agency (from both a WFD water quality and a flood risk perspective) and Natural England, as the catchment became, shortly before reporting (and after the project commenced), a Catchment Sensitive Farming (CSF) Target Area.

The initial intention was to try to develop a relatively ‘light touch’ method, based on:

- Making use of an existing GIS dataset that had previously been used to generate a map of the risk of soil loss within the catchment;
• Reviewing the literature on the effectiveness of land management interventions at reducing soil erosion and flood risk – (and providing other ecosystem services);
• With this information, determining the likely effectiveness of measures in different locations across the catchment; and (subsequently)
• Scoring submissions put forward by farmers under a reverse auction approach.

However, it became clear that this approach would have to be adapted to reflect:
• The site-specific nature of the reported effectiveness of interventions, and the resulting difficulty in transferring findings to other locations;
• The importance, in the case of soil erosion in particular, of understanding connectivity within the catchment, i.e., the specific sources of sediment and the pathways by which it reaches watercourses; and
• The small number of farmers within the catchment.

As a result of this review of the approach, Bristol Water commissioned a detailed walkover survey of the catchment which was effective in identifying specific issues giving rise to the problem, and proposing measures to address them. It is subsequently intended that the approach to identifying changes appropriate for funding will be adviser-led, rather than using a reverse auction mechanism as originally planned.

E.2.0 Key Findings

Key findings from the project are as follows:

1. **The avoided costs of sediment removal provide a clear indication of the marginal financial benefits associated with reduced levels of erosion within a catchment.** This contrasts with other potentially avoided costs, such as those related to reducing the likelihood of algal blooms in water supply reservoirs through measures that decrease the input of phosphorus and nitrogen to waterbodies. Avoided costs of sediment removal can, therefore, be used to provide a lower bound estimate of the available fund to support changes in management on the part of providers, recognising that from the perspective of the beneficiary (in this case the water company), measures may lead to wider (but as yet unquantified) benefits in terms of reducing the risk of algal blooms. The present value to Bristol Water associated with each cubic metre reduction in erosion per year is estimated to lie between £666 and £1,025 (depending on one’s view as to the longevity of the changes bringing about the anticipated reduction);

2. **Management of soil nutrients on land within the catchment is expected to be more cost-effective for water companies than investment in ‘grey’ infrastructure.** Wessex Water indicated that managing soil nutrients on land would potentially mean that they can reduce or avoid future nutrient removal costs at sewage treatment works (STW). If Wessex Water was to install
treatment infrastructure at a Sewage Treatment Works to deal with Phosphorus from the catchment the cost is estimated to lie between £2m and £5m. Wessex anticipates, on basis of previous experience that a catchment approach would cost one sixth of this, suggesting that the intended outcomes could be achieved for an expenditure of between £300,000 and £800,000 on catchment measures to reduce the phosphorus requiring treatment.

3. **An adviser-led approach may deliver a more cost-effective outcome than a reverse auction.** The smaller the number of farmers in the catchment and the more location specific the issues, then the more likely it becomes that an adviser-led approach will deliver a more cost-effective outcome than a reverse auction. This is aligned with the findings from the Fowey PES Pilot. In the Chew Magna catchment, the project team set out with an expectation that a reverse auction-based largely on using existing data on areas at highest risk of soil erosion, combined with information on the likely effectiveness of generic measures - would be the preferred approach. However, in respect of soil erosion, it became increasingly clear that identifying the precise sources and pathways was very important to ensure that beneficiaries were not simply paying for actions that delivered limited benefits. Hence, the decision to commission a walkover survey to identify the specific locations where measures were most likely to be effective. In addition, it became clear that the small numbers of landowners within the catchment meant that the scope for efficiencies through an auction would be reduced relative to the administrative costs.

There is an interesting question, related to more general cases, which flows from this experience: What is the nature of the trade-off between:

   a. more effective targeting of interventions through walk-overs / more detailed surveying; and

   b. the additional costs of undertaking such surveys?

Theory suggests that the greater the number of participants, the more one moves away from more ‘administratively cumbersome’ approaches. Yet land management practices are not ‘fixed’, and there is scope for strategic behaviour on the part of providers. Furthermore, beneficiaries such as water utilities have to demonstrate value for money to the regulator. As such, there may be a requirement for monitoring of the efficacy of interventions anyway (not least, to ensure that ‘providers’ have made changes, and that they are still providing what they claimed they would). We believe, therefore, that the trade-off may be less significant than might be imagined, and that there may be gains (rather than losses) in efficiency that flow from more detailed survey work (rather than ‘pure’ market mechanisms).

4. **Baseline monitoring is important in giving confidence to potential beneficiaries that the effect of subsequent interventions will be able to be identified.** As part of demonstrating to the regulator that customer money has been spent wisely over the 5-year AMP period, water companies will need to know, and be able to report on, the impacts of the interventions that they have funded. Bristol Water is already monitoring for water quality (total phosphorus, suspended solids, dissolved phosphorus and nitrates) just upstream of Chew Magna Reservoir.
From May 2015, monitoring commenced at a number of other locations within the catchment recommended following the walkover survey. The importance of monitoring is arguably greatest for the regulated water companies, although any contributing beneficiaries will rightly want to know what they will get for their funding.

5. **For tackling soil erosion, offering funding for location-specific measures proposed by advisers will give greater certainty to beneficiaries that their money is being spent efficiently.** The approach applied in the Fowey PES Pilot project, and indeed, the approach applied by Catchment Sensitive Farming, is to allow farmers to select from a list of possible measures. The risk with this format is that farmers will select measures that best suit their own farm plans, while opportunities to address the concerns of the funders in a more cost-effective manner may be overlooked.

6. **The current rules on awarding funding via Catchment Sensitive Farming (CSF) do not facilitate combining this kind of PES scheme with CSF.** There was discussion with Natural England about the possibility of a ‘top-up’ to the CSF fund in the catchment from beneficiaries (i.e. water companies). However, the fact that farmers would be able to choose measures from a list, and the limit of £10,000 funding per farm, means that the potential efficiency of the approach is limited. Arguably, shifting funds in the opposite direction, i.e. from the CSF ‘pot’ to the multi-beneficiary fund ‘pot’, would be a more attractive, and efficient, proposition.

Earlier in the project, prior to the catchment being considered as a target CSF area, similar thoughts had been considered vis a vis countryside stewardship (CS). At the time it was felt that it might be possible to deploy the funds from CS, strategically, to enhance the additionality of beneficiary funds through using them to provide the incremental funding that might persuade a given farmer to adopt specific CS measures.

7. **In order to secure funding from as wide a range of beneficiaries as possible, it is important to select a catchment that is a priority for as many beneficiaries as possible.** Whilst this may appear to be a statement of the obvious, at a time of constrained budgets, even though potential contributors perceive that they will obtain a net benefit from funding interventions, they may only be able to justify financial contributions to PES schemes in locations that have been identified as key priorities to their organisation.¹ It may, therefore, be worthwhile for future schemes to undertake a ‘beneficiary mapping’ exercise, to understand which geographical areas are of greatest interest to a broad range of potential beneficiaries. Targeting such ‘hotspots’ would thus offer the greatest potential for multiple financial contributions.

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¹ This was the case for the Environment Agency. While the EA representatives could see benefits to the EA from interventions in the Winford Brook catchment, funding could not be provided as the catchment was not a top priority from the Agency’s perspective.
8. **Even within catchments of interest to a number of different potential beneficiaries, the exact areas of interest may not coincide.** In the case of the Winford Brook catchment, Bristol Water was interested principally in the catchment of the Chew Magna Reservoir. This does not include the part of the catchment that feeds the Winford Brook downstream of Chew Magna Reservoir. This part of the catchment was not included in the Bristol Water-funded walkover, but when the findings were presented to the wider group of beneficiaries, Bath & North East Somerset Council indicated that this area was of greatest interest to them, and that including this area in the study would have assisted in making a case for contributory funding. This reinforces the previous point in that the area of focus chosen might usefully consider issues of connectivity within the catchment, and whether extending the area of interest has the potential to draw in other beneficiaries.

9. **Setting up PES schemes takes time.** It is fair to say that the project team was (with the benefit of hindsight) a little ambitious in terms of the expectations of what would be achieved in less than a year, and using the available resources. Had funding been awarded for the establishment of the Natural Capital Trust (NCT – see below), the resources directed towards the establishment of PES schemes in the West of England, and in the Winford Brook in the first instance, would have been enhanced, and further progress made.\(^2\) However, this pilot project for Defra has undertaken much of the groundwork that will prove to be of great use in taking the scheme forward (to implementation), and rolling out to other catchments should the NCT eventually obtain funding.

### E.2.1 Proof of Concept

The aim of the project was to set in place the foundations for a multi-beneficiary PES scheme rather than proceed to a point where financial exchanges took place between beneficiaries and suppliers. Indeed, there was a question in the team’s mind, when the project commenced, as to whether the magnitude of the benefits would justify the changes in land use that might reasonably have been expected to give rise to those benefits. Because no transactions have yet taken place, proof of concept in its fullest sense has not yet been demonstrated: that having been said, there are very good reasons to be confident that the potential benefits (and the fund that this notionally represents) are sufficient to support the changes required to deliver the benefits. Proof of concept will, however, only be demonstrated once the multi-beneficiary contributory fund is established, transactions have taken place, and monitoring has identified that measures within the catchment have been effective (and we strongly suggest that

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\(^2\) The Natural Capital Trust (NCT) is a concept developed by Dr Bevis Watts. The NCT, for which a funding application was submitted to the West of England Enterprise Partnership, is intended to be a not-for-profit entity to facilitate the strategic development of trading markets for natural capital investment in the West of England. One of the proposed aims of the NCT would be to broker PES schemes, including the creation and management of a multi-beneficiary contributory PES fund.
research councils be alerted to situations where schemes are being implemented to help inform our understanding of the benefits that flow from particular interventions. The partners are still working together to achieve this (beyond the pilot project’s duration).

However, the key findings both reinforce lessons from earlier pilot projects, and add additional evidence to the growing literature on the theoretical and practical aspects of developing PES schemes.

Finally, it is worth commenting on the commerciality of PES schemes in the general sense. From the perspective of beneficiaries (and policy makers), whilst it would, of course, be desirable to be 100% certain of the scale of the benefits relative to the costs, in the absence of data, this might be perceived as presenting a fundamental challenge. However, we were consistent in our approach which maintained that in the absence of perfect information, what mattered most was that the beneficiary had a reasonable expectation of deriving benefits that exceeded the costs of bringing about land use changes that they expected to provide benefits. Hence, what is important to beneficiaries is the expectation that the risk-adjusted benefits that they feel are likely to materialise from the changes they support exceed the costs of the intervention. The benefits will, after all, be not only uncertain, but variable with the climate and rainfall in a given year. If we wait for the situation to arise when costs are only incurred where benefits are certain, then given the state of the data and information at our disposal, we might be waiting for a very long time indeed. Until agreements are concluded with landowners and interventions implemented, and only once monitoring has been able to demonstrate the impacts, will it be possible to calculate, with any precision, the scale of the benefits, and the benefit:cost ratio.³

### E.2.2 Achievements

The key achievements of the pilot project are as follows:

- The potential avoided costs associated with a reduction in the requirement for dredging have been shown to be relatively easy to identify. To the best of our knowledge such calculations have not been performed before in the context of a potential PES scheme;
- The walkover report highlighted the importance of roads as both sources, and conduits, of eroded sediment, bringing into view the possible dual role of the local authority – as lead local flood authority and highways authority - as both a potential supplier and beneficiary;

³ In this respect it is worth noting that the scale of benefits will vary between years. For example, measures to reduce soil erosion may show very little benefit relative to the baseline in years of little rain, whereas in very wet years the benefits from the interventions may be very high.
The process of engagement with beneficiaries has enabled the identification of ‘guiding principles’ in relation to the establishment of a multi-beneficiary contributory PES fund; and

The legal issues surrounding the establishment of a multi-beneficiary contributory PES fund have been considered and are reported as an annex to this report. Again, as far as we are aware, this is a first for the UK.

### E.2.3 Challenges

The main challenge faced by the project team related to data, primarily in respect of the likely effectiveness of specific measures in particular locations. This meant that the initially intended ‘light-touch’ approach turned out not to be possible. The walkover study reinforced the importance of detailed ‘on the ground’ investigations, especially when seeking to address issues relating to soil erosion. As noted above, notwithstanding the costs involved in this, it remains an open question as to whether such activities are justified in the general case through the more efficient use of beneficiary funds that they might give rise to.

Another challenge was the lack of data relating to flood risk within the catchment, and specifically in terms of possible effects on flood risk of changes in land use. Environment Agency modelling had only considered changes within the channel of the Winford Brook, rather than considering the possible effect of wider land use changes within the catchment, which meant that the possibility of flood risk reduction could only be considered qualitatively.

A further challenge related to landholding data. Bristol Water sought to obtain RPA data to identify landholdings and associated data. However, the RPA stated that only Government Agencies are allowed access to the Customer and Land (CLAD) database of holdings data. Instead, Bristol Water purchased information from the Land Registry in order to obtain names and addresses of landowners in the catchment. This lack of access to CLAD data acts as a barrier for organisations, such as water companies, who might wish to undertake a PES scheme involving landowners.

This lack of certainty at present should not be a reason to delay the implementation of PES projects. By contrast, as long as adequate provision is made for monitoring, the greater the number of PES projects that are undertaken, and the sooner they are implemented, the faster our knowledge will develop regarding the magnitude of the benefits relative to the costs. This should, in turn, facilitate targeting of measures to achieve outcomes in the most cost-effective manner.

One final challenge is that the scale of the transaction costs that might be involved in negotiating with landowners within the catchment is as yet unknown. Where the landowner’s activities are currently not aligned with good practice, it is anticipated that the transaction costs may be relatively higher, albeit the potential benefits associated with taking the opportunity to ensure good practice is adhered to prior to being able to participate in a PES scheme may also be high.
E.2.4 Transferability of Findings

While much of the data gathered in the study relates to the study location, the approaches used and the lessons learned are fully transferable to other situations. Specifically, the approach to determining the potentially avoided dredging costs can be replicated elsewhere, whilst the recommendations in respect of establishing a multi-beneficiary contributory PES fund can also be readily transferred.

In addition, the pilot project highlighted the importance of walkover surveys in identifying the particular locations within catchments where issues arise, and thus where specific interventions might best be placed. Furthermore, the walkover survey helps to identify location specific monitoring requirements that will enable a ‘baseline’ to be developed which will assist in the subsequent demonstration of impact to beneficiaries, and in some cases to their regulators. There is also a role for walkover surveys as part of the post-implementation monitoring. Such findings in relation to the role of walkover surveys are fully transferable to other catchments. As noted above, there may be reasons to believe that, especially where detailed, on the ground monitoring is a requirement for beneficiaries (as it may be for regulated utilities), then the costs of detailed survey are part of the required expenditure to ensure value for money: as such, to the extent that such approaches facilitate better targeting of beneficiary spend, there may be a reasons to advocate such an approach.

E.2.5 Barriers Requiring Government Intervention

Reflecting one of the key findings of the pilot project, there is a need to further explore whether the rules for Catchment Sensitive Farming (or rather its successor, the Water Capital Grants under the Countryside Stewardship Fund) allow, or could be adapted, for the budget for specific catchments to be allocated to a multi-beneficiary PES fund. At present, the rules on awarding funding via CSF do not appear to facilitate combining this kind of PES scheme with CSF. The most efficient approach would be to shift funds from the CSF ‘pot’ to the multi-beneficiary fund ‘pot’.

From the perspective of beneficiaries, it makes sense, for the time being, to let the current round of CSF grant applications in the catchment proceed, as this will reveal the preferences of the farmers for specific measures, and allow for a subsequent round of more targeted funding of interventions under the PES scheme, so as to maximise the additionality of the spend.

The lack of access to CLAD data from the RPA acts as a barrier for organisations, such as water companies, who might wish to undertake a PES scheme involving landowners.

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Government intervention to permit such data to be shared with relevant organisations, such as water companies, that are not Government Agencies, would be welcome.

At the regional level, it had been hoped that the project could be carried forward under the aegis of the Natural Capital Trust. By working alongside the West of England Local Enterprise Partnership (LEP), the WENP had hoped to secure funding for a call for ERDF funds, to be issued by CLG. A number of unnecessary obstacles have emerged, however, largely related to CLG advice to the LEP regarding the LEP’s strategy for managing ESIF funds. At the time of writing, notwithstanding the fact that the second strategic objective of the LEP read:

*Ensure a resilient economy, which operates within environmental limits. That is a low carbon and resource efficient economy, increases natural capital, and is proofed against future environmental, economic and social shocks.*

it is unclear as to whether CLG will allow the call related to the NCT to proceed, even though this (or similar) has been envisaged from an early stage in the formulation of the strategy for managing the funds (and the project itself appears in the LEP’s Strategic Economic Plan). A decision from CLG is awaited (this is due, we understand, on November 6th).

As previously noted, good monitoring is essential for any scheme in order for the impacts to be understood, and importantly for regulated companies to demonstrate the effectiveness of their expenditure on catchment management measures to regulators. Furthermore, such monitoring is key in helping to increase understanding of the relative costs and benefits of interventions. Accordingly, in order to help advance knowledge in this area, there may be a role for government funding, possibly directed via research councils, in helping to fill this knowledge gap.

**E.2.6 Future Prospects for PES**

The wider project team is currently considering the next steps. The missing element of the jigsaw is seed funding to support the NCT. The findings of, and lessons learned from, this pilot project are likely to inform any submission, and we believe that the preliminary legal work undertaken as part of the pilot will be a significant strength of any bid.
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1.0 Introduction

This report presents the findings of the Winford Brook Pilot Payments for Ecosystem Services (PES) Project, one of the Round 3 PES Pilots funded by Defra in 2014/15. The project partners for the work are Eunomia Research & Consulting Ltd. (Eunomia), Avon Wildlife Trust Consultancy (AWT), Wessex Water, Bristol Water and TLT Solicitors. The project gained the support of the West of England Local Enterprise Partnership. Several of the partners are involved in the West of England Nature Partnership: the project partners worked closely with the Environment Agency, Natural England, Bath & North East Somerset Council, and North Somerset Council.

The project is centred on the Winford Brook catchment, south of Bristol, identified by the Environment Agency as a Rapid Response Catchment. There has been flood-related loss of life in the area in recent years, and there are now frequent flood surgeries in Chew Magna involving local residents, the Environment Agency, Bristol Water and other stakeholders.

Bristol Water also owns a reservoir in the catchment, the Chew Magna Reservoir, which lies upstream of Chew Magna itself, from which it has to remove silt periodically due to erosion in the catchment. To date, the silt has been stored on site, but due to space constraints, any that is removed in future will have to be removed from the site, most probably, being sent for landfill (or other forms of management). Accordingly, the expense attributable to the accumulation of silt will increase, and Bristol Water is keen to explore cost-effective measures to reduce the amount of silt entering the reservoir. Research undertaken prior to commencement of the pilot project identified, at a relatively high level, possible land-based measures and management actions to reduce erosion at specific locations in the catchment. There is potential for measures intended to reduce erosion in the catchment to also reduce flood risk (and vice versa).

The chosen location, the Winford Brook Catchment, therefore exhibits all of the characteristics identified by Defra as leading to the greatest likelihood of the emergence and application of PES schemes, namely:

1) Specific land or resource management actions have the potential to increase the supply of a particular service (or services);
2) There is a clear demand for the service(s) in question, and its provision is financially valuable to one or more potential buyers; and
3) It is clear whose actions have the capacity to increase supply.

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5 Water from Chew Magna Reservoir can be released to the River Chew, or transferred to Chew Valley Lake, from where Bristol Water abstracts water for potable supply.

6 Defra (2013) Payments for Ecosystem Services: A Best Practice Guide
It is understood that this is the first time that a water company, as the ‘anchor’ beneficiary, has worked alongside a Local Nature Partnership (LNP), supported by the Local Enterprise Partnership (LEP), to broaden the base of contributing beneficiaries to a multiple benefits Payments for Ecosystem Services (PES) scheme. The intention is that the Winford Brook pilot will provide a widely replicable and scalable approach that can be applied by water companies, LEPs and others across England.

1.1 Report Structure

The report is laid out as follows:

- The approach to the project is summarised in Section 1.2;
- Background information on the catchment is provided in Section 1.3
- In Section 2.0 the demand for ecosystem services within the catchment from beneficiaries is identified. This draws on research undertaken during the course of the project, including via engagement with beneficiaries;
- The initial approach to identifying potential land management actions, and the challenge of predicting the effects of such interventions if implemented within the Winford Brook catchment is described in Section 3.0;
- The process of engagement with suppliers and beneficiaries, is explained in Section 4.0;
- In Section 5.0 the walkover study is introduced (with the full report included as an accompanying document and the key findings presented in Appendix A.7.0);
- Section 6.0 reports on the progress in developing the framework for the Natural Capital Trust and the associated multi-beneficiary contributory fund; and
- Section 7.0 contains conclusions.

1.2 Approach to the Project

The initial intention was to try to develop a relatively ‘light touch’ method, based on:

- Making use of an existing GIS dataset that had previously been used to generate a map of soil loss risk within the catchment (see Section 1.3);
- Reviewing the literature on the effectiveness of land management interventions at reducing soil erosion and flood risk – and providing other ecosystem services;
- With this information, determining the likely effectiveness of measures in different locations across the catchment; and subsequently
- Scoring submissions put forward by farmers under a reverse auction approach.

However, it became clear that this approach would have to be adapted to reflect:

- The site-specific nature of the reported effectiveness of interventions, and the resulting difficulty in transferring findings to other locations;
• The importance, in the case of soil erosion in particular, of understanding connectivity within the catchment, i.e. the specific sources of sediment and the pathways by which it reaches watercourses; and
• The small number of farmers within the catchment.

As a result of this review of the approach, Bristol Water commissioned a detailed walkover survey of the catchment which was effective in identifying specific issues giving rise to the problem, and proposing measures to address them. It is subsequently intended that the approach to identifying changes appropriate for funding will be adviser-led, rather than using a reverse auction mechanism as originally planned.

We had also envisaged, at the outset, that the Natural Capital Trust (see Section 6.0) would be awarded funding via the West of England Local Enterprise Partnership’s (LEP) Strategic Economic Plan (SEP). However, while it was included in the SEP, it did not receive the anticipated funding. This has hindered progress - to the extent that had it been funded there would have been a fully resourced entity working alongside, and informed by, the pilot project, focused on delivering PES schemes in the West of England. However, this pilot project for Defra has undertaken much of the groundwork that will prove to be of great use when the NCT does obtain funding.

1.3 The Catchment

A schematic overview of the catchment is provided at Figure 1-1. This shows the Chew Magna Reservoir (CMR), just upstream of Chew Magna, with the CMR catchment boundary marked in green. The Winford Brook and its tributaries upstream of CMR are indicated. Downstream of Chew Magna, the Winford Brook joins the River Chew.

Bristol Water abstracts water from Chew Valley Lake for potable supply, with raw water from Chew Valley Lake going to Stowey and Barrow Water Treatment Works. Chew Valley Lake itself receives inputs of water pumped directly to the lake from Chew Magna Reservoir, as indicated.
Information about the propensity for erosion in different parts of the catchment, of a relatively high level nature, is the subject of a 2012 report by AMEC for Bristol Water. This largely GIS-based study provided the project team with useful initial information about the catchment. A map from this study, showing a general overview of the catchment is provided at Figure 1-2.

This study also looked at the land use within the catchment, which is predominantly pasture. This, along with the area that is woodland, arable land, urban and disturbed soils is shown in Figure 1-3.

Catchment slope data was also considered in the study, with the areas of land of differing gradients shown in Figure 1-4.

The AMEC study brought together these factors, along with proximity to watercourses and soil classification (whether free draining or slowly permeable) to develop a GIS-based sediment source risk classification, shown in Figure 1-5. As noted previously, the initial expectation of the PES pilot project team was that this GIS data could be used alongside knowledge of the likely effects of different types of interventions to develop a ‘light touch’ approach to identifying and scoring measures.

In order to identify landholdings, Bristol Water sought to obtain RPA data, but were informed that only Government Agencies are allowed access to the Customer and Land (CLAD) database of holdings data. Instead, Bristol Water purchased information from the

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Land Registry in order to identify names and addresses of landowners in the catchment. However, this lack of access to CLAD data acts as a barrier for organisations such as water companies who might wish to undertake a PES scheme.

Personal communication with Matthew Pitts, Bristol Water, June 2015
Figure 1-2: Overview of the Winford Brook Catchment (Source AMEC for Bristol Water)
Figure 1-3: Winford Brook Catchment Landuse
Figure 1-4: Catchment Slope
Figure 1-5: Sediment Source Risk Classification

The risk classification is based on a basic qualitative classification of four datasets:

a) Soil HOST (1 or 3);
b) Proximity to watercourse 25m (4), 100m (5), 300m (2) and 1000m (1);
c) slope (less than 2.5% (1), 2.5% to 5% (2), 5% to 7.5% (3) and greater than 7.6% (4);
d) Landscape: woodland (1), pasture (2), urban (3), ploughed (4) and disturbed sites (5).

The classification is intended as a guide to the prioritisation of key sediment sources. Further investigation should be undertaken to confirm key sources.

Further information is provided in section 4 of the report.
2.0 Identifying Demand

At the outset, it was clear to the project team that the most likely sources of demand were from:

- Bristol Water (relating to avoided costs of removing silt from Chew Magna Reservoir); and
- Wessex Water (seeking to avoid nutrient removal costs at waste water treatment works).

In addition, it was felt that there would be interest from:

- Environment Agency (relating to flood risk reduction and water quality);
- Natural England (given the importance of some of the unimproved grassland within the catchment); and
- Bath & North East Somerset Council and North Somerset Council as lead local flood authorities (LLFAs).

A range of other possible negative impacts from current practices / positive impacts associated with addressing these issues were considered, as per the framework shown in Figure 2-1. However, priority was given to investigating those impacts where it was felt that a beneficiary would:

1) Recognise the scale of the problem; and
2) Be sufficiently motivated to make an investment to tackle it.

Accordingly, while air pollution caused by particulate matter (PM) from bare soils could have an impact, it seemed less likely to motivate a payment than other impacts. Of course, in other locations this may be a much higher priority. Issues such as biodiversity enhancement and carbon sequestration were likewise considered to be of interest, but arguably as secondary drivers. For example, we know that Wessex Water has a preference for measures that in addition to delivering reduced nutrient removal costs, can sequester carbon and enhance biodiversity (and possibly deliver other benefits) over measures that do not.

In the sections below we report on:

- Accumulation of silt in Chew Magna Reservoir (Section 0);
- Raw water quality – algal blooms in Chew Valley Lake (Section 2.2);
- Wastewater nutrient removal (Section 2.3);
- Impacts of soil erosion on sewerage infrastructure (Section 2.4);
- Water quality and the Water Framework Directive (Section 2.5);
- Flood risk reduction (Section 2.6); and
- Road gully clearance (Section 2.7).
In addition, in Section 2.8 we consider how the PES scheme might operate alongside Natural England’s Catchment Sensitive Farming (CSF) grants scheme which offered the first round of grants to farmers in the Winford Brook catchment from March 2015.

**Figure 2-1: Conceptual Approach to Identifying Impacts and Benefits of Interventions**

For most of the sources of potential demand, it was not possible, given current information constraints, to identify a monetary value. However, there were two exceptions to this:

1) The present value to Bristol Water associated with each cubic metre reduction in erosion per year is estimated to lie between £666 and £1,025 (depending on one’s view as to the longevity of the changes bringing about the anticipated reduction); and

2) Wessex Water has indicated that managing soil nutrients on land will potentially mean they can reduce or avoid future nutrient removal costs at sewage treatment works (STW). If Wessex Water were to install treatment infrastructure at a Sewage Treatment Works to deal with Phosphorus from the catchment the cost is estimated at between £2m and £5m. On the basis of Wessex’s experience that a catchment approach would cost one sixth of this, this would suggest expenditure of between £300,000 and £800,000 on catchment measures to reduce P.
2.1 Accumulation of Silt in Chew Magna Reservoir

The most immediate financial driver reported by Bristol Water was the desire to avoid the cost of dredging silt that has accumulated in Chew Magna Reservoir and taking it offsite for disposal. However, no detailed information is held by Bristol Water on the rate of accumulation, the frequency at which Chew Magna Reservoir has historically been dredged, or the amount removed. In the absence of precise data we were initially reliant on Bristol Water’s best estimate, which is that 55,000m$^3$ of silt is removed from Chew Magna Reservoir each time the reservoir is dredged. This is based on the following data and assumptions from a report by AMEC for Bristol Water: 9

1. The surface area of Chew Magna Reservoir is 2.75 ha;
2. The assumed mean depth is 4m;
3. On this basis the maximum volume is 110,000 m$^3$;
4. It is assumed that Chew Magna Reservoir would require full dredging to remove material filling 50% of the reservoir volume, i.e. 55,000m$^3$ once every 50 years.

On this basis it is therefore estimated that in an average year 1,100m$^3$ of silt enters Chew Magna Reservoir.

The AMEC report estimates the unit costs for the removal of sediment as shown in Table 2-1.10 It is not, however, clear from the report what is involved in terms of ‘pre-treat’ while ‘dispose’ appears to include transport costs.

Table 2-1: Estimated Unit Costs for Removal of Sediment

<table>
<thead>
<tr>
<th>Dredging Costs</th>
<th>Low (£)</th>
<th>High (£)</th>
<th>Value Used in AMEC’s Assessment (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove (per m$^3$)</td>
<td>5</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Pre-treat (per m$^3$)</td>
<td>15</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td>Dispose (per m$^3$)</td>
<td>20</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Total (per m$^3$)</td>
<td>40</td>
<td>139</td>
<td>105</td>
</tr>
</tbody>
</table>

Source: AMEC for Bristol Water

The report models the cost, over a 100 year period, of removing 55,000m$^3$ in Year Zero, and again in Year 50. A constant real terms unit cost of dredging and disposal of £105/m$^3$

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is assumed, meaning that costs of £5,775,000 are incurred in Year Zero and Year 50. This cost is discounted at a rate of 4.5% to obtain a present value cost to Bristol Water of sediment removal of £6,414,348. However, assuming the unit costs are accurate, this approach appears to substantially overestimate the present value cost of silt removal.

It is understood that the reservoir, as of 2012 was silted to the extent that its capacity was reduced by 35%. This would imply a total volume of sediment in 2012 of 38,500m$^3$. Allowing for a further two years of sediment accumulation at a rate of 1,100m$^3$ per annum, the volume of sediment in 2014 would be 40,700m$^3$. Assuming that 50% of capacity is a threshold which would trigger the requirement to dredge, at the current rate of sedimentation, this level would be reached in 2027, and again in 2077. Assuming a constant real terms cost of dredging and disposal of 55,000m$^3$ of silt of £5,775,000, and discounting again at 4.5% over a 100 year period, the present value cost to Bristol Water is £3,619,435.

Given the above assumptions, the financial benefits to Bristol Water from reduced annual rates of sedimentation in Chew Magna Reservoir derive from the deferred requirement for dredging. Given a positive discount rate, for each additional year that it takes to reach the 50% capacity threshold, and therefore trigger the requirement to dredge, the present value cost to Bristol Water is reduced. An illustration of this is shown in Table 2-2. The second column of Table 2-2 shows the present value cost of sediment removal (over a 100 year period) that would result from different rates of sediment accumulation (shown in the first column). The third column shows the present value savings associated with incremental reductions in sedimentation rates (i.e. the difference between the two present value costs). For example, reducing sedimentation rates from 1,100m$^3$/annum to 1,000m$^3$ per annum (a reduction of 100m$^3$/annum) delivers a present value saving to Bristol Water of £370,273. A further 100m$^3$/annum reduction in sedimentation, to 900m$^3$/annum, will deliver an additional present value saving to Bristol Water of £330,153. The fourth column then presents these savings per m$^3$ of additional sedimentation avoided per year.

*Table 2-2: Estimated Present Value of Savings by Rate of Sedimentation based on Central Cost from AMEC Study*

<table>
<thead>
<tr>
<th>Rate of Sediment Accumulation (m$^3$/annum)</th>
<th>Present value cost of Removal (£)</th>
<th>Present Value Saving (£) due to incremental reduction in sedimentation</th>
<th>Present Value Saving per m$^3$ avoided per annum (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,100</td>
<td>£3,619,434.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>£3,429,161.73</td>
<td>£370,273.07</td>
<td>£3,702.73</td>
</tr>
<tr>
<td>900</td>
<td>£2,919,008.83</td>
<td>£330,152.90</td>
<td>£3,301.53</td>
</tr>
<tr>
<td>800</td>
<td>£2,622,355.74</td>
<td>£296,653.09</td>
<td>£2,966.53</td>
</tr>
<tr>
<td>700</td>
<td>£2,192,772.61</td>
<td>£429,583.12</td>
<td>£4,295.83</td>
</tr>
<tr>
<td>600</td>
<td>£1,838,774.35</td>
<td>£353,998.26</td>
<td>£3,539.98</td>
</tr>
</tbody>
</table>
2.1.1 Verifying Sedimentation Rates

As previously noted, there has been no monitoring of the actual rate of sedimentation, and the assumed average rate of 1,100 m$^3$ is based on a number of assumptions. A ‘sense check’ was therefore undertaken by reviewing baseline sediment loss ranges for different farm typologies reported in a study by ADAS for Defra. The annual baseline sediment loss figures for the different farm typologies, on a kg/ha basis, are shown in the second column of Table 2-3. The Winford Brook catchment above Chew Magna Reservoir has an area of 17 km$^2$ (1,700 ha), and the third column in Table 2-3 shows the theoretical range of sediment loss (in tonnes per annum) if the entire catchment were represented by a specific single farm typology. Finally, in the fourth column of Table 2-3, the tonnes per annum figure is converted into m$^3$ per annum based on a sediment density of 2,100 kg/m$^3$.

Table 2-3: Accumulation Rate using Sediment Baseline Loss Ranges

<table>
<thead>
<tr>
<th>Farm Typology</th>
<th>Annual Sediment Baseline Loss Range (kg/ha)</th>
<th>Sediment Accumulation Range: Total Catchment Area (1,700 ha) (Tonnes)</th>
<th>Estimated Sediment Accumulation Rate (m$^3$/ year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing Lowland</td>
<td>5 - 250</td>
<td>8.5 – 425</td>
<td>4.1 - 202</td>
</tr>
<tr>
<td>Horticulture</td>
<td>10 - 650</td>
<td>17 – 1,105</td>
<td>8.2 - 526</td>
</tr>
<tr>
<td>Combinable crops</td>
<td>10 - 800</td>
<td>17 – 1,360</td>
<td>8.2 - 648</td>
</tr>
<tr>
<td>Roots/ combinable crops</td>
<td>10 - 850</td>
<td>17 - 1,445</td>
<td>8.2 - 688</td>
</tr>
<tr>
<td>Outdoor pigs</td>
<td>400 – 1,200</td>
<td>680 – 2,040</td>
<td>324 - 971</td>
</tr>
<tr>
<td>Dairy</td>
<td>5 - 300</td>
<td>8.5 - 510</td>
<td>4.1 - 243</td>
</tr>
<tr>
<td>Mixed</td>
<td>10 - 450</td>
<td>17 - 765</td>
<td>8.2 - 364</td>
</tr>
</tbody>
</table>

It can be seen that even if outdoor pig farming covered the entire catchment, the maximum expected annual rate of sedimentation, based on the ADAS figures, would be

lower (at 971m$^3$/year) than the rate of 1,100m$^3$/year previously assumed.\textsuperscript{12} The agricultural land use within the catchment is predominantly pasture, followed by ploughed fields/arable, with a small area classified as disturbed soils. In addition there is woodland, common and urban land use. Using the sediment accumulation loss rates for the farm typologies listed in Table 2-3, an illustrative calculation is made of the likely range of sedimentation within the catchment in Table 2-4. This suggests that the upper end of the range for sedimentation within the catchment, based on ADAS data, is approximately 350m$^3$ per annum.

Table 2-4: Illustrative Estimate of Likely Range of Sedimentation

<table>
<thead>
<tr>
<th>Farm typology</th>
<th>% of Catchment</th>
<th>Total sediment loss (tonnes per annum) for catchment</th>
<th>Sediment Accumulation Rate (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing Lowland</td>
<td>75%</td>
<td>6.4–319</td>
<td>3.04 - 151.79</td>
</tr>
<tr>
<td>Combinable Crops</td>
<td>15%</td>
<td>2.6–204</td>
<td>1.21 - 97.14</td>
</tr>
<tr>
<td>Outdoor Pigs (representing disturbed soils)</td>
<td>10%</td>
<td>68–204</td>
<td>32.38 - 97.14</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>77-727</td>
<td>36.63 - 346.07</td>
</tr>
</tbody>
</table>

An alternative, if somewhat dated, source of evidence is a 2001 report by Halcrow Water on sedimentation in storage reservoirs.\(^{13}\) While the authors do not make reference to the Chew Magna Reservoir, they do comment on the unexpectedly high rate of sedimentation observed in the neighbouring Chew Valley Reservoir. Despite its catchment being described as ‘mainly grass covered farmland’, which would be expected to have a low level of sediment loss, based on observed sedimentation rates the authors estimate an annual sediment yield of 100-150 tonnes per km\(^2\). Applying such a yield to the 17km\(^2\) Chew Magna catchment, which has a similar pattern of land use, leads to a calculated rate of sedimentation within the reservoir of approximately 800 to 1,200m\(^3\) per year. This therefore suggests that the initial estimate of a sedimentation rate of 1,100m\(^3\) per year may not be inaccurate.

Indeed, a walkover study undertaken as part of this pilot project has identified that roads within the catchment may be a significant source of sediment where verges become eroded by vehicles, and they are highly efficient conveyors of water and sediment. If the true level of erosion within the catchment is well above that suggested by the ADAS estimates, the dual effects of roads as both sources and conduits may be part of the reason.

2.1.2 Updating Dredging Costs

In order to obtain a more accurate, and up to date estimate of the costs of dredging than those provided in the AMEC study, Bristol Water sought a quote from a commercial contractor. At the same time Bristol Water provided a revised estimate for the current level of sediment in CMR of 30,000 tonnes. The quote obtained was provided on the basis of the following assumptions:

1. As per Section 4.1 of HM Revenue and Customs Excise Notice LTF1 (July, 2013), dredgings from CMR are exempt from Landfill Tax.
2. As per the Environment Agency’s Guidance on Waste Exemptions, dredgings from CMR are classified under waste code 170506 (dredging spoil not containing dangerous substances) exempt under D1: depositing waste from dredging inland waters.
3. Two options are available for the dredging of sediment (estimated for the purposes of the quote to be about 30,000 m$^3$) from the Chew Magna Reservoir – by either Excavation Method (Option 1) or Pumping Method (Option 2). The fixed and variable costs for each of these are detailed in Table 2-5.

<table>
<thead>
<tr>
<th>Method of Silt Removal Works</th>
<th>Fixed Costs</th>
<th>Variable Costs</th>
<th>Contingency Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1 (Excavation)</td>
<td>£ 30,000</td>
<td>£40.72 per m$^3$</td>
<td>20%</td>
</tr>
<tr>
<td>Option 2 (Pumping)</td>
<td>£30,900</td>
<td>£45.74 per m$^3$</td>
<td>20%</td>
</tr>
</tbody>
</table>

Given this cost structure, the range of per unit costs for removal of silt from CMR (upper estimate including 20% contingency costs) is calculated as:

- Option 1: £41.72 - £50.64 per m$^3$ of sediment
- Option 2: £46.77 - £56.124 per m$^3$ of sediment

For illustrative purposes we use a cost of £50 per m$^3$. We further assume that the threshold that triggers dredging is when the amount of sediment in CMR reaches 30,000 m$^3$, meaning that dredging would happen in year zero. Again, the financial benefits to Bristol Water from reduced annual rates of sedimentation in Chew Magna Reservoir derive from the deferred requirement for dredging. For each additional year that it takes to reach the 30,000 m$^3$ threshold, and therefore trigger the requirement to dredge, the present value cost to Bristol Water is reduced. An illustration of this is shown in Table 2-6. As can be seen, the present value savings (calculated over a 100 year period – for consistency with the earlier calculations based on the AMEC study) per m$^3$ avoided per annum are somewhat lower than those estimated using earlier assumptions.
### Table 2-6: Estimated Present Value of Savings by Rate of Sedimentation based on Quoted Costs

<table>
<thead>
<tr>
<th>Rate of Sediment Accumulation (m³/annum)</th>
<th>Present value cost of Removal (£)</th>
<th>Present Value Saving (£) due to incremental reduction in sedimentation</th>
<th>Present Value Saving (over a 100 year period) per m³ avoided per annum (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,100</td>
<td>£2,111,217.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>£2,035,984.79</td>
<td>£75,232.61</td>
<td>£752.33</td>
</tr>
<tr>
<td>900</td>
<td>£1,932,806.57</td>
<td>£103,178.22</td>
<td>£1,031.78</td>
</tr>
<tr>
<td>800</td>
<td>£1,836,880.39</td>
<td>£95,926.18</td>
<td>£959.26</td>
</tr>
<tr>
<td>700</td>
<td>£1,760,038.70</td>
<td>£76,841.69</td>
<td>£768.42</td>
</tr>
<tr>
<td>600</td>
<td>£1,684,449.41</td>
<td>£75,589.29</td>
<td>£755.89</td>
</tr>
<tr>
<td>500</td>
<td>£1,606,933.51</td>
<td>£77,515.90</td>
<td>£775.16</td>
</tr>
<tr>
<td>400</td>
<td>£1,555,254.73</td>
<td>£51,678.78</td>
<td>£516.79</td>
</tr>
<tr>
<td>300</td>
<td>£1,518,384.94</td>
<td>£36,869.79</td>
<td>£368.70</td>
</tr>
<tr>
<td>200</td>
<td>£1,500,000.00</td>
<td>£18,384.94</td>
<td>£183.85</td>
</tr>
<tr>
<td>100</td>
<td>£1,500,000.00</td>
<td>£0.00</td>
<td>£0.00</td>
</tr>
</tbody>
</table>

**Assumptions:**
- £50/m³ cost of dredging
- 30k m³ sediment in reservoir in year zero
- 30k m³ is threshold for dredging
- 30k m³ removed each time dredging occurs

As can be seen from Table 2-6, the marginal savings from reductions in sediment loss - for each cubic metre of sediment loss avoided each year - are at least £750 up to the point where annual soil loss from the catchment is reduced to 500m³ per annum. Further reductions beyond this point would appear to deliver diminishing financial returns under the assumptions applied.

While the basis for the quotation was for the removal of 30,000m³ of silt, recent correspondence with Bristol Water has highlighted that while volumes removed are unknown, de-silting operations have taken place on three occasions over the past 20
years.\textsuperscript{14} If this were the case, based on an annual siltation rate of 1,100m\(^3\) per annum this might mean that approximately 7,700m\(^3\) are removed each time dredging occurs. To illustrate more frequent dredging of smaller amounts of sediment we model the removal of 7,000m\(^3\) of silt per dredge. The present value savings associated with reduced sedimentation rates in this scenario is shown in Table 2-7.

**Table 2-7: Estimated Present Value of Savings by Rate of Sedimentation under Assumptions of Increased Dredging Frequency**

<table>
<thead>
<tr>
<th>Rate of Sediment Accumulation (m(^3)/annum)</th>
<th>Present value cost of Removal (£)</th>
<th>Present Value Saving (£) due to incremental reduction in sedimentation</th>
<th>Present Value Saving per m(^3) avoided per annum (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,100</td>
<td>£1,391,963.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>£1,306,918.63</td>
<td>£85,044.52</td>
<td>£850.45</td>
</tr>
<tr>
<td>900</td>
<td>£1,177,405.39</td>
<td>£129,513.24</td>
<td>£1,295.13</td>
</tr>
<tr>
<td>800</td>
<td>£1,071,940.31</td>
<td>£105,465.08</td>
<td>£1,054.65</td>
</tr>
<tr>
<td>700</td>
<td>£975,188.60</td>
<td>£96,751.71</td>
<td>£967.52</td>
</tr>
<tr>
<td>600</td>
<td>£854,487.09</td>
<td>£120,701.51</td>
<td>£1,207.02</td>
</tr>
<tr>
<td>500</td>
<td>£755,325.98</td>
<td>£99,161.11</td>
<td>£991.61</td>
</tr>
<tr>
<td>400</td>
<td>£640,766.02</td>
<td>£114,559.96</td>
<td>£1,145.60</td>
</tr>
<tr>
<td>300</td>
<td>£537,567.75</td>
<td>£103,198.27</td>
<td>£1,031.98</td>
</tr>
<tr>
<td>200</td>
<td>£441,055.79</td>
<td>£96,511.96</td>
<td>£965.12</td>
</tr>
<tr>
<td>100</td>
<td>£366,066.74</td>
<td>£74,989.05</td>
<td>£749.89</td>
</tr>
</tbody>
</table>

**Assumptions:**

- £50/m\(^3\) cost of dredging
- 7k m\(^3\) sediment in reservoir in year zero
- An additional 7k m\(^3\) entering the reservoir is the threshold for dredging
- 7k m\(^3\) removed each time dredging occurs
- Present value calculated over 100 years

\textsuperscript{14} Personal communication with Matthew Pitts, Bristol Water
Under this scenario it can be seen from Table 2-7 that the marginal savings from reductions in sediment loss - for each cubic metre of sediment loss avoided each year - are higher than those shown in Table 2-6. The average present value saving for each cubic metre of annual erosion avoided is £1,025, and financial returns only decline to £750/m$^3$ where annual soil loss from the catchment is reduced to 100m$^3$ per annum. It is important to bear in mind, however, that these present values are calculated over a period of 100 years. It is thus assumed that the changes in land use or other measures that would lead to such reductions in erosion would endure over this period. However, it is not clear that farmers would be willing to sign contracts that would commit them to specific measures for such a long period of time. Therefore, for sensitivity, we estimate the present value savings associated with reductions in sedimentation rates over a 25 year period, as shown in Table 2-8.
Table 2-8: Estimated Present Value of Savings (over 25 years)

<table>
<thead>
<tr>
<th>Rate of Sediment Accumulation (m$^3$/annum)</th>
<th>Present value cost of Removal (£)</th>
<th>Present Value Saving (£) due to incremental reduction in sedimentation</th>
<th>Present Value Saving per m$^3$ avoided per annum (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,100</td>
<td>£949,810.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>£935,056.06</td>
<td>£14,753.98</td>
<td>£147.54</td>
</tr>
<tr>
<td>900</td>
<td>£890,875.27</td>
<td>£44,180.79</td>
<td>£441.81</td>
</tr>
<tr>
<td>800</td>
<td>£743,996.68</td>
<td>£146,878.59</td>
<td>£1,468.79</td>
</tr>
<tr>
<td>700</td>
<td>£720,499.69</td>
<td>£23,496.99</td>
<td>£234.97</td>
</tr>
<tr>
<td>600</td>
<td>£678,078.57</td>
<td>£42,421.12</td>
<td>£424.21</td>
</tr>
<tr>
<td>500</td>
<td>£538,990.50</td>
<td>£139,088.07</td>
<td>£1,390.88</td>
</tr>
<tr>
<td>400</td>
<td>£508,480.13</td>
<td>£30,510.37</td>
<td>£305.10</td>
</tr>
<tr>
<td>300</td>
<td>£471,696.22</td>
<td>£36,783.91</td>
<td>£367.84</td>
</tr>
<tr>
<td>200</td>
<td>£350,000.00</td>
<td>£121,696.22</td>
<td>£1,216.96</td>
</tr>
<tr>
<td>100</td>
<td>£350,000.00</td>
<td>£0.00</td>
<td>£0.00</td>
</tr>
</tbody>
</table>

Assumptions:
- £50/m$^3$ cost of dredging
- 7k m$^3$ sediment in reservoir in year zero
- An additional 7k m$^3$ entering the reservoir is the threshold for dredging
- 7k m$^3$ removed each time dredging occurs
- Present value calculated over 25 years

Table 2-8 shows that considered over a 25 year period, the marginal savings from reductions in sediment loss are - unsurprisingly - lower than those considered over a 100 year period (as shown in Table 2-7). The average present value saving for each cubic metre of annual erosion avoided is £666 up to the point where annual soil loss from the catchment is reduced to 200m$^3$ per annum, after which it declines to zero.

2.1.3 Benefits of Marginal Reductions in Erosion

The total level of erosion within the catchment remains subject to a certain amount of uncertainty. Assuming that the true range of accumulation of sediment within the Chew Magna Reservoir is between 400m$^3$/annum and 1,100m$^3$/annum, then the present value
cost to Bristol Water, over a 25 year period, associated with dredging lies between £500,000 and £950,000.

From the analysis above it would appear that unless dredging is carried out very infrequently (e.g. once an additional 30k cubic metres has entered Chew Magna Reservoir) the marginal benefits of erosion reduction do not exhibit diminishing financial returns at lower rates of sediment accumulation, i.e. below 500m$^3$ per annum (albeit over a 25 year period and applying the assumptions shown in Table 2-8, reducing erosion to below 200m$^3$ per annum delivers no present value benefit in respect of reduced dredging costs).

It would therefore appear sensible for Bristol Water to value anticipated cubic metre reductions in erosion per year at between £666 and £1,025 (depending on their view as to the longevity of the changes bringing about the anticipated reduction). As an example, if a change in land use is expected to deliver a 15 tonne reduction in soil erosion per year and the farmer were willing to sign up to a 25 year contract, the value to Bristol Water associated with the avoided dredging costs alone would be £9,990 (£666*15). Of course, there may be other benefits associated with this reduction in soil erosion, or indeed with the measure that leads to the reduction, and these will be considered below.

2.2 Raw Water Quality - Algal Blooms in Chew Valley Lake

Under the Water Framework Directive any water body from which >10m$^3$/day is abstracted for human consumption, or any water body serving more than 50 people, is defined as a Drinking Water Protected Area (DrWPA). Chew Magna Reservoir is, indirectly, a source of drinking water.

Bristol Water abstracts water from Chew Valley Lake for potable supply, with raw water from Chew Valley Lake going to Stowey and Barrow Water Treatment Works. Chew Valley Lake itself receives inputs of water from the River Chew to the south and Hollow Brook to the east. There are further inputs of water from the drainage area to the west of the lake which is separated into Southern and Northern Catchwaters. Water is also pumped directly to the lake from Chew Magna Reservoir. The main water quality issues for Chew Valley Lake, and the associated Drinking Water Protected Area – the Safeguard Zone of which encompasses the Winford Brook catchment - are blue green algae and metaldehyde.

Algal peaks, due to nutrient enrichment, are increasing in magnitude and frequency, with occurrences of over 20,000 cells/ml, and in September 2008 Bristol Water had to stop using Chew Valley Lake due to Cyanobacteria. There are costs associated with providing an alternative source of water for Stowey WTW when Chew Valley Lake is

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unavailable, in addition to increased treatment costs and expense associated with posting of warning signs and notifications, which were required in 2008 and 2009.\textsuperscript{16}

Inputs of nutrients to the reservoir have been estimated using:

1. Output from the national SAGIS (Source Apportionment GIS) tool; and
2. Analysis of observed water quality data.

### 2.2.1 Phosphorus Loads

The estimated phosphorus loads from source sectors using SAGIS are shown in Table 2-9.

**Table 2-9: Estimate Phosphorus Loads from Source Sectors (SAGIS Output)**

<table>
<thead>
<tr>
<th>Phosphorus (orthophosphate) Load (kg/day)</th>
<th>River Chew</th>
<th>Outflow from Chew Valley Lake\textsuperscript{1}</th>
<th>Chew Magna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewage works</td>
<td>0.442</td>
<td>0.487</td>
<td>0.090</td>
</tr>
<tr>
<td>Intermittent Discharges</td>
<td>0.261</td>
<td>0.311</td>
<td>0.112</td>
</tr>
<tr>
<td>Agriculture - Livestock</td>
<td>1.577</td>
<td>1.971</td>
<td>0.231</td>
</tr>
<tr>
<td>Agriculture - Arable</td>
<td>0.089</td>
<td>0.111</td>
<td>0.008</td>
</tr>
<tr>
<td>Urban</td>
<td>0.002</td>
<td>0.002</td>
<td>0.015</td>
</tr>
<tr>
<td>On Site Waste Water Treatment Works</td>
<td>0.212</td>
<td>0.263</td>
<td>0.090</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2.583</strong></td>
<td><strong>3.145</strong></td>
<td><strong>0.546</strong></td>
</tr>
</tbody>
</table>

Notes:

1: Includes loads from the River Chew and other streams entering the lake, but does not include the input load from Chew Magna

\textsuperscript{16} Bristol Water (2013) WFD Safeguard Zone Action Plan for the Drinking Water Protected Area Chew Valley Lake for Blue Green Algae.
It can be seen that the Chew Magna Reservoir (i.e. the Winford Brook catchment), at 0.546kg/day, represents about 17% of the total phosphorus load entering Chew Valley Lake. Within the Winford Brook catchment the SAGIS output indicates that approximately 44% of the phosphate load is due to agriculture, with almost all of this deriving from livestock farming.

The analysis of observed data combined water quality monitoring data (from the Environment Agency and Bristol Water) for the influent streams and pumped inputs to Chew Valley Lake with estimated flows into the reservoir. Monthly average concentrations were multiplied by average flows to estimate loads for each input. Estimated inputs, showing the average daily load over the period 1995-2011, are shown in Table 2-10.

Table 2-10: Estimated Phosphorus Inputs to Chew Valley Lake based on Monitoring Data

<table>
<thead>
<tr>
<th>Input</th>
<th>Phosphorus (orthophosphate) Load (kg P/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Chew</td>
<td>4.09</td>
</tr>
<tr>
<td>Hollow Brook</td>
<td>0.69</td>
</tr>
<tr>
<td>Chew Magna</td>
<td>0.28</td>
</tr>
<tr>
<td>Southern Catchwater</td>
<td>0.70</td>
</tr>
<tr>
<td>Northern Catchwater</td>
<td>0.25</td>
</tr>
<tr>
<td>Other (local catchment)</td>
<td>1.39</td>
</tr>
<tr>
<td>Total</td>
<td>7.41</td>
</tr>
</tbody>
</table>

It can be seen that the estimated phosphorus inputs from Chew Magna Reservoir, based on observed data, are lower than those estimated using SAGIS (0.28kg/day as opposed to 0.546kg/day). The authors of the report note that:18

Differences between estimated loads based on SAGIS and those derived from the monitoring data are partly due to the difference in calculating loads – the SAGIS loads are calculated from the simulated daily flows and concentrations whereas for the monitoring data, monthly averages for flow and quality are multiplied

They further recognise that for both methods there are considerable uncertainties in the data and process representation, for example in the underpinning livestock, land use and soil data, but conclude that the outputs are broadly comparable and help to develop the evidence on the main sources of nutrients to Chew Valley Lake.

2.2.2 Nitrogen Loads

The estimated nitrogen loads from source sectors using SAGIS are shown in Table 2-11.

### Table 2-11: Estimated Nitrogen Loads from Source Sectors (SAGIS Output)

<table>
<thead>
<tr>
<th>Source Sectors</th>
<th>Nitrogen (Total Oxidized Nitrogen) Load (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>River Chew</td>
</tr>
<tr>
<td>Sewage works</td>
<td>2.76</td>
</tr>
<tr>
<td>Intermittent Discharges</td>
<td>1.55</td>
</tr>
<tr>
<td>Background - Agriculture</td>
<td>107.85</td>
</tr>
<tr>
<td>Urban</td>
<td>0.02</td>
</tr>
<tr>
<td>On Site Waste Water Treatment Works</td>
<td>1.40</td>
</tr>
<tr>
<td>Total</td>
<td>113.58</td>
</tr>
</tbody>
</table>

Notes:
1: Includes loads from the River Chew and other streams entering the lake, but does not include the input load from Chew Magna

It can be seen that the Chew Magna Reservoir (i.e. the Winford Brook catchment), at 56.29kg/day, represents about 38% of the total nitrogen load entering Chew Valley Lake. Within the Winford Brook catchment the SAGIS output indicates that approximately 95% of the nitrogen load is due to agriculture.

As for phosphorus, the analysis of observed data combined water quality monitoring data (from the Environment Agency and Bristol Water) for the influent streams and pumped inputs to Chew Valley Lake with estimated flows into the reservoir. Monthly average concentrations were again multiplied by average flows to estimate loads for
each input. Estimated inputs of nitrogen, showing the average daily load over the period 1995-2011, are shown in Table 2-12.

Table 2-12: Estimated Nitrogen Inputs to Chew Valley Lake based on Monitoring Data

<table>
<thead>
<tr>
<th>Input</th>
<th>Nitrogen (Total Oxidized Nitrogen) Load (kg N/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Chew</td>
<td>171.90</td>
</tr>
<tr>
<td>Hollow Brook</td>
<td>44.02</td>
</tr>
<tr>
<td>Chew Magna</td>
<td>12.44</td>
</tr>
<tr>
<td>Southern Catchwater</td>
<td>18.45</td>
</tr>
<tr>
<td>Northern Catchwater</td>
<td>8.27</td>
</tr>
<tr>
<td>Other (local catchment)</td>
<td>41.95</td>
</tr>
<tr>
<td>Total</td>
<td>297.04</td>
</tr>
</tbody>
</table>

It can be seen that the estimated nitrogen inputs from Chew Magna Reservoir, based on observed data, are lower than those estimated using SAGIS (12.44kg/day as opposed to 56kg/day).

2.2.3 Associated Costs

In an earlier draft of the WFD Safeguard Zone Action Plan report, the authors note that:

> The costs to Bristol Water of deteriorating water quality are difficult to quantify for a range of reasons. In particular, costs would be strongly dependent on the frequency and duration of events, which are hard to predict. In addition, increased costs would be a complex combination of: increased operating costs (for example sand filter or membrane maintenance); costs associated with public health risk notification; potential loss of revenue from recreation and, in a more extreme case, potential costs of plant upgrade.

We have sought information from Bristol Water on potential costs associated with algal blooms from deteriorating water quality, but they have not been able to provide them.

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Even if such costs were available, to then calculate the possible contribution towards a reduced likelihood of algal blooms from a drop in nutrient loads to Chew Valley Lake from Chew Magna Reservoir would be an exercise fraught with uncertainty.

The potentially avoided costs from an (unknown) reduction in the likelihood of algal blooms provides an interesting comparator against the avoided dredging costs. The cost of an algal bloom is uncertain, but potentially large, and would be incurred once a ‘threshold’ is breached. By contrast, for the avoided dredging costs, the likely marginal benefit to Bristol Water of every m$^3$ reduction in soil entering Chew Magna Reservoir can be calculated with reasonable accuracy.

Any attempt to justify Bristol Water’s investment in catchment management in the Winford Brook solely on the basis of reducing the likelihood of algal blooms in Chew Valley Lake, would seem to be unlikely to succeed at present. To do so would require more information on:

- The costs of dealing with an algal bloom in Chew Valley Lake;
- The current likelihood of an algal bloom in any one year;
- The relative contribution to the likelihood of an algal bloom from nitrogen and phosphorus inputs to Chew Valley Lake from Chew Magna Reservoir; and
- The effectiveness of management measures in the Winford Brook catchment in reducing the load of nitrogen and phosphorus entering Chew Magna Reservoir.

However, in the situation where interventions in the catchment can be justified on the basis of avoided dredging costs alone, the knowledge that such measures should also reduce the likelihood of algal blooms gives Bristol Water further comfort that value for money will be achieved through a PES scheme.

### 2.3 Wastewater Nutrient Removal

Wessex Water has indicated that managing soil nutrients on land will potentially mean they can reduce or avoid future nutrient removal costs at sewage treatment works (STW). On this basis Wessex Water is keen to contribute financially to a PES scheme within the catchment.

#### 2.3.1 Phosphorus Removal Costs

At present, there are no specific costs available for the upstream STWs in the Chew Magna catchment in terms of phosphorus removal, and the requirement has yet to arise. However, in order to comply with the Water Framework Directive, in the absence of measures to manage nutrients in the catchment, treatment will have to be put in place by 2027.

As part of its AMP5 investigations, Wessex investigated options to reduce phosphorus levels in the catchment upstream of their Sutton Bingham reservoir near Yeovil. There are two STWs within the catchment where P removal was considered to a 2mg/litre limit. This was compared against a catchment management approach. The STWs were both quite small, each being around 300 population equivalent.
The options appraisal highlighted that to provide P removal at both STWs to 2mg/l would cost £2.4m and deliver 27% of the reduction required to achieve the WFD target. However, catchment management would cost £67k per annum and deliver 44% of the reduction required in addition to wider biodiversity and environmental benefits.21

Wessex Water has experience of the cost effectiveness of catchment management for drinking water supply. At none of the sites where catchment management has been undertaken has Wessex had to install treatment, nor do they have any plans to do so. The relative costs vary from site to site, but on average when using catchment management it is reported that Wessex solves water quality problems for approximately one sixth of the cost of the treatment alternative.22

2.3.2 Application to Winford Brook

The capital cost of installing treatment infrastructure at a STW to deal with P from the catchment is estimated at between £2m and £5m. On the basis that a catchment approach would cost one sixth of this, this would suggest approximate expenditure of between £300,000 and £800,000 on catchment measures to reduce P. In addition, Wessex Water has a preference for measures that also deliver biodiversity and carbon benefits.

2.4 Impacts of Soil Erosion on Sewerage Infrastructure

Chew Magna and Winford are part of the Chew Stoke sewage catchment, as shown in Figure 2-2. The sewage either gravitates or is pumped to Chew Stoke STW for treatment before discharge to the River Chew. The population equivalent is 7,500 but this also includes the sewerage from Bristol Airport. The STW has a 2mg/l total phosphorus consent.

There is a combined sewer overflow (CSO) in Chew Magna (Battle Lane) which is just downstream of Chew Magna reservoir. This is the only CSO in Chew Magna or Winford. The CSO currently only has a 10mm screen and no spill monitoring. Wessex Water has experienced 4 sewer collapses in the village since 1999 and there has been some replacement work. In recent years Wessex Water has been undertaking CCTV surveys in the area so has a sewer deterioration and hydraulic model for the catchment, both of which have indicated some issues which means the CSO is considered ‘substandard’. Wessex Water understands that the catchment is 100% combined sewers (i.e. surface water and foul water are conveyed in the same sewer) with an element of highway drainage ingress.

21 Personal communication with Ruth Barden, Environment & Catchment Strategy Manager, Wessex Water
The model shows that there is a significant amount of infiltration into the sewer with some specific hotspots. The CSO spills approximately 60 times per year but c. 25% of these are small spills which are classified as ‘insignificant’ by the Environment Agency. Wessex Water believes that the airport flows have an impact on this, possibly accounting for up to 30% of the storm flows. As a result, an improvement scheme planned, which is scheduled to be completed by the end of March 2015.

The details of the scheme are as follows:

- Provision of 150m$^3$ of storm storage upstream of the CSO;
- Flow control and flow monitoring associated with the storm storage and CSO; and
- Fine screening (6mm 2-dimensional mechanical screen).

The model predicts that this will reduce the number of spills from the CSO by 1/3 and significantly reduce the spill volume by over 50%.

In some ways it’s a shame that this scheme is going forward prior to the PES project, but it does provide a good asset solution comparator, with a capital cost of £285,000. As the entire catchment is combined sewer this means that any reduction in surface water flooding achieved through land management interventions would have a benefit in reducing CSO spills.
However, it has not been possible to identify the flood risk reduction potential from possible land management measures undertaken within the catchment. If it were possible to identify what level of reduction in infiltration or runoff could be expected there would be the potential for Wessex Water’s model to be re-run using a lower infiltration figure. This would then determine how much capital investment (if any) would be required to deliver a similar level of spill reduction from the CSO, so identifying the avoided cost resulting from land management measures.

Ideally, Wessex Water would like to be able to confidently model and then obtain a reduction in CSO spills resulting from reduced flooding and sediment loads which can be achieved (in part) through measures within the catchment (e.g. buffer strips and fencing of watercourses). However, the available data on flood risk reduction from specific measures, and specifically their effectiveness when applied to this catchment, does not yet allow this to be determined with sufficient confidence.

Therefore, for Wessex Water, while nutrient removal from waste water will be the primary driver, and the one which will provide justification for their investment, it can be expected that these measures will have a positive benefit in reducing sewer flooding, albeit one that cannot be accurately quantified at present. Further modelling would be needed to better understand the effects.

2.5 Water Quality and Water Framework Directive

One of the potential drivers for Environment Agency contributions to a PES scheme is to achieve Good Ecological Status under the Water Framework Directive.

2.5.1 Ecological Status of Winford Brook

An Environment Agency Report from 2012 identifies the status of the Winford Brook (Water Body ID GB109053021900) in 2009 with respect to objectives under the Water Framework Directive. The overall status, as shown in Table 2-13, is ‘Poor’, with ‘Fish’ noted as the element driving the classification.

Table 2-13: Winford Brook Ecological Status

<table>
<thead>
<tr>
<th>Overall Ecological Status/Potential in 2009 RBMP</th>
<th>Status Objective</th>
<th>Confidence in Achieving Objective</th>
<th>Elements Driving Classification</th>
<th>Other Failing Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor (Very Certain)</td>
<td>Good Ecological Status by 2027</td>
<td>Low</td>
<td>Fish</td>
<td>None</td>
</tr>
</tbody>
</table>

The report notes that main reason for the Poor classification for fish is due to several barriers within the waterbody being impassable to fish, including the Chew Magna Reservoir itself. The presence of rainbow trout was also thought to have the potential for a detrimental impact on the brown trout population of the Winford Brook, as well as the isolated population of native crayfish present in the Winford Brook.

A more recent Environment Agency report provides a summary of the classifications for the Winford Brook up to and including 2014. These are shown in Table 2-14.

### Table 2-14: Winford Brook WFD Summary Classifications

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall</th>
<th>Ecological</th>
<th>Chemical</th>
<th>MMA</th>
<th>Invertebrates</th>
<th>Fish</th>
<th>Phytoplankton</th>
<th>Macrophytes</th>
<th>Phosphate</th>
<th>Ammonia</th>
<th>Dissolved Oxygen</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>DNR</td>
<td>Poor</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2010</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>DNR</td>
<td>Poor</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2011</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>DNR</td>
<td>Poor</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2012</td>
<td>Moderate</td>
<td>Moderate</td>
<td>DNR</td>
<td>Poor</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2013</td>
<td>Moderate</td>
<td>Moderate</td>
<td>DNR</td>
<td>Poor</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2014</td>
<td>Moderate</td>
<td>Moderate</td>
<td>DNR</td>
<td>Poor</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: DNR = “Does not require assessment”  NA = “Not assessed”  DNSG = “Does not support good”

Again, the reason for the failure to achieve Good Ecological Status is ‘Fish’. This WB is currently classified (for fish) using data from a survey undertaken in 2011. This data was used to re-classify the WB in 2012 and resulted in an improved classification of Moderate. However, it should be noted that since this time a revision to the Fisheries Classification Tool will mean that this element will be re-classified once again as Poor in 2015 (this change is a result of data from adjacent WBs no longer being used in the classification). The relatively low numbers of brown trout found in the survey are driving this classification.

### 2.5.2 Objectives and Predicted WFD Outcome for Winford Brook

The objectives and predicted WFD outcomes for the Winford Brook are shown in Table 2-15, which shows the objective for 2027 as Good.

### Table 2-15: Winford Brook WFD Objectives and Predicted Outcome

<table>
<thead>
<tr>
<th>Type</th>
<th>Overall</th>
<th>Ecological</th>
<th>Chemical</th>
<th>MMA</th>
<th>Invertebrates</th>
<th>Fish</th>
<th>Phytoplankton</th>
<th>Macrophytes</th>
<th>Phosphate</th>
<th>Ammonia</th>
<th>Dissolved Oxygen</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 - Objective</td>
<td>Poor</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2015 - Predicted</td>
<td>Poor</td>
<td>DNR</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2017 - Objective</td>
<td>Good</td>
<td>Good</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
<tr>
<td>2017 - Predicted</td>
<td>Good</td>
<td>Good</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>8</td>
</tr>
</tbody>
</table>

Risks to the overall water body are shown in Table 2-16. This identifies that achievement of Good status is probably at risk from alien species and water abstraction and the flow regime. By contrast it is considered to be ‘not at risk’ from combined source nutrients.

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25 Personal Communication with Jeremy Taylor, Catchment Co-ordinator (Bristol Avon), Environment Agency
and ‘probably not at risk’ from diffuse source pollution and physical or morphological alteration.

Table 2-16: Winford Brook WFD Risks

<table>
<thead>
<tr>
<th>Risks</th>
<th>Overall Water Body Risk</th>
<th>Probably At Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Level</td>
<td>Elements</td>
<td></td>
</tr>
<tr>
<td>Not At Risk</td>
<td>Combined source nutrients, Combined source sanitary, Point source pollution</td>
<td></td>
</tr>
<tr>
<td>Probably At Risk</td>
<td>Alien species, Water abstraction and flow regulation</td>
<td></td>
</tr>
<tr>
<td>Probably Not At Risk</td>
<td>Diffuse source pollution, Physical or morphological alteration</td>
<td></td>
</tr>
</tbody>
</table>

The risks in this case all relate to the fish element, the only one failing. The actual reasons for failure (as they relate to the risks) are physical modifications for water supply purposes acting as barriers to fish movement and non-native rainbow trout probably impacting upon native brown trout.  

It therefore appears that changes in land use, or indeed any measures that will reduce the rate of erosion within the catchment will not necessarily assist the achievement of Good Ecological Status for the Winford Brook. However, one local Environment Agency representative has indicated that silt ‘smothers’ the base of the Winford Brook, and that there is a lot of phosphate run-off within the catchment. Another has stated that reducing phosphates and reducing sediment loads are objectives within the catchment. However, as the Winford Brook itself does not fail for phosphorus, the driver for reducing levels of P entering the Winford Brook, from a WFD perspective, would be to help reduce levels further downstream, as P is a priority in the wider Chew catchment. Although it may be expensive and technically difficult, resolving ‘fish failure’ is much more of a priority for the EA in the Winford Brook.

2.5.3 Wider Downstream Impacts

It is useful to consider the wider downstream effects that may arise from sediment and phosphates entering the Winford Brook. The Environment Agency’s 2012 Report identifies the status of the River Chew from the confluence with the Winford Brook to the confluence with the River Avon (Water Body ID GB109053021950) in 2009 with respect to objectives under the Water Framework Directive. The overall status is Poor,

26 Personal Communication with Jeremy Taylor, Catchment Co-ordinator (Bristol Avon), Environment Agency
27 Personal communication with Paula Sage, Environment Agency
28 Personal communication with Jeremy Taylor, Catchment Co-ordinator (Bristol Avon), Environment Agency
29 Personal communication with Jeremy Taylor, Catchment Co-ordinator (Bristol Avon), Environment Agency
as shown in Table 2-17. The element driving the classification is phytobenthos. These are microscopic plants that live attached to substrates such as rocks/stones or large plants. Phytobenthos are good indicators of nutrient enrichment and other pressures. Phosphate is noted as another failing element.

Table 2-17: River Chew Ecological Status

<table>
<thead>
<tr>
<th>Overall Ecological Status/Potential in 2009 RBMP</th>
<th>Status Objective</th>
<th>Confidence in Achieving Objective</th>
<th>Elements Driving Classification</th>
<th>Other Failing Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor (Quite Certain – WCE)</td>
<td>Good by 2015</td>
<td>Low</td>
<td>Phytobenthos</td>
<td>Phosphate</td>
</tr>
</tbody>
</table>

The report notes that 65% of the phosphate contribution to the waterbody is considered to be due to point sources, notably Stanton Drew, Compton Dando and Chewton Keynsham sewage treatment works. The other 35% is attributed to diffuse sources, which would include the Winford Brook catchment.

The Environment Agency’s summary report also identifies waterbody level measure actions, shown in Table 2-18. It can be seen that the Measure Aim ‘To control or manage diffuse source inputs’ is ‘Confirmed cost beneficial’. However, discussion with the Environment Agency has clarified that this refers to a high-level analysis of suites of generic measures, which actually demonstrate higher benefit:cost ratios in other parts of the Bristol Avon Urban Catchment.

Table 2-18: Winford Brook WFD Waterbody Level Measure actions.

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2.5.4 Environment Agency Priorities

In terms of water quality, apart from seeking to resolve the fish failure, the Winford Brook catchment is not a top priority for the Environment Agency, and due to funding cuts, there is thus no possibility of a financial contribution from the EA towards a PES scheme addressing water quality within the catchment. As can be seen from Section 2.6, the same is true in respect of flood risk reduction.

2.6 Flood Risk Reduction

The Winford Brook catchment has steep topography which leads to a rapid response to rainfall, with water levels rising quickly in the village of Chew Magna. The village has a long history of flooding.

2.6.1 Property-Level Protection

In 2010, Chew Magna was selected as one of the 63 sites across England to take part in a two year property-level protection (PLP) grant scheme. Bath & North East Somerset Council was awarded £325,000 from central government to provide surveys and individual flood protection measures to a total of 69 properties at significant flood risk in the village. A further £200,000 is being spent on PLP in 2014/15.

2.6.2 Potential Flood Alleviation Schemes

Following flooding in Chew Magna in 2012, the Environment Agency reviewed options for a potential flood alleviation scheme. Under current arrangements, the extent of government funding received for specific schemes depends on the benefits the scheme provides. In the case of schemes proposed for Chew Magna the benefits are estimated to be circa £10 million, which would qualify such interventions for up to £830,000 of central government funding.

The least expensive option explored was for a riverside flood wall, at an estimated cost of £4 million. To enable the scheme to go ahead, the remaining cost of the scheme (after the central government contribution of £830,000) would have to be found locally. This scheme has not progressed to date.

A modelling exercise was undertaken in 2014 using the existing Environment Agency model to test a number of scenarios including:

The influence of Chew Magna Reservoir and Chew Valley Lake by assuming they are full, half empty, empty and if they did not exist; The impact of silt build up at a number of structures on the River Chew and Winford Brook; and Removal of a weir.

The modelling did not consider catchment level measures such as the implementation of sediment ponds and swales, buffer strips or tree planting.

2.6.3 Environment Agency Funding

The position of the Environment Agency at present is that there is not enough evidence of the effectiveness of potential interventions within the catchment to deliver flood risk reduction. Alongside current constraints on Environment Agency funding, there is no possibility in the immediate future of a financial contribution from the EA towards a PES scheme in the Winford Brook catchment.

2.7 Road Gully Clearance

Bath and North East Somerset (B&NES) is the local highway authority, and lead local flood authority for the lower half of the Winford Brook catchment, while North Somerset has these responsibilities in respect of the upper half of the catchment.

The observation was made in the first beneficiaries meeting that highways could be a major source of sediment, due to erosion of verges. It was further noted that misplacement of field gates (perhaps at the bottom of a steep slope) leads to soil eroded from fields washing onto the highway.

Due to budgetary constraints in recent years, the frequency of gully emptying has declined in B&NES to just once a year, and the list of ‘special attention’ gullies has been reduced. The concern is thus that gullies become blocked with silt, meaning that water flows on the surface of the road where it can pick up pollutants such as oil, and further erode the verge. However, B&NES does not hold data at present on which gullies collect the most silt, nor is it possible for B&NES to identify a cost associated with road gully clearance.

More broadly, as LLFA, B&NES has not been able to identify costs that might be avoided through changes in land management within the catchment. In part, this is down to the uncertainty of the effectiveness of specific measures to reduce flood risk within the catchment.

The walkover study undertake by APEM (see Section 5.0) was very useful in revealing the importance of roads within the catchment as both sources of sediment (by erosion of verges by vehicles) and as conduits for water and sediment. It was identified that in many cases there was a strong interaction between livestock land use and road/track drainage, with road/track runoff frequently acting to convey sediment which had been eroded as a result of heavy livestock grazing.
At the second beneficiaries meeting the APEM walkover report was presented, and subsequent discussion on the issues of road drains and gully clearance highlighted that while B&NES would arguably be a beneficiary in respect of measures to reduce run-off within the catchment, it could also be a supplier. All things being equal, the reduced frequency of gully clearance is likely to have the effect of increasing the proportion of eroded soil that reaches watercourses and sewers. A brief discussion identified that as a short term measure, Bristol Water and Wessex Water would consider funding an enhanced regime of gully emptying within the catchment. However, their strong preference is for preventing erosion at source.

The APEM walkover survey, funded by Bristol Water had focused on the Chew Magna Reservoir catchment. As a result it did not include some areas of the wider Winford Brook catchment that were of interest to B&NES. The B&NES representative stated that he would be more interested in funding measures in the area outside the CMR catchment.37

2.7.1 Bath & North East Somerset Contribution

B&NES has not been able to commit any funds towards the PES scheme within the catchment, but has offered to assist with providing drainage consents where works require these. The authority has also offered to assist in identifying where activities undertaken by farmers that affect watercourses appear to be illegal, or ‘quasi-legal’. This knowledge will assist in subsequent negotiation over funding of measures, and should allow for a more cost-effective disbursal of funds.

2.8 Natural England – Catchment Sensitive Farming

Up until the end of 2014, the Winford Brook catchment was not a priority for Natural England. However, in January 2015, the Winford Brook catchment was included as a Catchment Sensitive Farming (CSF) Target Area, meaning that farmers are able to apply for fixed rate grants to implement measures supported under the CSF scheme. The main driver for including the catchment as a target area is because of abstraction of water from Chew Magna Reservoir to Chew Valley Lake, for drinking water supply.

Applications for grants were invited in March 2015. Discussion with the local CSF Officer has indicated that the most popular measures taken up by farmers under this scheme involve roofing and concreting yards. There is some fencing of watercourses (which is considered to be effective in reducing the amount of sediment entering watercourses) but not much. It therefore appears that farmers are, unsurprisingly, selecting the projects that deliver them the greatest private benefit. Also, fencing of watercourses

37 When offered a walkover survey to cover the relevant area at a cost of £500, B&NES stated that they felt this wouldn’t add anything for them as they already understood the issues in the catchment.
needs consent from the EA or Lead Local Flood Authority (LLFA), which may take some time and act as a further deterrent to farmers making applications for these measures.38

2.8.1 Using PES Funds to ‘Top-up’ CSF?

At the second beneficiaries meeting there was some discussion as to how the PES scheme should best work with the CSF programme. One option suggested by Natural England was for Bristol Water and Wessex Water (i.e. those who had identified a financial case for investing in measures within the catchment) to provide ‘top-up’ funding to the CSF scheme. However, this was rejected for a number of reasons, primarily related to efficiency and selection of measures.

Under CSF, farmers are able to select from a list of measures. Within the Winford Brook catchment these measures are:

- First-flush rainwater diverters/downpipe filters;
- Pipework for livestock troughs;
- Livestock troughs;
- Cross drains;
- Hard bases for livestock drinkers;
- Hard bases for livestock feeders;
- Post-and-wire fencing;
- Sheep fencing/netting;
- Permanent electric fencing;
- Rabbit fencing supplement; and
- Earth banks and soil bunds.

Farmers are free to select whichever of these measures they wish, and are then paid a fixed rate per unit (i.e. per metre of fencing or pipework, or per livestock trough etc.) There is a limit on the grant that can be awarded of £10,000 per farm, and farmers are obliged to maintain the measure for five years.

Given the importance within the catchment (as identified by the walkover) of targeting the right measure in the right place, it was felt that leaving farmers to select their own might not be the most effective way of meeting the beneficiaries’ objectives. This outcome had been identified in follow-up visits in the Fowey catchment after funding had been awarded via the PES Pilot. Visits to successful bidders’ farms revealed that the projects the farmers had identified for investment would all have been identified by a farm advisor as worthy of funding in an advisor-led scheme. However, those same visits revealed a large number of additional issues that had not been addressed through the

38 As noted in CSF Guidance, any proposed works in the proximity of a watercourse or where works will be situated within 10 metres (depending on local byelaws) of the top of the riverbank may require flood defence consent. This is because the proposed works may affect the flow of a river or other watercourses. Decisions on whether or not consent should be granted are made by the EA (for main rivers) or the lead local flood authority (for ordinary watercourses).
projects included in the farmers’ bids. Indeed, the projects identified by the farmers themselves represented only 54% of the interventions that would have been identified by a farm advisor in an advisor-led scheme.\[30\] The evidence suggests that the omission of these additional investments from farmers’ bids is usually because the farm business priorities which motivate the farmer do not perfectly coalesce with the environmental objectives of the scheme.

Bristol Water and Wessex Water stated their preference to identify specific measures they would wish to fund in the catchment. In addition, allowing all farmers to apply for funding, and limiting the amount available per farm, was not felt to be an efficient approach. Within the catchment there may be justification for spending perhaps £50,000 on one single land-holding, while the location of other farms mean that no spending can be justified. This flexibility was felt to be a key advantage of a PES scheme, and there was understandable reluctance to hand over money to CSF.

Finally, the five year duration of the maintenance agreements under CSF were not seen to be sufficient for the needs of the water companies, where longer term contracts would be required.

2.8.2 Disbursal of CSF Funds via PES

By contrast, there was, unsurprisingly, interest among contributing beneficiaries of the potential for funds allocated to CSF within the catchment being added to a multi-beneficiary ‘pot’ for subsequent disbursal as part of the PES project. This would seem to have a great deal in its favour. While the current approach to awarding grants via CSF is understandable, given the desire to reduce the burden of administering the scheme, in locations where there is a suitable distribution mechanism, we feel there is merit in exploring alternatives.

Of course an argument could be made that if water companies and others are already planning to invest in measures in specific catchments, then it does not make sense to also include these as CSF Target Areas. To avoid such overlaps would require co-ordination between the relevant organisations. However, where such co-location of funding streams does occurs, it is important to consider how best to proceed.

2.8.3 Approach in the Winford Brook Catchment

In the case of the Winford Brook Catchment, applications for grants under CSF will be invited in March 2015. From the perspective of the PES project partners, it was felt that knowing the measures applied for by farmers would be useful in revealing their preferences. The expectation, in common with previous CSF funding rounds, is that farmers will select measures that best fit with their own farm plans, and that this will not include interventions such as fencing of watercourses. Subsequently, targeted measures

that should best meet the requirements of the funding beneficiaries can be taken forwards.

Ideally, soil erosion monitoring would be undertaken before and after the CSF interventions are implemented, to understand the effects. In theory, one would expect the implementation of a CSF scheme to reduce the extent of erosion, and thus reduce the extent of potentially avoided costs that form the basis for other beneficiaries to justify the case for investment in the catchment. We will review the effects of this if data becomes available.
3.0 Identifying Land Management Actions

The original intention was to identify the effectiveness of land management options via the literature, and then to apply these findings to the catchment, using existing GIS data to weight them according to what appeared to be ‘priority locations’. However, it became clear in reviewing the literature, and was subsequently emphasised at the suppliers’ workshop, that the application of generic values to measures applied within the catchment would not be appropriate. For services such carbon sequestration, such a ‘top-down’ approach would have been suitable, but not for soil erosion or flood risk management in this catchment.

In the sections below we present the findings of the literature review, and consider how these findings might be applied to the Winford Brook catchment.

In Section 3.1, we identify land management options that have the potential to increase the supply of services for which a demand was anticipated at the outset, namely:

- The reduction of soil erosion; and
- The reduction in flood risk.

In Section 3.2, we identify wider benefits associated with measures that can be implemented within the catchment.

3.1 Measures to Increase the Supply of Services for which Demand Exists

Catchment management measures to provide benefits for water quality, flood risk reduction and other ecosystem services are increasingly becoming a focus for land managers, landowners, public bodies and utility companies. The aim was to use existing information to identify potential interventions to reduce key problems within the catchment and identify where measures could potentially be quantified.

The objectives of the assessment were to:

- Complete a data trawl and literature review, focusing on studies and best practice examples with relevance to sediment reduction in run-off and flood risk reduction;
- Identify potential catchment interventions from field-based case studies, empirical data, modelling and academic data, again focusing on sediment and flood risk;
- To identify where quantification would be possible, to identify data gaps and challenges and to identify potential monitoring activities to address these.

3.1.1 Approach

Studies relating to reduction of soil erosion and slowing/reducing water flows were assembled in a Rapid Evidence Assessment (REA). Information was based on sources
provided by project partners and stakeholders, the authors’ own knowledge, and online searches.

The intention was to search for data sources from the following categories:

1) Existing case studies and pilot projects including Defra Payments for Ecosystem Services pilots, Catchment Sensitive Farming Case Studies and other funded catchment projects e.g. projects led by utility companies;

2) Models for the Winford Brook catchment;

3) General toolkits and models for interventions on a catchment scale;

4) Studies produced by government departments including research reports and studies for Defra, Natural England and the Environment Agency;

5) Peer reviewed academic journals; and

6) Non-peer reviewed academic papers e.g. review papers published by a university or conference proceedings.

Case studies were given a high weighting as, although they do not often have associated quantification and scientific analysis, such studies highlight interventions which have been found to solve or reduce problems and are likely to be replicable.

In addition to information provided and known to the project team, a trawl of Google and Google Scholar was completed using ecosystem-specific keywords (e.g. 'sedimentation' and 'flood risk reduction'). Variations were then used to attempt to capture the broadest range of data; for example, 'reducing soil erosion' and 'reducing sediment run-off'. In addition, key words for potential interventions including 'buffer strips', 'covered yard', 'livestock management plan', 'bank stabilisation' and 'sediment pond' were used.

It was also intended to use an academic search tool such as Bristol University's MetaLib. However, given time constraints and the large amount of data to review from the initial review, this was not completed.

3.1.2 Existing Catchment Information and Case Studies

Bristol Water commissioned a preliminary study for the Winford Brook catchment in 2012, which identified likely high risk areas for soil erosion and potential interventions to reduce sedimentation of Chew Magna Reservoir.\footnote{AMEC (2012) Winford Brook Catchment Chew Magna Reservoir: Project Report to Bristol Water, June 2012.} The report combined a GIS analysis using data on the topography (slope), land use and soil type within the catchment with a rapid walkover, focusing on roads and some footpaths to identify any obvious problems. This is a fairly high level risk assessment rather than a detailed survey identifying issues at the landholding scale. This information has been used during consultations and discussions to assist in identifying the likely location of high risk areas for soil erosion.

Key findings of this preliminary study were:

- Relatively steep slopes to the north and south of the Winford Brook;
• Pasture is the predominant land-use with a small but notable number of arable fields on steep slopes;
• The western end of the catchment is underlain by limestone, with mudstone elsewhere, especially to the south;
• Higher density of tributaries to the north on Dundry Hill and fewer to the south of Winford Brook - all tributaries likely to be ‘flashy’ based on geology and slope and sediment/high turbidity was noted in many during the walkover;
• Identification of several cattle watering areas close to watercourses with significant poaching;
• Sediment and run-off along roads and at crossings identified as being a key issue;
• Well-used tracks and gates next to watercourses were identified as being a likely key sediment source;
• Under-capacity culverts result in diversion of muddy run-off to Winford Brook tributaries e.g. Littleton Lane;
• Catchment management should be effective in Winford Brook as a small catchment; and
• Additional benefits for stakeholders from catchment management are likely to be increased infiltration resulting in reducing the ‘flashiness’ of the catchment and augmenting base flows, improvements in water quality e.g. reduction in phosphate levels and potential habitat/biodiversity benefits.

In terms of case studies, there is a wide range of projects, including previous and current PES pilot projects, from which indications of impact on soil erosion and flood risk can be gleaned. Several key examples, with specific relevance to reducing soil erosion and/or slowing peak flows linked to flood events, are detailed in Table 3-1.

Table 3-1: Case Study Examples

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Interventions</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCaMP, United Utilities</td>
<td>Reduce livestock intensity; grip blocking; replanting/stabilisation of eroding peat.</td>
<td>Monitoring is ongoing. 30% of the land within the project area is designated as a SSSI. Before the project 14% was assessed as being in a favourable condition – now this is 98.6%. The area of bare peat has been substantially reduced, and sphagnum cover has increased. Ground water levels have increased in blanket bogs. Statistically significant improvements in water quality and reduction in water colour and in-stream turbidity</td>
</tr>
</tbody>
</table>
River Parrett, Dorset/Somerset  
- Tree planting; timing of over winter stubbles; silt traps; buffer strips.
- Modelling has shown variable results, predicting reductions in the scale of flooding events as well as limited impacts due to woodland planting. Project has met social and economic needs as well as environmental needs and has taken an integrated approach with other methods of flood risk management.

Pontbren, mid-Wales; CCW  
- Tree belts; reducing stock density.
- Mean infiltration up to 60x higher in belts than surrounding pasture (1m/hr compared to 0.05m/hr). Other benefits include shelter for grazing animals, timber harvest, stream protection and reduced soil compaction.

Upstream Thinking, SWW  
- Block drainage ditches; peat bog and upland habitat restoration.
- Exmoor Mires – 1/3rd less water leaves moorland during heavy rainfall compared with 3 years ago. Large-scale habitat restoration with biodiversity and water quality benefits.

Bassenthwaite Lake  
- Woodland planting
- Forestry Commission has completed opportunity mapping for woodland and tree planting to reduce sedimentation. Main sediment sources and pathways have been identified.

CSF – Various Case Studies  
- Land use changes; land management changes including cropping methods; sediment ponds; capital works including covered yards, etc.
- Limited quantitative studies but many studies where there is a noticeable reduction in erosion and muddy run-off due to interventions. Usually focus on one farm. CSF171-032 reduced muddy water transfer to Dowlish Brook, a tributary of the River Parrett through guttering, drainage & livestock management improvements.

3.1.3 Modelling and Scientific Studies

As a result of the Rapid Evidence Assessment, 38 studies and papers were identified including modelling studies, field-based and empirical studies specifically focusing on sediment reduction and/or flood risk reduction as a result of catchment interventions.
Only 16% of the studies involved field data, with 32% involving modelling and the majority being review papers. A summary, including key findings, is provided as Appendix A.1.0

There are several modelling programmes and studies which are regularly used to inform catchment management work in the UK. These include Farmscoper and SCIMAP, which are briefly described below:

- **Farmscoper**: This is a model produced based on the ADAS study, An Inventory of Mitigation Measures & Guide to Their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions & Ammonia Emissions from Agriculture (Newell Price et al 2011). This was produced as part of Defra project WQ0106. The tool contains over 100 mitigation methods, including measures which reduce sedimentation. In addition to the original study, the model also includes additional consequences for biodiversity, energy use and water use. The model is intended to be used on a farm by farm basis.

- **SCIMAP**: This is a modelling project lead by Lancaster and Durham Universities, supported by NERC, Defra, the Eden Rivers Trust and the EA. The model focuses on the issue of diffuse pollution, based on connectivity between sources and waterbodies. A model for fine sediment is also included in the project. The models are intended for use on a catchment scale.

**3.1.4 Constraints, Limitations and Challenges**

Whilst the catchment management approach is widely and increasingly used, with many case studies (e.g. through Catchment Sensitive Farming), there are very few field studies and trials where a baseline has been established before interventions are completed and then monitored for an appropriate period afterwards. This is due to a number of constraints and challenges including the following:

- Difficulties in identifying key risk areas and problems, often due to lack of access to all land within a catchment and a lack of baseline data;
- Complexities of understanding the contribution of individual sources of sediment to a catchment scale problem;
- The complexity of hydrological systems, making assessment of the contribution of land at a given point/area within a catchment to a flood event downstream extremely challenging;
- Difficulties of monitoring the impact of individual interventions on a catchment scale;
- Evaluation of whether a problem has been solved or reduced is usually reported at a high level, especially for localised issues, but quantitative assessment is not usually completed;
- The magnitude of sedimentation and volume of run-off will vary greatly depending on weather conditions, seasonal timings and farm management practices. The contribution of an intervention or series of interventions towards reducing a problem will also depend on the context of actions within the landholding and on other landholdings within a catchment.
3.1.5 Interventions – Identification and Quantification

The studies identified in the literature, and catchment specific information from Bristol Water, were used to identify potential interventions. The CSF grant funded process for interventions was also reviewed. Findings are summarised in Table 3-2, showing indicative potential for reductions in erosion, sediment capture and flood risk reduction. However, variations between catchments mean that without an understanding of the baseline situation, and catchment specific modelling, it is difficult to estimate likely impacts of such measures if implemented in specific locations within the Winford Brook catchment.
<table>
<thead>
<tr>
<th>Type of Intervention</th>
<th>Potential Reduction in Soil Erosion</th>
<th>Potential Reduction in Flood Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree/hedgerow planting or gapping up at field boundaries</td>
<td>Moderate reduction by up to 20%</td>
<td>Low to moderate reduction. Potentially less than 10% infiltration rate but shelterbelts could reduce peak flows by 13-48%</td>
</tr>
<tr>
<td>Buffer strips (trees/ scrub/marsh/wet or rough grassland)</td>
<td>Moderate to high reduction by 20-80%. Studies have shown sediment capture rates as high as 95-98%.</td>
<td>Moderate reduction (uncertain). Infiltration rates can be up to 60x high in tree cover buffers</td>
</tr>
<tr>
<td>Create ponds, ditches or swales to collect sediment</td>
<td>Moderate to high reduction by up to 80% from arable</td>
<td>Uncertain - likely low reduction.</td>
</tr>
<tr>
<td>Woodland planting (catchment scale)</td>
<td>Uncertain. One study in China showed 95% reduction in sedimentation due to increased forest cover.</td>
<td>Uncertain but potentially low to moderate. Woodland run-off shown to be 20-30% of flow from arable fields but variable impacts in catchment-scale modelling.</td>
</tr>
<tr>
<td>Wetland creation e.g. meanders, washlands (catchment scale)</td>
<td>Moderate to high reduction by up to 80% from arable</td>
<td>High impact (case studies &amp; review papers).</td>
</tr>
<tr>
<td>Fencing for watercourses</td>
<td>Low reduction by up to 5%</td>
<td>No likely effect</td>
</tr>
<tr>
<td>Type of Intervention</td>
<td>Potential Reduction in Soil Erosion</td>
<td>Potential Reduction in Flood Risk</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Installing watercourse crossings</td>
<td>Low reduction by up to 5%</td>
<td>No likely effect</td>
</tr>
<tr>
<td>Bank stabilisation</td>
<td>Likely low reduction - banks contribute 5-15% of sediment</td>
<td>Potential effect but depends on work</td>
</tr>
<tr>
<td>Dealing with blocked culverts</td>
<td>Uncertain (increase/decrease)</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Installing road drainage soakaways</td>
<td>Uncertain</td>
<td>Likely low effect but depends on hydrology</td>
</tr>
<tr>
<td>Fencing field boundaries &amp; buffer strips</td>
<td>Low reduction by up to 5%</td>
<td>No likely effect</td>
</tr>
<tr>
<td>Relocating field gates &amp; then gapping up</td>
<td>Low reduction by up to 5%</td>
<td>No likely effect but may be low effect if flow along highways is an issue</td>
</tr>
<tr>
<td>Surfacing of tracks &amp; gateways</td>
<td>Low reduction by up to 2%</td>
<td>No effect to low increase depending on details and location</td>
</tr>
<tr>
<td>Improved drainage</td>
<td>Uncertain can increase or decrease by up to 10%</td>
<td>Uncertain. Can increase or decrease.</td>
</tr>
<tr>
<td>Provide rainwater storage infrastructure</td>
<td>No effect</td>
<td>Likely low reduction on catchment scale</td>
</tr>
<tr>
<td>Install roofing or covers for silage/slurry &amp; livestock gathering areas</td>
<td>No effect</td>
<td>Uncertain.</td>
</tr>
<tr>
<td>Type of Intervention</td>
<td>Potential Reduction in Soil Erosion</td>
<td>Potential Reduction in Flood Risk</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Install livestock troughs or drinking bays</td>
<td>Low reduction by up to 10%</td>
<td>No likely effect</td>
</tr>
<tr>
<td>Relocation and design of sheep dips</td>
<td>No information, except case studies</td>
<td>No likely effect.</td>
</tr>
<tr>
<td>Improved catchment management awareness</td>
<td>No information, except case studies</td>
<td>No information, except case studies</td>
</tr>
<tr>
<td>Changes to arable methods</td>
<td>Moderate reduction of 20-80%</td>
<td>Potential low reduction e.g. South Downs paper from arable to grassland conversion.</td>
</tr>
<tr>
<td>Production of sediment/nutrient management plans</td>
<td>No information, except case studies</td>
<td>No information, except case studies</td>
</tr>
<tr>
<td>Changes to stock management especially management of cattle trampling e.g. by seasonal electric fencing</td>
<td>Low reduction by up to 20%</td>
<td>Uncertain - no likely effect.</td>
</tr>
<tr>
<td>Reducing mud on trackways</td>
<td>No information, except case studies.</td>
<td>No likely effect</td>
</tr>
<tr>
<td>Avoiding seasonal use of high risk areas</td>
<td>Low reduction from reducing grazing density or time spent grazing by 10-30%.</td>
<td>Uncertain.</td>
</tr>
</tbody>
</table>

Changes to Management
Recommendations outlined in the 2012 study by AMEC for Bristol Water included:

- Focusing on the 60% (1,200 hectares) of the catchment at the highest risk;
- Combining farm visits/raising awareness with funding for other interventions where needed;
- Locating buffer strips by arable fields as a priority;
- Constructing cattle watering points, with gravel surface and fencing to keep cattle in defined area;
- Constructing small bunds along ditch up/downstream of crossing and replacing surface under gates with raised area of hardstanding;
- Upsize culverts and isolate from road runoff ingress, especially along Littleton Lane;
- Construct cuts through the road verges to route runoff to field to infiltrate/deposit sediment load, rather than being piped to a watercourse;
- A programme of monitoring and bathymetry to assess ascertain the volume of sediment in Chew Magna Reservoir and the rate of sediment delivery; and
- Using monitoring data to assess, at least at a high level, catchment interventions.

However, the project team did not feel confident that the results of the literature review, in tandem with the maps and recommendations from the AMEC study would be sufficient to best target efforts within the catchment. This view was reinforced at the workshop with land managers (see Section 4.1)

### 3.2 Opportunities Assessment – Wider Impacts

Sediment reduction and flood risk/peak flow reduction were the two key issues identified in the catchment with a clear potential value for beneficiaries. However, as a result of the interventions outlined above, other ecosystem services are likely to benefit. There may also be potential dis-benefits depending on the location and type of intervention.

#### 3.2.1 Approach

Any information found during the Rapid Evidence Assessment completed as outlined in Section 3.1.1 was also reviewed for benefits or impacts on provision of other ecosystem services. The search focused on key services which are likely to be impacted rather than assessing all services. The search by intervention type also involved identifying and recording impacts on complementary ecosystem services. Due to the volume of information, a search by different services was not completed, but it is felt that a representative sample of available information has been obtained by the approach outlined in Section 3.1.1.

Ecosystem services were considered following the UK National Ecosystem Assessment definitions. Where landtake would be required e.g. for buffer strips, this would potentially result in the loss of farmed area and may result in a disbenefit in terms of agricultural production. The scale of the impact will vary for each landholding, depending on
crop/grazing type, land values and the context of other management within the farm. Due to this range of possible impacts, such effects are not considered further in this initial high-level assessment. However, such ‘opportunity costs’ would clearly inform the terms upon which individual landowners may seek to enter an agreement as part of a PES scheme. Supporting services e.g. nutrient cycling are complex and due to limited applicability and complexity of assessing scale of contribution of some interventions, these services have not been considered.

Likely relevant ecosystem services which will be affected as a result of the interventions are shown in Table 3-3. Underlying data, including quantified data where available, is summarised in Appendix A.2.0.
<table>
<thead>
<tr>
<th>Intervention</th>
<th>Sediment reduction</th>
<th>Flood risk reduction</th>
<th>Provisioning Services</th>
<th>Climate regulation (inc carbon)</th>
<th>Hazard regulation</th>
<th>Noise regulation</th>
<th>Biodiversity (pollination)</th>
<th>Supporting services</th>
<th>Cultural services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree planting/gapping up of boundaries</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Buffer strips</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Sediment ponds/swales</td>
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<td></td>
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<tr>
<td>Bank stabilisation</td>
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<td></td>
<td></td>
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<tr>
<td>Fencing for watercourses</td>
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<tr>
<td>Upgrading/installing crossings</td>
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<td></td>
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<tr>
<td>Dealing with blocked culverts/vegetation management</td>
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<tr>
<td>Installing road drainage soakaways</td>
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<td></td>
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<tr>
<td>Fencing for boundaries</td>
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<tr>
<td>Relocating field gates</td>
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<td></td>
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<tr>
<td>Surfacing of tracks/gateways</td>
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<td></td>
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<tr>
<td>Improved drainage in yards</td>
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<td></td>
<td></td>
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<tr>
<td>Rainwater storage infrastructure</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Covers for silage/slurry/livestock gathering areas</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Install drinking bays</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Behaviour change to reduce mud on trackways</td>
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<td></td>
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<tr>
<td>Behaviour change to avoid use of high risk areas seasonally</td>
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<tr>
<td>Engineering solutions for flood risk reduction</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Property level protection for flood risk reduction</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
- Major/proven benefit
- Some/likely benefit
- Limited/unproven benefit
- No benefit/possible dis-benefit
3.3 Summary of Findings

While the project team was able to identify a wide range of possible measures to reduce erosion and flood risk, and data on associated impacts from case studies, it was not clear that such impacts could be expected in the Winford Brook catchment. This is because of the variations in circumstances between catchments.

In order to further inform thinking about which measures might be appropriate in the catchment, and any location specific issues, a workshop with possible suppliers was held. This is described in Section 4.1.
4.0 Engagement with Stakeholders

The initial stages of this project involved identifying demand (at a relatively high level), and reviewing the literature to understand what measures could be implemented in the catchment, and their likely effectiveness. Having identified possible measures, a workshop was held in late September 2014 with local landowners to understand their views on such interventions, and seek to obtain further knowledge on specific locations within the catchment that would require targeting. This is described in Section 4.1.

Following the workshop with local landowners, a meeting was held with potential beneficiaries in early December 2014, details of which are provided in Section 4.2. Subsequently, it was determined that a second meeting with beneficiaries was required. Information on this meeting, which was held in February 2015, is presented in Section 4.3.

A further meeting with those beneficiaries able to contribute financially to discuss contractual arrangements was arranged for April 2015, as described in Section 4.4

4.1 Workshop with Potential Suppliers

This workshop was held from 2-5pm on the 29th September 2014 at Bristol Water’s Woodford Lodge, Chew Valley Lake. This was attended by approximately 30 landowners and managers from the Winford Brook catchment, and others in catchments that drain to Chew Valley Lake and Blagdon Lake. The invitation was extended beyond the Winford Brook catchment as Bristol Water intend to roll out the catchment based approach across the wider area around the Mendip Lakes in future years.

4.1.1 Presentations and Discussion

A number of presentations were given by the project partners. Patric Bulmer from Bristol Water and Ruth Barden from Wessex Water explained the water companies’ interest in the project, and in catchment management more generally. They highlighted to participants that such approaches held the promise of reducing future increases in water bills compared to asset based solutions.

Sarah Dale from Avon Wildlife Trust Consultancy then described some of the measures that could be implemented within the catchment, drawing from her research described in Section 3.0. The slides from this presentation are included as Appendix A.4.0

Chris Sherrington from Eunomia then introduced the concept of payments for ecosystem services to the landowners. The slides from this presentation are included as Appendix A.5.0. He first explained what is meant by ecosystem services, before moving onto the principles of payments for ecosystem services, including that actions undertaken must be voluntary and additional. He presented different approaches to payment, including upfront and annual payments, and described the approach taken in the Fowey – first as an adviser led grant process, and then using a reverse auction. Finally, Chris presented a number of key questions that landowners should consider in relation to a PES scheme, including:
What is the minimum level of payment you would be willing to accept?
What payment terms would you expect?
  - Frontloaded or annual payments?
Would you part-fund certain investments?
Over what timescale are you willing to deliver ecosystem service benefits?
  - What length of contract would you sign up to?
What might disrupt your capacity to deliver the necessary interventions?

In the subsequent discussion, the response from the farmers in attendance towards a reverse auction approach appeared to be positive. While evidence from the Fowey suggests that some farmers disliked the idea of competing against neighbours for funds, such a view was not voiced in the workshop. Of course, that view may be held by farmers at the workshop who chose not to voice it, or others in the catchment who did not attend.

4.1.2 Land Ownership and Location-specific Issues

The workshop was well attended by farmers within the Winford Brook catchment, and the opportunity was taken to spend time with individual participants marking up details of land ownership and issues of which the farmers were aware, on large scale maps.

A number of very site-specific issues were identified in this way. While useful, this increased the growing awareness among the project team that using the existing high-level GIS analysis to score measures (measures for which, as seen in Section 3.0, effectiveness is highly dependent upon location) across the catchment may not prove to be an effective approach.

One further issue that became clear at the workshop was the dominance of a small number of farmers over key parts of the catchment, with one farmer owning much of the section on the northern slopes identified as an area of high erosion risk in the 2012 study for Bristol Water. The total number of farms in the catchment is 20. The farmers all knew each other well, and this raised additional concerns among the project team as to how effective a reverse auction approach would be in harnessing competition to drive down farmers’ grant requests.

4.1.3 Importance of Engagement with Individual Farmers

One more positive aspect of discussing issues with farmers and marking them on a large scale map was to see how the actions of some farmers had the potential to negatively affect the activities of other farmers. It was felt that this might have the potential to lead to individual agreements between farmers being brokered outside of the formal PES mechanism.

It is in fact intended that the catchment walkover (see Section 4.1.4) be followed in due course by discussion with specific farmers about particular interventions that could be implemented on their land. We expect this engagement to be an important step in the process, which we hope should make farmers realise the value to themselves (and their neighbours) of particular interventions. We expect, all things being equal, that this...
should mean that farmers will require a lower level of funding for specific land management changes, than would otherwise be the case.

### 4.1.4 Need for a Walkover Survey

At the end of the meeting the project partners agreed that a walkover survey would be required to obtain a better understanding of the sources and pathways by which sediment reaches watercourses. This survey would also begin to identify the particular measures, in specific locations, that could be applied to reduce soil erosion. Bristol Water subsequently agreed to fund a walkover survey.

The findings of the walkover survey are briefly presented in Section 5.0 and the draft report is included as an accompanying document.

### 4.2 First Beneficiaries Meeting

The first meeting with potential beneficiaries was held on 1\textsuperscript{st} December at Wessex Water’s head office in Bath. This included representatives from:

- Wessex Water
- Bristol Water
- Bristol Avon Catchment Group
- Environment Agency
- Natural England
- North Somerset Council
- Bath & North East Somerset Council
- TLT Solicitors
- APEM Ltd
- Avon Wildlife Trust Consultancy
- Eunomia Research & Consulting

Prior to the meeting, engagement had taken place with all of the invitees. In part the aim of this was to understand the extent to which they currently incur expense as a result of issues within the catchment that could be addressed via land management measures. Through this engagement the project team had an indication as to whether beneficiaries would be able and willing, to contribute funds to a PES project within the catchment.

The meeting was structured around a presentation delivered by Dominic Hogg of Eunomia. After introductions, this first involved an update on the pilot project (including a review of key drivers within the catchment, aspirations for the pilot and progress to date). Discussion then turned to what the project team already knew, and would ideally like to know about the effects of interventions within the catchment, and the potentially avoided costs to beneficiaries, based on the framework shown in Figure 4-1.
This lead to a lot of useful discussion, which was of great assistance in more accurately determining potential demand from beneficiaries. The information relating to demand gathered from this workshop, and from other sources, is reported in detail in Section 2.0. On the effectiveness of interventions, beneficiaries agreed with the findings of the review (reported in Section 3.0) that the effectiveness of interventions (particularly those related to soil erosion, water quality and flood risk) will vary greatly between catchments. Pete Stone from APEM Ltd., who had been commissioned by Bristol Water to undertake the walkover survey (which subsequently took place in January 2015) emphasised that in the case of soil erosion, the issue of connectivity, between source and pathway, is very important, making ‘value transfer’ unreliable.  

4.2.1 Approach to Payments

The presentation included detail on the possible approaches to determining levels of payments to farmers that had been used elsewhere, be this through an adviser led

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40 It would seem that value transfer is less reliable for issues such as flood risk reduction, soil erosion and water quality improvements than it would be for services such as carbon sequestration, where ‘connectivity’ is not an issue. As further primary studies are undertaken one would expect the accuracy of estimates based on value transfer to increase, but at present, and particularly in the case of the Winford Brook catchment, given the focus on soil erosion, determining the links between sources and pathways requires primary data.
approach with a grant of a fixed percentage, or via a reverse auction where farmers pick from a range of possible measures. The participants were informed that the project team’s preference in the case of the Winford Brook was for adviser-led approach, for the following reasons:

- The catchment is small – at 17km$^2$ it is ten times smaller than the Fowey catchment, and all things being equal, the smaller the catchment the lower the costs of actually visiting farms and advising on measures. In such cases, the administrative costs of setting up an auction risk outweighing the cost of such visits;
- The catchment is far from homogenous – significant variations in land use and gradient mean that some of the interventions will be very site specific; and
- The number of ‘providers’ is small – the limited number of land owners within the catchment will reduce the competitive pressures that mean that auctions can operate efficiently.

While there was agreement with this adviser-led approach, the project team indicated that they wished to explore the possibility of a ‘hybrid’ approach based on individual negotiation with farmers rather than a fixed percentage or fixed rate grant. It was envisaged that this could take the form of an advisor score for a particular farm based on the measures proposed and the advisor’s view as to the potential effectiveness of the measures in a given location, with subsequent negotiation around the funding request. This negotiation would be to firstly meet a value-for-money threshold and secondly ensure that the project is deemed sufficiently cost-effective to be in line for a payout (on the basis that the available money is awarded to projects in order of their cost-effectiveness until it is all awarded (subject to a value for money threshold) (See Table 4-1) For the Winford Brook catchment, this was felt to be a suitable approach, to be further developed.

**Table 4-1: Example of Scoring Sheet as Basis for Negotiating Funding**

<table>
<thead>
<tr>
<th>Farmer</th>
<th>Measures</th>
<th>Advisor Score</th>
<th>Funding Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A,B,C,G</td>
<td>80</td>
<td>?</td>
</tr>
<tr>
<td>2</td>
<td>B,C,D</td>
<td>90</td>
<td>?</td>
</tr>
<tr>
<td>3</td>
<td>B,E,F,H</td>
<td>40</td>
<td>?</td>
</tr>
<tr>
<td>4</td>
<td>A,D,G</td>
<td>35</td>
<td>?</td>
</tr>
<tr>
<td>5</td>
<td>F,G,H</td>
<td>70</td>
<td>?</td>
</tr>
</tbody>
</table>
4.2.2 Possible Contributions

Participants were then invited to state whether at this stage they believed themselves to be beneficiaries, and whether they could contribute funding towards a multi-beneficiary fund. If able to contribute funding, they were asked to indicate what constraints there would be on this funding, for example:

- Would they be able to fund capital items, or operational costs, or both?
- Timing of contributions – would it be a one-off upfront contribution, or an annual payment?
- Types of intervention – would they be able to fund
  - Only specific types of intervention (e.g. relocating gates, fencing watercourses);
  - Only interventions that address certain issues (e.g. flood risk reduction)
  - Any type of intervention that addresses the issue of concern identified within the catchment
- What sort of evidence would be required in relation to the intervention, i.e. what form of audit process would be needed to identify installation of the measure and ongoing maintenance and effectiveness of the measure?

At this point only Bristol Water and Wessex Water could indicate that they would be willing to contribute. Details of the potentially avoided costs to Bristol Water and Wessex Water, and thus consideration of the amount they might justifiably spend within the catchment are provided in Sections 0 and 2.3 respectively.

4.2.3 Next Steps

The beneficiaries agreed that the walkover study would be very useful in identifying specific locations where interventions are required. They also agreed to attend a subsequent meeting where the initial findings of the walkover would be presented, and where further discussion as to the specific approach to contributions to a fund could be agreed.

4.3 Second Beneficiaries Meeting

The second meeting of beneficiaries took place on the 14th February 2015 at Eunomia’s office in Bristol. This included representatives from:

- Wessex Water
- Bristol Water
- Bristol Avon Catchment Group
- Environment Agency
- Natural England
- North Somerset Council
- Bath & North East Somerset Council
- TLT Solicitors
- APEM Ltd
The meeting provided an opportunity for the findings of the walkover study (see Section 5.0) to be presented, which was very useful in informing subsequent discussion about the types of measures that could be applied in specific locations. This detailed presentation included maps and photos of the locations of concern. An intention of the meeting was also to agree the requirements of beneficiaries in order to enable them to contribute to a multi-beneficiary PES fund for the Winford Brook catchment, and to understand what legal structure will be required to give them the confidence to contribute.

4.3.1 Addressing ‘Quasi-unlawful’ Issues

What became clear from some of the photos was that a number of the activities undertaken by farmers were not in line with regulatory requirements, e.g. in relation to the Flood & Water Management Act. As a key aim of any PES project is only to pay for the delivery of additional services above and beyond what is legally required, partners discussed the best approach to such situations. One possible approach would be that farmers would be required to fully address these issues before being eligible for funding for additional work under the PES project. By contrast, another view, more ‘carrot’ than ‘stick’, was that pointing out such issues would give extra leverage to those negotiating on behalf of the beneficiaries, meaning that farmers would be encouraged to take on a greater proportion of the costs of interventions that would both bring them up to, and move beyond, the required standard.

4.3.2 Geographical Limitations of the Walkover Survey

During the second beneficiaries meeting, the question arose from Bath & North East Somerset Council as to why the walkover had only focused on part of the Winford Brook catchment. The reason for this is that Bristol Water is interested principally in the catchment of the Chew Magna Reservoir, as they will only be able to fund measures within the reservoir’s catchment. This, of course, does not include the part of the catchment that feeds the Winford Brook downstream of Chew Magna Reservoir, and hence this was not included in the Bristol Water-funded walkover.

Bath & North East Somerset council stated that this area was of greatest interest to them, and including this in the walkover study would have assisted in making a case for contributory funding. It was noted that the needs of the different beneficiaries have become clearer in the course of the pilot project, and that even within catchments of interest to a number of different potential beneficiaries, the exact areas of interest may not coincide. It was felt that this is a key lesson for other PES projects. One possible way...
to address this would be through undertaking ‘beneficiary mapping’ at the outset, where possible beneficiaries outline the geographical extent of the areas of interest to them, and in particular the areas of greatest priority.

4.3.3 B&NES as Both a Provider and Beneficiary

One interesting finding to come out of the walkover survey (see Section 5.0) is that it revealed the importance of roads within the catchment as both sources of sediment (by erosion of verges by vehicles) and as conduits for water and sediment. Discussion during the beneficiaries meeting on the issues of road drains and gully clearance highlighted that while B&NES would arguably be a beneficiary in respect of measures to reduce run-off within the catchment, it could also be a supplier. All things being equal, the reduced frequency of gully clearance is likely to have the effect of increasing the proportion of eroded soil that reaches watercourses and sewers. A brief discussion identified that as a short term measure, Bristol Water and Wessex Water would consider funding an enhanced regime of gully emptying within the catchment. However, their strong preference is for preventing erosion at source.

4.3.4 Relationship with Catchment Sensitive Farming

Up until the end of 2014, the Winford Brook catchment was not a priority for Natural England. However, in January 2015, the Winford Brook catchment was included as a Catchment Sensitive Farming (CSF) Target Area, meaning that farmers are able to apply for fixed rate grants to implement measures supported under the CSF scheme. The main driver for including the catchment as a target area is because of abstraction of water from Chew Magna Reservoir to Chew Valley Lake, for drinking water supply.

During the meeting, participants discussed how best to deal operate the PES scheme given the existence of the CSF grants to be offered within the catchment. Three main options were apparent:

1) Beneficiaries could provide ‘top-up’ funding to be distributed via the CSF schemes within the catchment;
2) CSF money could be added to the multi-beneficiary fund ‘pot’ for distribution via the PES scheme; or
3) The two schemes could run separately and independently.

The majority of participants felt that the second of these options would be the most efficient, and could be explored further. However, given that the CSF scheme was about to offer grants to farmers, the most appropriate approach at present would be to let farmers apply for the first round of CSF grants, and to then follow up with the PES scheme, with money focused more closely on the measures that will best meet the needs of the beneficiaries.

This discussion is reported in more detail in Section 2.8.
4.3.5 Requirements for Contribution to a Multi-Beneficiary Fund

The only confirmed contributors to a PES scheme at present are Wessex Water and Bristol Water. We explored in the meeting what would be required in order to give them the confidence to contribute to a multi-beneficiary fund which would then be responsible for negotiating agreements with farmers, disbursing funds, monitoring and obtaining evidence on their behalf. Issues of governance and the decision-making process were considered.

For Bristol Water, given that such an approach is far removed from the current way of operating, retaining a certain amount of control would be key. Decisions would need to be made as to who could authorise expenditure on their behalf, and the chain of accountability. For Wessex Water, again, if it is a regulatory requirement, e.g. meeting a commitment to reduce nutrient inputs to a waterbody under the National Environment Programme some control over expenditure would be required. However, for measures that are not so much driven by regulatory requirements, there would be less need for direct control (i.e. biodiversity).

The multi-beneficiary fund concept – as part of the Natural Capital Trust – is that there would be an administrative and technical overhead, and some money available to ‘lubricate’ deals. In order to ensure that such an approach delivers in an efficient manner for contributors it is important to ensure, as far as possible, that for contributing beneficiaries, the administrative aspects of the delivery of the PES scheme via the Natural Capital Trust lead to genuine savings relative to the counterfactual of directly running such schemes themselves.

It was agreed that a further meeting was required with contributing beneficiaries, to talk specifically about the structure of the multi-beneficiary fund including legal issues relating to its operation, with water company lawyers in attendance.

4.4 Funders Meeting

It was agreed to hold a further meeting in April 2015 to identify the legal requirements for managing the relationship between the Natural Capital Trust / multi-beneficiary fund and the contributors. This is reported in Section 6.4.
5.0 Walkover Survey

APEM Ltd was commissioned by Bristol Water to undertake a walkover survey in the Winford Brook catchment upstream of Chew Magna Reservoir. The approach and findings of this report are summarised in Appendix A.7.0, and the walkover report itself is provided as an accompanying document.
6.0 Natural Capital Trust

Of the various PES schemes in operational globally, a common feature is that there is just a single buyer, be it the Global Environment Facility, a regulator acting on behalf of a regional government, or a bottled water company.\(^\text{42}\)

In the following sections:

- We briefly review the difficulties associated with obtaining contributions from multiple beneficiaries (Section 6.1);
- Consider the proposal for a Natural Capital Trust for the West of England (Section 6.2);
- Outline progress on developing the framework for the Natural Capital Trust in the course of the PES Pilot project (Section 6.3); and
- Describe the framework for a multi-beneficiary contributory PES fund (Section 6.4).

6.1 The Challenge of Securing Multiple Purchasers

A question that has not, until recently, been addressed by the academic literature is why PES schemes have not developed with market structures other than those characterised by a single buyer. UEA, in their report on the Fowey PES pilot, explore some of the issues that might arise in developing PES markets with more than a single dominant buyer. They undertake some theoretical modelling that reveals that the issue of free-riding is one of the key obstacles to developing multi-purchaser market structures, and explore whether the free-riding problem in a multiple-purchaser PES mechanism might be overcome by getting purchasers to commit to contributions through a process of negotiation.\(^\text{43}\)

The authors suggest that one approach might be for the lead purchaser to create rules, such as committing to match contributions from other purchasers. However, they state that for such a mechanism to be credible, it must be the case that the lead purchaser can commit to not paying anything themselves unless contributions are forthcoming from other purchasers. It is observed, however, that such a commitment is hard to maintain given the strong incentives that the lead purchaser has to see the ecosystems services delivered.

It is further suggested by UEA/WRT that an alternative approach would be a PES mechanism in which purchasers could commit to making contributions decided upon in negotiations. The key to such a solution is that the commitments are binding, perhaps backed by legal documentation.


It is this latter approach that we are seeking to develop in respect of the Natural Capital Trust.

6.2 Proposal for a Natural Capital Trust

One of the intended aims of the Winford Brook PES Pilot project was:

To explore the role, as a PES scheme broker, of the Natural Capital Trust (NCT), which is funded by the West of England LEP through its Strategic Economic Plan, in partnership with the West of England LNP. It is the intention of the LEP and the LNP that the NCT would subsequently be used to deliver further PES schemes across the West of England.

At the time of submitting the bid to Defra, the project team fully expected the NCT to be funded, given that it was included in the Strategic Economic Plan (SEP) for the West of England. This reflected the development of a good understanding between the LNP and the LEP, and the fact that the Chair and Chief Executive of the LEP were supportive of, and understood the value of, what the LNP was trying to do. However, the supportive words in the SEP did not translate into financial support. It should be said that this is not necessarily due to the LEP itself: our understanding is that the decisions around funding for the LEPs have been taken out of the LEPs’ hands and been heavily influenced by central government priorities. The previous government appears to have seen less merit in the NCT idea than the LEP. Indeed it is our understanding that central Government’s focus on assessing schemes in SEPs in terms of their impact on Gross Value Added (GVA) will inevitably mean PES projects are less likely to be funded. This is because such interventions are intended to lead to cost savings – potentially directly reducing GVA in the short term – albeit increasing the potential for growth in the longer term through the more efficient allocation of resources.

The intention remains that the NCT will, once it receives funding, be a not-for-profit entity, with the aim of facilitating the strategic development of trading markets for natural capital investment in the West of England. This initiative is expected to provide national leadership and, we firmly believe, the potential for replication in other parts of England, and the rest of the UK. The Trust’s initial focus will be on water catchment management, while exploring PES concepts in other areas.

It is also intended that the Trust will form a multi-beneficiary contributory PES fund, facilitate the development of relationships between buyers and sellers, and manage transactions. In addition, if a need is demonstrated, the NCT may apply to the Local Growth Fund to develop innovative financial mechanisms to moderate the cash-flow demands on both buyers and sellers.

6.3 Progress within the Pilot Project

Given that funding has not, to date been forthcoming, the NCT has not been established. This has meant that ambitions in this regard within the PES pilot project have been somewhat tempered, given that we would otherwise have been operating alongside a newly formed and fully-funded entity set up to deliver such schemes.
6.4 Framework for a Multi-beneficiary Contributory PES Fund

A meeting was held on the 8th April to discuss the framework that would be required for a multi-beneficiary contributory PES fund. This meeting involved the following:

- Bristol Water – Patric Bulmer (Environment Manager) and Stuart Cleland (Land & Property Manager);
- Wessex Water – Ruth Barden (Environment & Catchment Strategy Manager) and Sue Johnson (Solicitor);
- TLT Solicitors – Philip Roberts (Associate);
- Avon Wildlife Trust – Bevis Watts (Chief Executive); and
- Eunomia – Chris Sherrington (Principal Consultant).

6.4.1 Rationale for a Multi-beneficiary Fund

It is important to note that the rationale for developing a ‘joint’ fund is to achieve a number of objectives:

1) It will reduce transaction costs by giving farmers and other land owners/managers a single buyer;
2) That ‘single’ buyer should theoretically have greater buying power than the individual beneficiaries acting independently as individual buyers; and
3) The co-ordination role ensures a balanced portfolio of measures that should add up to ‘more than the sum of their parts’ as they are intended to be mutually reinforcing. If beneficiaries were acting independently, this co-ordination would be absent and measures funded by one buyer could have a detrimental effect in respect of the objectives of another buyer.

In order for the fund to work as intended, it is necessary to ensure clear governance structures, and consider how to deal with different levels of funding from different beneficiaries, and issues relating to potentially diverging objectives. These are addressed in the sections below.

6.4.2 Legal Structure

Initial discussion centred on whether at its simplest, a fund could be established without the need to create a separate legal entity. It was envisaged that this would have a governance committee composed of representatives of contributory funders, providing funds for specific interventions. Effectively this could be a ‘virtual fund’, comprising a bank account managed by a lead partner.

However, given the requirement for contracts between landowners/managers and the fund, and agreements between the fund and the contributing funders, it was determined that a separate legal entity would need to be established.

A number of possible suggestions were put forward, including:

- Company Limited by Guarantee;
- Industrial and Provident Society; and
• Community Interest Company.

At the end of the meeting the most promising way forward was considered to be the formation of a Limited liability Partnership (LLP), as this offers the following advantages:

1) LLPs are relatively cost-effective to establish;
2) All contributing funders are partners;
3) The exposure of any one partner is limited;
4) The expected deliverables are clear for each partner (akin to the expected rate of return in typical LLPs);
5) There is clarity, via a Partnership Agreement, in relation to the internal workings of the LLP. Among other things, the Partnership Agreement covers admission of new members, management and decision making, retirement and expulsion from the LLP and entitlement and obligations of outgoing members; and
6) The formation of an LLP will not preclude additional future beneficiaries from contributing to measures in the catchment.

It was agreed that the LLP should include an administrative function, to identify the appropriate interventions and subsequently lead the negotiations with landowners. This administrative function could be provided by either a lead partner or a managing partner contracted under a management agreement, and the costs of this administrative function covered by an administrative overhead paid by fund contributors (as a fixed proportion of their overall fund contribution).

The LLP should also include a board, with members of the board representing the contributing partners. The board would provide oversight and sign off the packages of proposed interventions put forward as part of the administrative function.

It is envisaged that the LLP model could readily be applied to other catchments, and in order to expedite the development of the fund in the West of England an application will be drawn up to the West of England LEP to request funding for the establishment of the multi-beneficiary contributory PES fund.

In the sections below we present some of the key issues raised in respect of the governance and operation of the fund:

• The process of identifying measures and approving those that are appropriate (Section 6.4.3);
• Deciding how to allocate funding by theme (Section 6.4.4);
• Spatial considerations in respect of allocating funding (Section 6.4.5);
• Securing agreements with landowners/managers (Section 6.4.6);
• Making payments to landowners/managers (Section 6.4.7);
• Leveraging additional contributions (Section 6.4.8);
• The need for water companies to demonstrate to the regulator that the choice to apply catchment management techniques can be justified, through undertaking prior analysis (Section 6.4.9);
The need for water companies to demonstrate to the regulator that the catchment management interventions funded have provided the anticipated benefits (Section 6.4.10); and

Future application of the approach to other catchments (Section 6.4.11).

6.4.3 Identifying and Approving Measures

In the case of the Winford Brook catchment, both Bristol Water and Wessex Water seek the following shared objectives from catchment management interventions:

- Reduced erosion of sediment;
- Nutrient reduction; and
- Reduced flow rate.

Part of the administrative function of the fund would be to identify, based on the available evidence, and discussions with landowners/land managers the proposed interventions that would best support the shared catchment objectives. In this case the shared catchment objectives are largely complementary, in that measures can be implemented that assist all three objectives simultaneously.

At present, as the only two potential contributors share these objectives, there should be little in the way of disagreement about proposed interventions. If B&NES and North Somerset councils were also to become members of the LLP, and make a financial contribution, their primary objective would be flood risk reduction. Again, this should largely align with the objectives of the main funders.

While other stakeholders have indicated that they are at present unable to commit funding, there would be merit in a minimum subscription of £100 from the outset. This would mean that B&NES, North Somerset and the Environment Agency could be involved with the fund knowing its initial priorities will be the three main objectives of the water companies, and that flooding could be addressed at a later date. In other words, the contributions from stakeholders may ratchet up and down but all the key players in the catchment are part of the governance to ensure joined-up thinking and oversight in relation to other investments.

There was discussion as to the way in which proposed interventions should be identified and agreed upon. A potential way forward is for the administrative function to identify a portfolio of potential measures, and for these to be presented to the board at set intervals for their approval, and a maximum budget allocated to securing these interventions (or as many of the interventions as possible) with the aim that these be secured at the lowest possible cost. A point noted by one of the water companies was that they might want to review each of the proposed interventions to ensure that they met their requirements. However, a counter-argument to this is that if every funder ‘micro-managed’ the choice of proposed interventions the administrative costs of the multi-beneficiary fund would increase, thus eroding the intended efficiency gains from collaborating on funding within the catchment.

Thus asking the board to approve a portfolio of measures across a number of different locations within the catchment, was felt to offer the appropriate balance between
efficient operation of the fund and giving confidence to water companies that their investments are appropriate.

A further question was posed about the aims of other contributing beneficiaries who may choose to join the LLP in future years. It was agreed that others would be allowed to contribute to the fund as long as their desired outcomes (e.g. improved air quality, carbon sequestration, public health benefits through access and recreation), and the measures that would be required to deliver these, do not conflict with those of the existing LLP partners.

6.4.4 Allocation of Funding by Theme

In principle, the allocation of funds to specific objectives should be in proportion to the amounts contributed by the individual funders.

Given that the two potential contributors share common objectives, even if the amounts of funding provided by Bristol Water and Wessex Water were to differ, the allocation of 100% of the amount disbursed at any round of funding would be directed towards schemes that address the common objectives.

If the two local authorities were to contribute to the fund, with flood risk management as a primary objective, there may be a divergence of opinion as to the types of scheme to be funded. If the local authorities were to provide 10% of the funding, and the water companies the remaining 90%, this could provide the basis for the allocation of funds in one of the following ways:

- If the local authorities are happy that the portfolio of measures proposed to address the main ‘shared’ catchment objectives will deliver the most cost-effective flood risk reduction benefits, they may choose to allocate their funds to these types of measures.
- If local authorities feel that other measures would be more appropriate in meeting their objectives, then as long as such measures (perhaps the relocation of field gates, for example) were not in conflict with the main catchment objectives, then 10% of the funds disbursed at any one funding round could go towards such measures.

6.4.5 Spatial Allocation of Funding

One issue that has arisen in the course of discussions with potential beneficiaries is that they might want, be required by regulators, or be constrained by jurisdictional boundaries, to allocate funding to only a proportion of the catchment.

For example, B&NES would be more interested in funding measures downstream of the Chew Magna Reservoir catchment, but still within the Winford Brook catchment. By contrast, Bristol Water is constrained by the regulator to only invest in measures upstream of Chew Magna Reservoir.

Accordingly, this would have to be accounted for in allocating funds to interventions within the catchment.
6.4.6  **Agreements with Landowners**

Once the board agrees the portfolio of measures, the administrative function of the LLP would be charged with securing agreements with landowners through a process of negotiation, at the lowest possible cost. While reverse auctions will not be applied, it will still be possible to undertake a process of negotiations with individual farmers to secure the best possible terms.

Depending upon the types of measure to be funded, different legal agreements will be required, such as wayleaves, or some form of charge on the property. These agreements will have to be between the LLP and the landowners (rather than directly with the water companies, for example). Therefore, the landowners would need to have the confidence that they are dealing with a body of sufficient financial standing, backed up by funding from water companies and others. Landowners may require written evidence of the LLP’s financial reserves and that it holds funds for the term of the payment contract.

Agreements will also have to include penalty clauses to ensure that if recipients of funds don’t maintain the funded asset, money would be clawed back, and spent elsewhere in the catchment. Maintenance of the asset can be further incentivised through the staging of payments, as detailed in Section 6.4.7.

6.4.7  **Payments**

It was felt that payments to the fund from contributing partners should be upfront (on the basis of the expected avoided costs). On receiving the funds, the contributing beneficiaries would require documentation from the LLP acknowledging receipt, with reference made as to the agreed approach to allocation.

However, there should then be annual rounds of allocations of funding to farmers within the catchment, to allow for learning on both sides. Farmers would develop a greater understanding of the approach, and the beneficiaries would gain greater knowledge relating to the effectiveness of specific interventions within the catchment. This would allow a re-orientation of future expenditure within the catchment if deemed necessary.

In order to further incentivise landowners/managers to maintain the asset, a set proportion of the funding (perhaps up to 25%, depending upon asset type) could be held back by the LLP and paid in future years conditional upon acceptable maintenance of the asset.

6.4.8  **Leveraging Additional Contributions**

Another possible role of the administrative function of the LLP would be to seek to secure funding for other ecosystem services within the catchment. Interventions funded in this way would at the least not hinder, and ideally would support, the shared catchment objectives. This could take the form of, for example, securing biodiversity offsets, or obtaining funding via the voluntary carbon credit market for tree planting. In effect this would involve the ‘layering’ or ‘bundling’ of funds.
6.4.9 Information Requirements – Avoided Costs

For Bristol Water, in order to demonstrate to the regulator that customer money has been spent wisely, they will need to have a clear understanding of the likely costs that can be avoided through undertaking land management interventions. This will be required at the outset before any funds can be allocated to an LLP.

For the Winford Brook catchment, Bristol Water is comfortable that the analysis on avoided costs undertaken by Eunomia will provide sufficient justification to contribute funds to an LLP. Effectively, this type of analysis, which, in the current case, has been funded by Defra under this pilot project, would need to be replicated in other catchments to unlock water company funds. Wessex Water is also comfortable that the ‘avoided costs’ approach will enable them to allocate funds to the catchment.

Accordingly, it is proposed that part of the administrative function of the fund will be to undertake such analysis to provide evidence on likely avoided costs.

6.4.10 Information Requirements - Monitoring

As part of demonstrating to the regulator that customer money has been spent wisely over the 5-year AMP period, water companies will need to know, and be able to report on, the impacts of the interventions that they have funded.

Bristol Water is already monitoring for water quality (total phosphorus, suspended solids, dissolved phosphorus and nitrates) just upstream of Chew Magna Reservoir. From May 2015, monitoring commenced at a number of other locations within the catchment recommended following the APEM walkover. Given the requirement to undertake baseline modelling for a certain period of time, Bristol Water anticipates that the earliest point at which it could contribute to a fund within the Winford Brook catchment is April 2016.

Wessex Water would also need to be able to report to the regulator the extent to which the catchment management interventions have been successful. Given the uncertainties involved, Wessex probably proceed at present using a ‘best endeavours’ approach in respect of the catchment, with a commitment to build an asset solution in AMP6 if catchment management doesn’t work. One possible approach to address the risk to Wessex that catchment management may not, for example, reduce the number of CSO spills by the required amount, is to seek to address 80% of the problem by an asset solution and 20% via a PES approach. Over time, as knowledge of, and confidence in, the effectiveness of catchment management approaches increases, the ratio might become 60% asset solution to 40% PES.

The importance of monitoring is arguably greatest for the regulated water companies, although any contributing beneficiaries will rightly want to know what they will get for their funding. The current and forthcoming water company monitoring within the Winford Brook catchment should be of use to wider beneficiaries in understanding the impacts of the interventions. It will, however, be useful to understand, over the next few years, whether water companies are best placed to directly undertake (or commission) monitoring, or whether there is merit in monitoring being an administrative function of
the LLP. One constraint of relying solely on Bristol Water’s monitoring in the Winford Brook catchment is that it will only cover locations upstream of Chew Magna Reservoir, i.e. excluding parts of the wider catchment (downstream of the reservoir) that are of interest to B&NES.

6.4.11 Application to Other Catchments

The LLP model could be more widely replicated, and would, we feel, map well onto the existing partnership work that is ongoing at catchment level. Future developments might include LLPs applying a project finance model, potentially levering in funds to pump prime natural capital investment based on the credit rating of water companies. This could also overcome the barrier of 5 year AMP periods to long-term investment.

7.0 Conclusions

The Winford Brook Pilot PES project has set in place the foundations for a multi-beneficiary PES scheme to be applied in the catchment in the coming years. It is anticipated that the approach outlined in this report, which will inevitably be further refined as it is implemented, can then be replicated in other catchments. In addition, key findings from the work undertaken during the pilot project reinforce some of the lessons from earlier pilots, and supplement the evidence base in respect of the growing literature on the theoretical and practical aspects of developing PES schemes.

Specific achievements of the pilot project include:

- Calculation of the potential avoided costs associated with a reduction in the requirement for dredging. These have been shown to be relatively easy to identify, and give a clear indication of the marginal benefits of reductions in soil erosion. These (relatively constant) marginal benefits contrast strongly with the benefits of reducing the likelihood of algal blooms, for which the potentially avoided costs are uncertain, but potentially large, and would be incurred once a ‘threshold’ is breached. To the best of our knowledge such calculations related to the avoided/deferred need for dredging have not been performed before in the context of a potential PES scheme;
- The walkover report highlighted the importance of roads as both sources and conduits of eroded sediment. This provided an important element of ‘ground-truthing’, and demonstrated the importance of understanding the role of ‘connectivity’ within the catchment. It also highlighted the possible dual role of the local authority, as lead local flood authority and highways authority, as both a potential supplier and beneficiary;
- The process of engagement with beneficiaries has enabled the identification of ‘guiding principles’ in relation to the establishment of a multi-beneficiary contributory PES fund; and
The legal issues surrounding the establishment of a multi-beneficiary contributory PES fund have been considered and are reported as an annex to this report. Again, as far as we are aware, this is a first for the UK.

7.1 Key Findings

Key findings from the project are as follows:

1. The avoided costs of sediment removal provide a clear indication of the marginal financial benefits associated with reduced levels of erosion within a catchment. This contrasts with other potentially avoided costs, such as those related to reducing the likelihood of algal blooms in water supply reservoirs through measures that decrease the input of phosphorus and nitrogen to waterbodies. Avoided costs of sediment removal can, therefore, be used to provide a lower bound estimate of the available fund to support changes in management on the part of providers, recognising that from the perspective of the beneficiary (in this case the water company), measures may lead to wider (but as yet unquantified) benefits in terms of reducing the risk of algal blooms. The present value to Bristol Water associated with each cubic metre reduction in erosion per year is estimated to lie between £666 and £1,025 (depending on one’s view as to the longevity of the changes bringing about the anticipated reduction);

2. Management of soil nutrients on land within the catchment is expected to be more cost-effective for water companies than investment in ‘grey’ infrastructure. Wessex Water indicated that managing soil nutrients on land would potentially mean that they can reduce or avoid future nutrient removal costs at sewage treatment works (STW). If Wessex Water was to install treatment infrastructure at a Sewage Treatment Works to deal with Phosphorus from the catchment the cost is estimated to lie between £2m and £5m. Wessex anticipates, on basis of previous experience that a catchment approach would cost one sixth of this, suggesting that the intended outcomes could be achieved for an expenditure of between £300,000 and £800,000 on catchment measures to reduce the phosphorus requiring treatment.

3. An adviser-led approach may deliver a more cost-effective outcome than a reverse auction. The smaller the number of farmers in the catchment and the more location specific the issues, then the more likely it becomes that an adviser-led approach will deliver a more cost-effective outcome than a reverse auction. This is aligned with the findings from the Fowey PES Pilot. In the Chew Magna catchment, the project team set out with an expectation that a reverse auction - based largely on using existing data on areas at highest risk of soil erosion, combined with information on the likely effectiveness of generic measures - would be the preferred approach. However, in respect of soil erosion, it became increasingly clear that identifying the precise sources and pathways was very important to ensure that beneficiaries were not simply paying for actions that delivered limited benefits. Hence, the decision to commission a walkover survey to identify the specific locations where measures were most likely to be effective.
In addition, it became clear that the small numbers of landowners within the catchment meant that the scope for efficiencies through an auction would be reduced relative to the administrative costs.

There is an interesting question, related to more general cases, which flows from this experience: What is the nature of the trade-off between:

- more effective targeting of interventions through walk-overs / more detailed surveying; and
- the additional costs of undertaking such surveys?

Theory suggests that the greater the number of participants, the more one moves away from more ‘administratively cumbersome’ approaches. Yet land management practices are not ‘fixed’, and there is scope for strategic behaviour on the part of providers. Furthermore, beneficiaries such as water utilities have to demonstrate value for money to the regulator. As such, there may be a requirement for monitoring of the efficacy of interventions anyway (not least, to ensure that ‘providers’ have made changes, and that they are still providing what they claimed they would). We believe, therefore, that the trade-off may be less significant than might be imagined, and that there may be gains (rather than losses) in efficiency that flow from more detailed survey work (rather than ‘pure’ market mechanisms).

4. **Baseline monitoring is important in giving confidence to potential beneficiaries that the effect of subsequent interventions will be able to be identified.** As part of demonstrating to the regulator that customer money has been spent wisely over the 5-year AMP period, water companies will need to know, and be able to report on, the impacts of the interventions that they have funded. Bristol Water is already monitoring for water quality (total phosphorus, suspended solids, dissolved phosphorus and nitrates) just upstream of Chew Magna Reservoir. From May 2015, monitoring commenced at a number of other locations within the catchment recommended following the walkover survey. The importance of monitoring is arguably greatest for the regulated water companies, although any contributing beneficiaries will rightly want to know what they will get for their funding.

5. **For tackling soil erosion, offering funding for location-specific measures proposed by advisers will give greater certainty to beneficiaries that their money is being spent efficiently.** The approach applied in the Fowey PES Pilot project, and indeed, the approach applied by Catchment Sensitive Farming, is to allow farmers to select from a list of possible measures. The risk with this format is that farmers will select measures that best suit their own farm plans, while opportunities to address the concerns of the funders in a more cost-effective manner may be overlooked.

6. **The current rules on awarding funding via Catchment Sensitive Farming (CSF) do not facilitate combining this kind of PES scheme with CSF.** There was discussion with Natural England about the possibility of a ‘top-up’ to the CSF fund in the catchment from beneficiaries (i.e. water companies). However, the fact that farmers would be able to choose measures from a list, and the limit of £10,000 funding per farm, means that the potential efficiency of the approach is
limited. Arguably, shifting funds in the opposite direction, i.e. from the CSF ‘pot’ to the multi-beneficiary fund ‘pot’, would be a more attractive, and efficient, proposition.

Earlier in the project, prior to the catchment being considered as a target CSF area, similar thoughts had been considered vis a vis countryside stewardship (CS). At the time it was felt that it might be possible to deploy the funds from CS, strategically, to enhance the additionality of beneficiary funds through using them to provide the incremental funding that might persuade a given farmer to adopt specific CS measures.

7. **In order to secure funding from as wide a range of beneficiaries as possible, it is important to select a catchment that is a priority for as many beneficiaries as possible.** Whilst this may appear to be a statement of the obvious, at a time of constrained budgets, even though potential contributors perceive that they will obtain a net benefit from funding interventions, they may only be able to justify financial contributions to PES schemes in locations that have been identified as key priorities to their organisation. It may, therefore, be worthwhile for future schemes to undertake a ‘beneficiary mapping’ exercise, to understand which geographical areas are of greatest interest to a broad range of potential beneficiaries. Targeting such ‘hotspots’ would thus offer the greatest potential for multiple financial contributions.

8. **Even within catchments of interest to a number of different potential beneficiaries, the exact areas of interest may not coincide.** In the case of the Winford Brook catchment, Bristol Water was interested principally in the catchment of the Chew Magna Reservoir. This does not include the part of the catchment that feeds the Winford Brook downstream of Chew Magna Reservoir. This part of the catchment was not included in the Bristol Water-funded walkover, but when the findings were presented to the wider group of beneficiaries, Bath & North East Somerset Council indicated that this area was of greatest interest to them, and that including this area in the study would have assisted in making a case for contributory funding. This reinforces the previous point in that the area of focus chosen might usefully consider issues of connectivity within the catchment, and whether extending the area of interest has the potential to draw in other beneficiaries.

9. **Setting up PES schemes takes time.** It is fair to say that the project team was (with the benefit of hindsight) a little ambitious in terms of the expectations of what would be achieved in less than a year, and using the available resources. Had funding been awarded for the establishment of the Natural Capital Trust (NCT – see below), the resources directed towards the establishment of PES schemes in the West of England, and in the Winford Brook in the first instance,

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44 This was the case for the Environment Agency. While the EA representatives could see benefits to the EA from interventions in the Winford Brook catchment, funding could not be provided as the catchment was not a top priority from the Agency’s perspective.
would have been enhanced, and further progress made. However, this pilot project for Defra has undertaken much of the groundwork that will prove to be of great use in taking the scheme forward (to implementation), and rolling out to other catchments should the NCT eventually obtain funding.

### 7.2 Challenges

The project team faced a number of data challenges, primarily in respect of the likely effectiveness of specific measures in particular locations. This meant that the initially intended ‘light-touch’ approach turned out not to be possible – a point reinforced by the walkover study. Another data-related challenge was the lack flood risk information within the catchment, specifically in respect of possible effects on flood risk of changes in land use. Environment Agency modelling had only considered changes within the channel of the Winford Brook, rather than considering the possible effect of wider land use changes within the catchment, which meant that the possibility of flood risk reduction could only be talked about qualitatively.

Finally, it is worth commenting on the commerciality of PES schemes in the general sense. From the perspective of beneficiaries (and policy makers), whilst it would, of course, be desirable to be 100% certain of the scale of the benefits relative to the costs, in the absence of data, this might be perceived as presenting a fundamental challenge. However, we were consistent in our approach which maintained that in the absence of perfect information, what mattered most was that the beneficiary had a reasonable expectation of deriving benefits that exceeded the costs of bringing about land use changes that they expected to provide benefits. Hence, what is important to beneficiaries is the expectation that the risk-adjusted benefits that they feel are likely to materialise from the changes they support exceed the costs of the intervention. The benefits will, after all, be not only uncertain, but variable with the climate and rainfall in a given year. If we wait for the situation to arise when costs are only incurred where benefits are certain, then given the state of the data and information at our disposal, we might be waiting for a very long time indeed. Until agreements are concluded with landowners and interventions implemented, and only once monitoring has been able to demonstrate the impacts, will it be possible to calculate, with any precision, the scale of the benefits, and the benefit:cost ratio.

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45 The Natural Capital Trust (NCT) is a concept developed by Dr Bevis Watts. The NCT, for which a funding application was submitted to the West of England Enterprise Partnership, is intended to be a not-for-profit entity to facilitate the strategic development of trading markets for natural capital investment in the West of England. One of the proposed aims of the NCT would be to broker PES schemes, including the creation and management of a multi-beneficiary contributory PES fund.

46 In this respect it is worth noting that the scale of benefits will vary between years. For example, measures to reduce soil erosion may show very little benefit relative to the baseline in years of little rain, whereas in very wet years the benefits from the interventions may be very high.
This lack of certainty at present should not be a reason to delay the implementation of PES projects. By contrast, as long as adequate provision is made for monitoring, the greater the number of PES projects that are undertaken, and the sooner they are implemented, the faster our knowledge will develop regarding the magnitude of the benefits relative to the costs. This should, in turn, facilitate targeting of measures to achieve outcomes in the most cost-effective manner.

7.3 Importance of Walkover Surveys

In addition, the pilot project highlighted the importance of walkover surveys in identifying the particular locations within catchments where issues arise, and thus where specific interventions might best be placed. Furthermore, the walkover survey helps to identify location specific monitoring requirements that will enable a ‘baseline’ to be developed which will assist in the subsequent demonstration of impact to beneficiaries, and in some cases to their regulators. There is also a role for walkover surveys as part of the post-implementation monitoring. Such findings in relation to the role of walkover surveys are fully transferable to other catchments. As noted above, there may be reasons to believe that, especially where detailed, on the ground monitoring is a requirement for beneficiaries (as it may be for regulated utilities), then the costs of detailed survey are part of the required expenditure to ensure value for money: as such, to the extent that such approaches facilitate better targeting of beneficiary spend, there may be a reasons to advocate such an approach.

7.4 Barriers Requiring Government Intervention

Reflecting one of the key findings of the pilot project, there is a need to further explore whether the rules for Catchment Sensitive Farming (or rather its successor, the Water Capital Grants under the Countryside Stewardship Fund) allow, or could be adapted, for the budget for specific catchments to be allocated to a multi-beneficiary PES fund. At present, the rules on awarding funding via CSF do not appear to facilitate combining this kind of PES scheme with CSF. The most efficient approach would be to shift funds from the CSF ‘pot’ to the multi-beneficiary fund ‘pot’.

From the perspective of beneficiaries, it makes sense, for the time being, to let the current round of CSF grant applications in the catchment proceed, as this will reveal the preferences of the farmers for specific measures, and allow for a subsequent round of more targeted funding of interventions under the PES scheme, so as to maximise the additionality of the spend.

The lack of access to CLAD data from the RPA acts as a barrier for organisations, such as water companies, who might wish to undertake a PES scheme involving landowners.

Government intervention to permit such data to be shared with relevant organisations, such as water companies, that are not Government Agencies, would be welcome.

At the regional level, it had been hoped that the project could be carried forward under the aegis of the Natural Capital Trust. By working alongside the West of England Local Enterprise Partnership (LEP), the WENP had hoped to secure funding for a call for ERDF funds, to be issued by CLG. A number of unnecessary obstacles have emerged, however, largely related to CLG advice to the LEP regarding the LEP’s strategy for managing ESIF funds. At the time of writing, notwithstanding the fact that the second strategic objective of the LEP read:

*Ensure a resilient economy, which operates within environmental limits. That is a low carbon and resource efficient economy, increases natural capital, and is proofed against future environmental, economic and social shocks.*

it is unclear as to whether CLG will allow the call related to the NCT to proceed, even though this (or similar) has been envisaged from an early stage in the formulation of the strategy for managing the funds (and the project itself appears in the LEP’s Strategic Economic Plan). A decision from CLG is awaited (this is due, we understand, on November 6th).
APPENDICES
## A.1.0 Literature Review for Interventions: Sedimentation & Flood Risk Reduction

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Type of Study</th>
<th>Service(s)</th>
<th>Intervention(s)</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atkins (2012). The value of woodland on flood reduction in the Derwent Catchment.</td>
<td>Model</td>
<td>Flood risk reduction</td>
<td>Tree (woodland) planting</td>
<td>Potential for woodland planting in catchments to provide benefits from flood reduction in Keswick.</td>
</tr>
<tr>
<td>Evidence</td>
<td>Type of Study</td>
<td>Service(s)</td>
<td>Intervention(s)</td>
<td>Findings</td>
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<tr>
<td>environment: a literature review of best management practice. Hydrology</td>
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<tr>
<td>&amp; Earth System Sciences Discussions 8:286-305.</td>
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<tr>
<td>role in water management. Journal of Practical Ecology &amp; Conservation</td>
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<td>7:153-167.</td>
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<tr>
<td>Calder, I.R. (1990). Evaporation in the Uplands. John Wiley and Sons</td>
<td>Review</td>
<td>Flood risk reduction</td>
<td>Tree (woodland) planting</td>
<td>Interception rate of conifers as a proportion of rainfall of conifers decreased with increasing storm size, and is a maximum of 6-7mm/day.</td>
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<td>Ltd., Chichester.</td>
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<tr>
<td>Calder, I.R. &amp; Aylward, B. (2006). Forests and floods: Moving to an</td>
<td>Review</td>
<td>Flood risk reduction</td>
<td>Tree (woodland) planting; land use changes</td>
<td>Limited evidence for significant effect on extreme flood flows. May be due to small amount of forest cover compared to other land use</td>
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<td>evidence-based approach to watershed and integrated flood management.</td>
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<td>Water International 31: 541-543.</td>
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<td>Evidence</td>
<td>Type of Study</td>
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<tr>
<td>Carroll, Z.L. et al (2004). Can tree shelterbelts on agricultural land reduce flood risk? Soil Use &amp; Management 20 357-359</td>
<td>Field study (Pontbren, Wales)</td>
<td>Flood risk reduction</td>
<td>Tree planting</td>
<td>Infiltration rates up to 60 times higher in areas planted with young trees than in adjacent grazed pastures. UK study</td>
</tr>
<tr>
<td>Defra (2006). Wetlands, Land Use Change &amp; Flood Management.</td>
<td>Review &amp; case studies</td>
<td>Flood risk reduction</td>
<td>Land use change - washlands and wetlands</td>
<td>Washlands and wetlands (flood storage) in the floodplain likely to be more significant contribution than other land use changes. Examples &amp; case studies provided.</td>
</tr>
<tr>
<td>Evidence</td>
<td>Type of Study</td>
<td>Service(s)</td>
<td>Intervention(s)</td>
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<td>agricultural sources: a review A Report by SAC to the Scottish Executive.</td>
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<td>Recommended widths 3-200m with 5-15m commonly adopted.</td>
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<td>Evidence</td>
<td>Type of Study</td>
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<td>Intervention(s)</td>
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<tr>
<td>Gilliam, J.W. (1994). Riparian Wetlands and Water Quality. Journal of Environmental Quality 23: 896-900.</td>
<td>Review</td>
<td>Sediment capture</td>
<td>Buffer strips</td>
<td>Several researchers have measured &gt;90% reductions in sediment and nitrate concentrations in water flowing through the riparian buffers. The riparian buffers are less effective for P removal but may retain 50% of the surface-water P entering them.</td>
</tr>
<tr>
<td>Hubbard, R.K. &amp; Lowrance, R.R. (1994). Riparian forest buffer system research at the Coastal Plain Experiment</td>
<td>Review</td>
<td>Sediment capture</td>
<td>Buffer strips; land use</td>
<td>Combination of woodland &amp; grassland strips enhanced sediment removal.</td>
</tr>
<tr>
<td>Evidence</td>
<td>Type of Study</td>
<td>Service(s)</td>
<td>Intervention(s)</td>
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<tr>
<td>Station, Tifton, G.A. Water, Air and Soil Pollution, 77: 409-432.</td>
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<tr>
<td>JBA (2007). Ripon land management project. Final report to DEFRA June 2007. JBA Consulting, Skipton.</td>
<td>Model (River Laver)</td>
<td>Flood risk reduction</td>
<td>Tree (woodland) planting</td>
<td>Converting 25% of area to woodland would only reduce 1-in-100 yr flood event by 1-2% &amp; delay peak by 15 mins.</td>
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<td>Evidence</td>
<td>Type of Study</td>
<td>Service(s)</td>
<td>Intervention(s)</td>
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<tr>
<td>Newell Price, J.P. et al (2011). An Inventory of Mitigation Measures &amp; Guide to Their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions &amp; Ammonia Emissions from Agriculture.</td>
<td>Model &amp; Review</td>
<td>Sediment capture</td>
<td>Land use changes; buffer strips; infrastructure; changes to management practices</td>
<td>Assume sediment loss for combined crops 10-800kg/ha &amp; lowland grazing 5-250kg/ha. Sediment can be reduced by variety of measures with land management changes having the biggest impact.</td>
</tr>
<tr>
<td>Evidence</td>
<td>Type of Study</td>
<td>Service(s)</td>
<td>Intervention(s)</td>
<td>Findings</td>
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<tr>
<td>Ryszkowski, L. &amp; Kedziora, A. (2008). The Influence of Plant Cover Structures on Water Fluxes in Agricultural</td>
<td>Review</td>
<td>Flood risk reduction</td>
<td>Tree (woodland) planting; pond creation</td>
<td>Can increase water retention &amp; reduce flood risk by creating shelterbelts, small mid-field ponds &amp;</td>
</tr>
<tr>
<td>Evidence</td>
<td>Type of Study</td>
<td>Service(s)</td>
<td>Intervention(s)</td>
<td>Findings</td>
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<tr>
<td>Thomas, H. &amp; Nisbet, T.R. (2006). An assessment of the impact of floodplain woodland on flood flows. Water &amp; Environment Journal 21:114-126</td>
<td>Model</td>
<td>Flood risk reduction</td>
<td>Tree (woodland) planting</td>
<td>Woodland along 2.2km bank; flood water storage increased by 71% &amp; increased flood peak travel time by 140 mins. 50 ha of woodland; flood water storage increased by 15% &amp; flood peak travel time increased by 30 mins.</td>
</tr>
<tr>
<td>Williams, J.R., Rose, S.C. &amp; Harris, G.L (1995). The impact on hydrology &amp; water quality of woodland &amp; set-aside establishment on lowland clay soils. Agriculture, Ecosystems &amp; Environment 54:215-222</td>
<td>Field study (Cambs)</td>
<td>Flood risk reduction</td>
<td>Buffer strips; tree (woodland) planting</td>
<td>Total runoff (surface and drainflow) from woodland was 20%-30% of flows from adjoining arable land.</td>
</tr>
</tbody>
</table>
### A.2.0 Literature Review for Interventions: Complementary Benefits

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Type of Study</th>
<th>Service(s)</th>
<th>Intervention(s)</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anon (2005). Sustainable Groundwater Management: A Handbook of best practice to reduce agricultural impacts on groundwater quality. A Water4All Project.</td>
<td>Model</td>
<td>Water quality</td>
<td>Land use changes; tree (woodland) planting; wetland creation</td>
<td>Average reduction in nitrate leaching was 33% across 86 catchments in Denmark between 1990-2003 as a result of land management measures.</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Title</td>
<td>Type</td>
<td>Keywords</td>
<td>Detail</td>
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<tr>
<td>Donnison, L. (2012)</td>
<td>Managing the Drought. Woodland Trust/Harper Adams University College</td>
<td>Review</td>
<td>Hazard regulation</td>
<td>Tree planting Tall shelterbelts of 40–60% porosity protect an area up to 30 times the height of the shelterbelt creating suitable shelter for crops. Shelterbelts can affect temperatures up to 10x distance of canopy height.</td>
</tr>
<tr>
<td>Reference</td>
<td>Method</td>
<td>Topic</td>
<td>Buffer</td>
<td>Buffer strips</td>
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<tr>
<td>Gilliam, J.W. (1994). Riparian Wetlands and Water Quality. Journal of Environmental Quality 23: 896-900.</td>
<td>Review</td>
<td>Water quality</td>
<td>Buffer strips</td>
<td>Multiple</td>
</tr>
<tr>
<td>Hall, J.M., Hanley, J.F. &amp; Eunos, A.R. (2012). The potential of tree planting to climate-proof high density residential areas in Manchester, UK. Landscape &amp; Urban Planning 104:410-417</td>
<td>Model</td>
<td>Climate regulation (temperature)</td>
<td>Tree planting</td>
<td>Computer modelling showed tree planting could reduce maximum surface temperature by between 0.5 oC and 2.3oC.</td>
</tr>
<tr>
<td>Jenerette, G.D. et al (2011).Ecosystem services and urban heat riskscape moderation: water, green spaces, and social inequality in Phoenix, USA.Ecological Applications 21:2637-2651</td>
<td>Model</td>
<td>Climate regulation (temperature)</td>
<td>Tree planting; land use changes</td>
<td>Vegetation provided nearly a 25°C surface cooling compared to bare soil on low-humidity summer days</td>
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<tr>
<td>Johnson, N. et al (2001).Developing markets for water services from forests: Issues and lessons for innovators, Forest Trends, USA.</td>
<td>Field study (France)</td>
<td>Water quality</td>
<td>Tree (woodland) planting</td>
<td>Reforestation in sensitive infiltration zones in France was a cost-effective measure to reduce polluted run-off and leaching.</td>
</tr>
<tr>
<td>Authors</td>
<td>Study Type</td>
<td>Topic</td>
<td>Method</td>
<td>Findings/Comments</td>
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<tr>
<td>Reference</td>
<td>Type</td>
<td>Water Quality</td>
<td>Climate Regulation</td>
<td>Land Use Changes</td>
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<tr>
<td>Newell Price, J.P. et al (2011). An Inventory of Mitigation Measures &amp; Guide to Their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions &amp; Ammonia Emissions from Agriculture.</td>
<td>Model &amp; Review</td>
<td>Water quality; air quality; climate regulation</td>
<td>Land use changes; buffer strips; infrastructure; changes to management practices</td>
<td>Different interventions can have a beneficial impact on water &amp; air quality and reduce emissions of greenhouse gases. However, some interventions could result in additional pollutant release.</td>
</tr>
<tr>
<td>Reference</td>
<td>Methodology</td>
<td>Topic</td>
<td>Intervention</td>
<td>Findings</td>
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<tr>
<td>Suggitt, A.J. (2011). Habitat microclimates drive fine-scale variation in extreme temperatures. Oikos 120:1-8</td>
<td>Field data (UK)</td>
<td>Climate regulation (temperature)</td>
<td>Tree planting; land use changes</td>
<td>Differences among grassland, heathland &amp; woodland habitats of &gt;5°C in monthly temperature maxima &amp; minima, &amp; of 10°C in thermal range</td>
</tr>
<tr>
<td>Weatherhead, E.K. &amp; Howden, N.J.K. (2009). The relationship between land use and surface water resources in the UK. Land Use Policy 26:243-250.</td>
<td>Review</td>
<td>Hazard regulation</td>
<td>Land use changes</td>
<td>To conserve usable water resources, land uses which increase evapotranspiration or rapid runoff should be discouraged, particularly in the south and east.</td>
</tr>
<tr>
<td>Williams, J.R., Rose, S.C. &amp; Harris, G.L (1995). The impact on hydrology and water quality of woodland and set-aside establishment on lowland clay soils. Agriculture, Ecosystems &amp; Environment 54:215-222</td>
<td>Field study (Cambridgeshire)</td>
<td>Water quality</td>
<td>Buffer strips; tree (woodland) planting</td>
<td>Nitrate concentrations were 20-70mg/l in run-off from arable but declined to 6mg/l from conversion to set-aside and &lt;5mg/l from planted woodland.</td>
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</tbody>
</table>
## A.3.0 Sediment Reductions from Intervention


<table>
<thead>
<tr>
<th>Intervention</th>
<th>Level of Sediment Reduction</th>
<th>Scale of Sediment Reduction</th>
<th>Other Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method 1A – Convert arable land to unfertilised and ungrazed grass</td>
<td>Moderate</td>
<td>By approx. 50%</td>
<td>High pollutant reduction; low CO2 reduction</td>
</tr>
<tr>
<td>Method 1B – Arable reversion to low fertiliser input extensive grazing</td>
<td>Moderate</td>
<td>By approx. 50%</td>
<td>Moderate pollutant reduction; some pollutant increases; low CO2 reduction</td>
</tr>
<tr>
<td>Method 2 – Convert arable/grassland to permanent woodlands</td>
<td>Moderate</td>
<td>By approx. 50%</td>
<td>Moderate to high pollutant reduction; low CO2 reduction</td>
</tr>
<tr>
<td>Method 3 – Convert land to biomass cropping (i.e. willow, poplar, miscanthus)</td>
<td>Moderate</td>
<td>By approx. 50%</td>
<td>Low to moderate pollutant reduction; low CO2 reduction</td>
</tr>
<tr>
<td>Method 4 – Establish cover crops in the autumn</td>
<td>Moderate</td>
<td>By 20-80%</td>
<td>Low to moderate pollutant reduction; minor increase in CO2</td>
</tr>
<tr>
<td>Method 5 – Early harvesting and establishment of crops in the autumn</td>
<td>Moderate</td>
<td>By 20-50%</td>
<td>No to low pollutant reduction; no impact on CO2</td>
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<tr>
<td>Method</td>
<td>Description</td>
<td>Impact</td>
<td>Reduction</td>
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<tr>
<td>Method 6</td>
<td>Cultivate land for crops in spring rather than autumn</td>
<td>Moderate</td>
<td>By 20-50%</td>
</tr>
<tr>
<td>Method 7</td>
<td>Adopt reduced cultivation systems</td>
<td>Moderate</td>
<td>Up to 60% on medium/heavy soils; up to 90% on light soils</td>
</tr>
<tr>
<td>Method 8</td>
<td>Cultivate compacted tillage soils</td>
<td>Moderate</td>
<td>By 10-50%</td>
</tr>
<tr>
<td>Method 9</td>
<td>Cultivate and drill across the slope</td>
<td>Moderate</td>
<td>By 40-80%</td>
</tr>
<tr>
<td>Method 10</td>
<td>Leave autumn seedbeds rough</td>
<td>Low</td>
<td>By 20%</td>
</tr>
<tr>
<td>Method 11</td>
<td>Manage over-winter tramlines</td>
<td>Moderate</td>
<td>By 30-50%</td>
</tr>
<tr>
<td>Method 12</td>
<td>Maintain and enhance soil organic matter levels</td>
<td>Low</td>
<td>Expected reduction over years</td>
</tr>
<tr>
<td>Method 13</td>
<td>Establish in-field grass buffer strips on tillage land</td>
<td>Moderate</td>
<td>By 20-80%</td>
</tr>
<tr>
<td>Method 14</td>
<td>Establish riparian buffer strips</td>
<td>Moderate</td>
<td>By 20-80%</td>
</tr>
<tr>
<td>Method 15</td>
<td>Loosen compacted soil layers in grassland fields</td>
<td>Moderate</td>
<td>By 10-50%</td>
</tr>
<tr>
<td>Method</td>
<td>Description</td>
<td>Effect</td>
<td>Reduction</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Method 16</td>
<td>Allow field drainage systems to deteriorate</td>
<td>Uncertain</td>
<td>By 10%</td>
</tr>
<tr>
<td>Method 17</td>
<td>Maintain/improve field drainage systems</td>
<td>Uncertain</td>
<td>Increase - by 10%</td>
</tr>
<tr>
<td>Method 18</td>
<td>Ditch management</td>
<td>Low</td>
<td>Increase - by 10%</td>
</tr>
<tr>
<td>Method 19</td>
<td>Make use of improved genetic resources in livestock</td>
<td>No effect</td>
<td>Reduced by up to 10% from mature management</td>
</tr>
<tr>
<td>Method 20</td>
<td>Use plants with improved nitrogen use efficiency</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 21</td>
<td>Fertiliser spreader calibration</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 22</td>
<td>Use a fertiliser recommendation system</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 23</td>
<td>Integrate fertiliser and manure nutrient supply</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 24</td>
<td>Reduce manufactured fertiliser application rates</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 25</td>
<td>Do not apply manufactured fertiliser to high-risk areas</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method</td>
<td>Description</td>
<td>Effect 1</td>
<td>Effect 2</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Method 26</td>
<td>Avoid spreading manufactured fertiliser to fields at high-risk times</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 27</td>
<td>Use manufactured fertiliser placement technologies</td>
<td>No effect</td>
<td>Reduction by up to 5%</td>
</tr>
<tr>
<td>Method 28</td>
<td>Use nitrification inhibitors</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 29</td>
<td>Replace urea fertiliser with another nitrogen form (e.g. ammonium nitrate)</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 30</td>
<td>Incorporate a urease inhibitor with urea fertiliser</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 31</td>
<td>Use clover in place of fertiliser nitrogen</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 32</td>
<td>Do not apply P fertiliser to high P index soils</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 33</td>
<td>Reduce dietary N and P intakes</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 34</td>
<td>Adopt phase feeding of livestock</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method</td>
<td>Description</td>
<td>Effect</td>
<td>Change in</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td>Method 35</td>
<td>Reduce the length of the grazing day/grazing season</td>
<td>Low</td>
<td>By up to 10%</td>
</tr>
<tr>
<td>Method 36</td>
<td>Extend the grazing season for cattle</td>
<td>Minor increase</td>
<td>Increase by up to 10%</td>
</tr>
<tr>
<td>Method 37</td>
<td>Reduce field stocking rates when soils are wet</td>
<td>Low</td>
<td>By up to 10%</td>
</tr>
<tr>
<td>Method 38</td>
<td>Move feeders at frequent intervals</td>
<td>Low</td>
<td>By up to 10%</td>
</tr>
<tr>
<td>Method 39</td>
<td>Construct water troughs with a firm but permeable base</td>
<td>Low</td>
<td>By up to 10%</td>
</tr>
<tr>
<td>Method 40</td>
<td>Low methane livestock feeds</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 41</td>
<td>Reduce overall stocking rates on livestock farms</td>
<td>Low</td>
<td>By up to 30%</td>
</tr>
<tr>
<td>Method 42</td>
<td>Increase scraping frequency in dairy cow cubicle housing</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 43</td>
<td>Additional targeted straw-bedding for cattle housing</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 44</td>
<td>Washing down dairy cow collecting yards</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method</td>
<td>Description</td>
<td>Effect on Pollutants</td>
<td>Effect on CO2</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Method 45</td>
<td>Outwintering of cattle on woodchip stand-off pads</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 46</td>
<td>Frequent removal of slurry from beneath-slatted storage in pig housing</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 47</td>
<td>Part-slatted floor design for pig housing</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 48</td>
<td>Install air-scrubbers or biotrickling filters to mechanically ventilated pig housing</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 49</td>
<td>Convert caged laying hen housing from deep-pit storage to belt manure removal</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 50</td>
<td>More frequent manure removal from laying hen housing with belt clean systems</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 51</td>
<td>In-house poultry manure drying</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 52</td>
<td>Increase the capacity of farm slurry (manure) stores to improve timing of slurry applications</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method</td>
<td>Description</td>
<td>Effect</td>
<td>Impact</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>53</td>
<td>Adopt batch storage of slurry</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>54</td>
<td>Install covers on slurry stores</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>55</td>
<td>Allow cattle slurry stores to develop a natural crust</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>56</td>
<td>Anaerobic digestion of livestock manures</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>57</td>
<td>Minimise the volume of dirty water (and slurry) produced</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>58</td>
<td>Adopt (batch) storage of solid manures</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>59</td>
<td>Compost solid manure</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>60</td>
<td>Site solid manure field heaps away from watercourses/field drains</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>61</td>
<td>Store solid manure heaps on an impermeable base and collect leachate</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method</td>
<td>Method Description</td>
<td>Effect</td>
<td>Uncertainty</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>Method 62</td>
<td>Cover solid manure stores with sheeting</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 63</td>
<td>Use liquid/solid manure separation techniques</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 64</td>
<td>Use poultry litter additives</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 65</td>
<td>Change from a slurry to solid manure handling system</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 66</td>
<td>Change from a solid manure to slurry handling system</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 67</td>
<td>Manure spreader calibration</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 68</td>
<td>Do not apply manure to high-risk areas</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 69</td>
<td>Do not spread slurry or poultry manure at high-risk times</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 70</td>
<td>Use slurry band spreading application techniques</td>
<td>No effect</td>
<td>None</td>
</tr>
<tr>
<td>Method 71 – Use slurry injection application techniques</td>
<td>No effect</td>
<td>None</td>
<td>High reduction in ammonia; low increase in nitrogen-related pollutants &amp; CO2</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-----------</td>
<td>------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Method 72 – Do not spread FYM to fields at high-risk times</td>
<td>No effect</td>
<td>None</td>
<td>Low reduction in pollutants; no impact on CO2</td>
</tr>
<tr>
<td>Method 73 – Incorporate manure into the soil</td>
<td>No effect</td>
<td>None</td>
<td>Low to moderate reduction in pollutants except minor increase to nitrogen-related pollutants; no impact on CO2</td>
</tr>
<tr>
<td>Method 74 – Transport manure to neighbouring farms</td>
<td>No effect</td>
<td>None</td>
<td>Moderate reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 75 – Incinerate poultry litter for energy recovery</td>
<td>No effect</td>
<td>None</td>
<td>Low to moderate reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 76 – Fence off rivers and streams from livestock</td>
<td>Low</td>
<td>By up to 5%</td>
<td>Low reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 77 – Construct bridges for livestock crossing rivers/streams</td>
<td>Low</td>
<td>By up to 5%</td>
<td>Low reduction in pollutants; minor increase in CO2 &amp; ammonia</td>
</tr>
<tr>
<td>Method 78 – Re-site gateways away from high-risk areas</td>
<td>Low</td>
<td>By up to 10%</td>
<td>Low reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 79 – Farm track management</td>
<td>Low</td>
<td>By up to 2%</td>
<td>Low reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 80 – Establish new hedges</td>
<td>Moderate</td>
<td>By up to 20%</td>
<td>Low reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 81 – Establish and maintain artificial wetlands</td>
<td>Moderate</td>
<td>By up to 80% from arable fields</td>
<td>Low reduction in pollutants; minor increases in CO2, ammonia &amp; methane</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td>----------------------------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td>Method 82 – Irrigate crops to achieve optimum yields</td>
<td>Minor increase</td>
<td>Increase by up to 20%</td>
<td>Low to moderate reduction in pollutants; minor increase in CO2</td>
</tr>
<tr>
<td>Method 83 – Establish tree shelter belts around livestock housing and slurry storage facilities</td>
<td>No effect</td>
<td>None</td>
<td>Low reduction in ammonia; no other impacts</td>
</tr>
</tbody>
</table>
A.4.0 Avon Wildlife Trust Consultancy
Presentation at Suppliers Workshop

Winford Brook
Catchment Management Measures

Catchment Projects

- Catchment Sensitive Farming
- Water companies
  - National Environment Programme/Catchment Based Approach
  - Upstream Thinking, SWW
  - Slowing the Flow at Pickering, Defra
- Bristol Avon Catchment Partnership/LNP
- Ongoing work with NE, EA, FWAG and others
Catchment Sensitive Farming

Purpose of interventions

• Tackle the source
• Slow the pathway
• Protect the receptor
Types of Intervention

- Land use changes or adaptations
- Capital works
- Changes to management
  - Livestock
  - Arable
  - Use of farm infrastructure

Land Use

- Tree/hedgerow planting at field boundaries
- Gapping up
- Buffer strips (trees/wet woodland/scrub/marsh/wet or rough grassland)
  - Focussed
  - High risk areas
- Create ponds, ditches or swales
- Woodland planting (catchment scale)
- Wetland creation e.g. meanders, washlands (catchment scale)
Land Use

Numerous small-scale examples
Example: River Dee Catchment Partnership
• Problems with sedimentation and diffuse pollution
• Created 80km buffer strips
• Installed 67 silt traps on feeder streams & ditches
• Surveys showed improvement
• 6m min effective width

Capital Works

Direct
• Fencing for watercourses
• Watercourse crossings
• Bank stabilisation
• Blocked culverts
• Road drainage soakaways
Capital Works

Indirect
- Fencing field boundaries and buffer strips
- Relocating field gates & gapping up
- Surfacing of tracks and gateways
- Improve drainage e.g. cross drains in tracks/yards
- Rainwater storage
- Roofing or covers for silage/slurry & livestock gathering areas
- Livestock troughs or drinking bays
- Relocation and design of sheep dips

Example: CSF in Somerset Levels and Moors Catchment
- 100 acres, 100 dairy cows
- Sediment and nutrient transfer to Dowlish Brook

Measures
- Resurfaced concrete areas to direct water
- Altered guttering
- Improved cow tracks with hardcore
- Fencing stream
- Free slurry and soil testing
Capital Works

Example: CSF in Somerset Levels and Moors Catchment
• 100 acres, 100 dairy cows
• Sediment and nutrient transfer to Dowlish Brook
Measures
• Resurfaced concrete areas to direct water
• Altered guttering
• Improved cow tracks with hardcore
• Fencing stream
• Free slurry and soil testing

Changes to Management

Arable
• Changes to arable methods
• Training and Awareness
• Nutrient Management Plans

Livestock
• Changes to stock management especially management of cattle trampling e.g. by seasonal electric fencing
• Training and awareness
• Nutrient Management Plans
Changes to Management

Use of infrastructure
• Reducing mud on trackways
• Seasonal use of high risk areas

Example: CSF South Petherton
• Arable
• Soil erosion caused muddy flooding on road
• Soil management plan
• Cross slope drilling
• Increase organic matter content
• In combination with capital works
Measures for Winford Brook Catchment

- Combination
- Will depend on:
  - Topography/slope
  - Soil type
  - Land use and stocking type
  - Extent, layout and use of infrastructure
  - Practicalities

Other Benefits

Example: Buffer strips could provide:

- Carbon uptake
- Biodiversity
- Noise reduction
- Shelter for livestock/drought protection

...as well as reducing sedimentation and flood risk reduction
Challenges

- Sufficient scale to solve problems
- Conflicts and dis-benefits
- Lack of quantitative/measurable data
- Cost:benefit analysis
- Identifying where to target
- Cost-effective
- Maximising multiple benefits

Next Steps

- Evidence assessment
- Geographic information
- Analysis of opportunities
- Discussion of practicalities and opportunities with landowners
- Funding/financing mechanisms
Questions
A.5.0 Eunomia’s Presentation at Workshop for Suppliers

Payments for Ecosystem Services

Introduction to the Concept

29th September 2014

Dr Chris Sherrington
Principal Consultant – Environmental Economics & Ecosystem Services

What are Ecosystem Services?

➢ Benefits we derive from the natural environment

   ○ Provision of:

      ○ Food, water, timber
What are Ecosystem Services?

- Benefits we derive from the natural environment
  - Regulation of:
    - Air quality, climate, flood risk

What are Ecosystem Services?

- Benefits we derive from the natural environment
  - Cultural services:
    - Recreation, tourism, education
What are Ecosystem Services?

- Benefits we derive from the natural environment
  - Supporting services:
    - Soil formation, nutrient cycling

Payments for Ecosystem Services
Payments for Ecosystem Services

Principles

- **Voluntary**
  - Stakeholders enter into PES agreements on a voluntary basis

- **Additionality**
  - Payments are made for actions over-and-above those which land or resource managers would generally be expected to undertake

Payments for Ecosystem Services

- Business-as-usual - Land managed primarily for agricultural production
- Private returns from agriculture
- Additional external benefits
- Ecosystem service benefits (e.g. flood risk management, water quality regulation, habitat for wildlife)
- Payments for ecosystem services - Land managed to provide multiple ecosystem services through wetland restoration
- Payment range (£)
- Maximum theoretical payment
- Minimum payment required to cover private returns foregone
Payments Approaches

- **Upfront payment**
  - Grant
    - Fixed rate e.g. 50%
    - Contract (10-25 years)
    - Covenant to the land deeds for larger long-term investments

Payments Approaches

- **Upfront payment**
  - Reverse Auction

![](chart.png)
Payments Approaches

- Upfront payment
  - Reverse Auction

![Graph showing aggregate grant requests over rounds with a threshold of £360,000.](image)

Payments Approaches

- Upfront payment
  - Reverse Auction

![Graph showing Grant Request (Funded) and Grant Request (Not Funded) over participating farmers' final grant requests.](image)
Key Questions for Landowners and Land Managers to Consider

➢ Payment
  o What is the minimum level of payment you would be willing to accept?
  o What payment terms would you expect?
    o Frontloaded or annual payments?
  o Would you part-fund certain interventions?

➢ Timescale
  o Over what timescale are you willing to deliver ecosystem service benefits?
    o What length of contract would you sign up to?
  o What might disrupt your capacity to deliver the necessary interventions?
A.6.0 Lessons from the Fowey River Improvement Auction

A particularly useful source of information was the Final Report from the University of East Anglia (UEA) and the Westcountry Rivers Trust (WRT) on the Fowey River Improvement Auction. The aim of the PES pilot was to fund capital investments on farms in order to improve water quality in the River Fowey in Cornwall.

The PES scheme was part of South West Water’s (SWW) Upstream Thinking Initiative. Part of Upstream Thinking involved WRT’s expert farm advisors visiting farms within specific catchments to identify capital projects that might be funded by SWW. Where opportunities were identified, farmers were offered 50% of the costs of the capital investment.

In the case of the Fowey catchment, WRT teamed up with UEA to explore whether an alternative PES mechanism could be applied, and looking to answer two key questions:

1. Could an auction mechanism be used to distribute funds to farmers?; and
2. Could other purchasers be encouraged to contribute funds to be distributed through the PES scheme?

The PES pilot demonstrated that an auction-based PES can successfully distribute funds to farmers for investment in capital items that improve water quality. The auction also significantly increases the efficiency with which funds are allocated to projects, i.e. the auction offers greater environmental improvements per pound spent than a grant scheme paying a fixed 50% of the costs of capital investments. The researchers identified that the Fowey River Improvement Auction delivered between 20% and 40% better value for money than the fixed grant alternative.

In addition, it is noted that an auction mechanism that encourages farmers to propose their own projects offers savings in administration costs (through the avoided requirement for advisors to visit farms) and extends the possibility of participating in the scheme to a wider number of farmers. By contrast, however, an advisor-led mechanism was thought to have advantages in respect of simplifying participation for farmers and allowing accurate definition of the specific projects that merit funding. It is suggested, therefore, by the authors of the report, that the two mechanisms are used in different situations, as shown in Box A7.1. The authors further note that ‘hybrid’ schemes that incorporate elements of both an auction and the on-site intervention of an expert advisor may be appropriate in many circumstances.

The second key objective, and one that is shared with the Winford Brook PES pilot, was to explore whether organisations other than SWW could be encouraged to contribute

funding. This objective, of establishing a multiple-purchaser PES mechanism, was not, however, achieved within the Fowey pilot. The authors subsequently undertook a series of theoretical and experimental investigations, exploring some of the issues in developing PES mechanisms that allow for multiple purchasers. The main finding of this was that:

Without specific attention to how such a mechanism overcomes incentives to free-ride it is likely that participation will be limited to the single purchaser who stands to gain most from the actions being funded through the scheme.

The authors suggest that one way of addressing this is to create an institution within which potential purchasers can make binding commitments to contributions, decided upon in a process of negotiation. This is the intended aim of the Natural Capital Trust (NCT) within the Winford Brook PES Pilot.

**Box A 7.1: Advisor-Led and Auction-Based PES Mechanisms**

The evidence from the Fowey River Improvement Auction PES Pilot suggests that:

- **Advisor-led PES Mechanisms** are to be preferred when an advisor’s expert judgement is needed on the ground to distinguish between diverse projects whose benefits differ according to site-specific considerations. In addition, advisor led mechanisms are likely to fare best where the scale of the scheme is small and where advisors have good local knowledge with which to target farms likely to yield good investment opportunities.

- **Auction-based PES Mechanisms** are to be preferred in distributing funds when the benefits of investment can be estimated reasonably accurately without site-specific knowledge. Auctions also have a considerable advantage in that they scale-up with relatively little additional cost. Accordingly, an auction might be preferred for large scale schemes, particularly where there is little detailed local knowledge of a region through which farms can be effectively targeted.


### A.6.1 PES Mechanism Design

The UEA/WRT report includes a diagram which illustrates some of the issues in PES mechanism design, reproduced here as Figure A 1-1.

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As shown in Figure A 1-1, the challenges facing the designer of a PES mechanism include:

- Which actions should be prioritised for payment through the scheme:
  - This will depend upon the extent to which each action is likely to deliver improvements in ecosystem service flow (for which there is an identified buyer), which will in turn depend upon a number of factors such as:
    - The location in which the action is undertaken; and
    - The current conditions at that location.
- How to monitor actions that deliver ecosystem service flows, to ensure that they have been, or are being performed;
- How to select which of the numerous potential providers to target with funding;
- How much different providers should be paid for undertaking actions, whether individually negotiated, or established through a competitive process via a reverse auction;
- Whether payments should simply be for actions or linked to the outcomes of actions; and
- Where there is more than one beneficiary, how to design a mechanism to elicit contributions from all, or a number, of beneficiaries.
A.6.2 Auction-Based PES Mechanism

The auction-based mechanism employed in the Fowey contrasted with the advisor-led mechanism in a number of ways:

1. In an auction mechanism, all farmers are contacted and asked to propose projects for funding and indicate the grant required to undertake the work. Projects are then assessed simultaneously, and funding awarded to those offering best value-for-money;
2. The auction process places far greater emphasis on farmers to initiate participation and propose capital investment projects; and
3. Under the auction process, the level of grant is not fixed but determined by competitive pressures.

The approach to designing the auction adhered to three key principles:

- **Fairness** – The auction has to improve river water quality in a way that is both acceptable to farmers and deliver value for money for SWW. The auction therefore had to be designed to:
  - Encourage farmers to enter credible bids that provide them with reasonable but not inflated returns;
  - Select only those bids offering best ‘value for money’ in terms of the trade-off between bid cost and the level of water quality improvement delivered
- **Truthfulness** – The auction must not knowingly provide respondents with false or deliberately misleading information; and
- **Simplicity** – Since none of the participating farmers will be familiar with the auction format, the auction must, where possible, err on the side of design simplicity.

A.6.3 Key Design Decisions

The key design decisions faced by the project team in relation to the Fowey auction are outlined in the sections below.

A.6.3.1 Action or Outcome-Based Payments

An *outcome-based* design would mean that the payment the farmer received would be conditional on the levels of improvement in water quality resulting from that farmer’s actions. Such a design would be advantageous for SWW in that they would only pay for verified improvements in water quality, however:

- The technology for monitoring the independent contribution of one farmer to changes in water quality was not available in the River Fowey; and
- Water pollution outcomes are highly variable depending not only on farmer actions but also on a variety of stochastic natural processes. Therefore, farmers would have only limited control over the levels of payments they might receive. If
payments were unpredictable, it is thought likely that farmer participation would be discouraged.

Therefore, an outcome-based design was rejected as being impractical in the case of the Fowey. Farmers instead received payments related to their commitment to undertake certain actions (e.g. installing capital items, or changing management practices). Such an actions-based auction means that:

- Monitoring is simplified since the object in need of verification is observable (e.g. installation of capital item or changes in management practice); and
- Payments are non-stochastic, which greatly reduces the risk perceived by the farmer in taking part in the auction.

However, an actions based auction has two important implications:

- **Outcome risk** – SWW will pay farmers for actions that have the potential to deliver water quality improvements, which is riskier for SWW in that payments are made independent of the level of improvement in water quality actually realised.
- **Additionality risk** – There is a risk that farmers might bid in the auction for actions that they planned to do irrespective of payment from SWW. Such payments would clearly yield no improvement in water quality relative to the counterfactual.

### A.6.3.2 Capital or Operational Actions

Farmers in the Fowey catchment could undertake two qualitatively different types of actions to improve water quality, namely:

- **Capital Investments** – Farmers could install certain types of on-farm capital, e.g. by increasing slurry storage or erecting fencing to keep stock out of rivers; or
- **Operational Activities** – Farmers could change their management practices, e.g. by not cultivating river banks to create buffer strips or by reducing fertiliser and pesticide applications

In terms of the improvements that they could deliver, neither capital nor operational actions were seen as inherently more advantageous. However, the Fowey River Improvement Auction was constrained in that payments made by SWW had to come from their Capital Expenditure budget, and hence had to be linked to the purchase of (non-mobile) items of farm capital.

Notwithstanding this constraint, the UEA/WRT team had considered, at an early stage of the pilot, a design in which the focus of the bids was for commitments to undertake operational activities (particularly limiting pesticide and fertiliser use). However, the operational activities design was ruled out when it became clear that such an auction would likely encourage adverse selection. Farming practices in the Fowey are quite diverse (some dairy farmers, arable farmers, organic farmers etc.), and of those some will already be doing more to control water pollution than others. Therefore, for any particular operational commitment there would be a significant proportion of farmers for whom making that commitment entailed little or no cost.
For example, committing not to use the harmful pesticides used by arable farmers is no cost to dairy farmers. Likewise, dealing with slurry properly is no cost to arable farmers. This means that the lowest bids in the auction would be received from farmers for whom the commitments meant no change in farming practices. Without definitive information on each bidders farming type, and t associated complex rules as to who is entitled to bid on which operational commitment, then those low bids would likely be selected for funding despite offering little in terms of water quality improvements.

By contrast, a capital-focused auction provided far greater certainty over additionality. Relative to operational activities, it would be far easier to:

- Verify the need for a capital item;
- Confirm that the item was not currently on a farm;
- Check that it had been installed; and
- Monitor its ongoing existence.

In terms of the number of possible actions, it is observed by UEA/WRT that at auction format for a PES mechanism is:

> much more readily amenable to a situation in which the focus is constrained to one or a few well-defined actions (e.g. capital investments) by the provider.

In the Fowey River Improvement Auction, the lack of precision in the definition of the items made it considerably more difficult to make accurate assessments of the relative merits of different bids.

While payment was constrained to investments in capital items, a novel feature of the auction was that it allowed farmers to augment their bids by committing to take on one or more of three Farm Management Packages for a duration of 5 years. These packages focused on practices that improved nutrient, pesticide and watercourse management respectively, providing a means by which operational activities could be tied in to an auction focused on the installation of capital items.

### A.6.3.3 Monitoring and Enforcement

Having the auction focusing primarily on capital items means that monitoring of compliance is less problematic than it otherwise might be. Indeed, payment can be withheld until documentary evidence is presented proving that capital items funded through the scheme have been properly installed or constructed.

In the Fowey River Improvement Auction, all farmers were required to sign a contract with WRT and SWW before payments under the scheme could be made. Those contracts stipulated that, for the duration of the contract, the capital items purchased would have to be used for the agreed purpose, be properly maintained, and insured against damage.

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The contract length depended upon the particular capital item – 25 years for substantial longer-lived investments (e.g. slurry, roofing) and 10 years for shorter-lasting capital items (e.g. fencing and concreting).

Farmers committing to one or more farm management packages would have those commitments added as a clause to the contract. Apart from this legal stipulation, however, no further mechanisms were created to ensure on-going compliance with the operational commitments. To ensure SWW’s investments would be maintained for the duration of the contract, payments of over £5,000 would require a covenant being added to the land deeds of the farm property, requiring future land owners and/or land managers to abide by the terms of the contract.

A.6.3.4 Budget

The budget for the auction had been allocated for investment in the Fowey catchment as a result of discussions between WRST and SWW at the start of the Upstream Thinking initiative, prior to considering an auction based approach. The project team discussed whether the available budget, of £360,000, should be revealed to participants. On the one hand it was argued that revealing the budget might deter participation if farmers felt that the overall amount was too small for them to be in with a chance of obtaining funds. The counter-argument was that revealing the budget would discourage inflated bids as farmers would be aware that available funding was constrained, and this argument prevailed.

A.6.3.5 Bidding Rules

The Fowey River Improvement Auction allowed for bids of up to 100% of costs. This risked the funds being allocated to a small number of farmers, so a cap of £50,000 was placed on grants paid out from the auction.

A.6.3.6 Coverage

It was agreed that all farmers active in the Fowey catchment (with the exception of those on very small holdings (below 15ha in size)) would be invited to bid in the auction.

A.6.3.7 Sealed or Open Bids

In line with the majority of PES auction previously implemented (e.g. the EcoMarket Tender scheme in Victoria, Australia, and the Georgia irrigation auctions in the United States), the auction in the Fowey invited sealed bids. This was thought to promote participation, reduce collusion and make it more difficult to bid strategically.
A.6.3.8 Uniform or Discriminatory Pricing

There are two different price formats for auction with differing incentive properties: 

- **Uniform price** auctions pay a fixed price to all successful participants, where that price is usually determined by the bid of the marginal bidder. This format encourages bidders to truthfully reveal the minimum amount they would need to be paid to take a particular action.
- **Discriminatory price** auctions pay successful participants exactly what they bid. This format encourages bidders to ‘shade up’ their offers, particularly where they believe they have a competitive advantage and can deliver the action at relatively lower costs.

In the case of the Fowey it was decided to run the auction as a discriminatory price auction, for the following reasons:

- **Additionality risk** – Discriminatory pricing provides some protection against additionality risk. In a uniform price auction, farmers for whom the cost of undertaking some action is low (perhaps because they intended taking that action already) might get a high payment despite offering very little additional benefit. Alternatively, provided farmers face difficulty in second guessing the value of their action to SWW, it was felt that discriminatory pricing should help encourage reasonably low bids from these farmers.
- **Transparency** – With discriminatory pricing farmers either get what they requested or nothing. UEA/WRT expected that farmers would find the auction mechanism quite unfamiliar, so it was felt that this would be easier to understand than a uniform price auction. Specifically, the amount a farmer would get paid if successful in the auction would be clear from the moment they bid. There would be no disappointment that might arise if the uniform price turns out to be lower than anticipated.

A.6.3.9 Bidding Method

Auction bids could be received by post or through a website, with the latter providing administrative advantages in that bids could be pre-checked by the software for completeness and accuracy. However, it turned out that the vast majority of bids arrived by post.

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A.6.3.10 Bid Selection Rule

Success in the auction was not determined simply by selecting those making the lowest grant request rate (i.e. those asking for the smallest percentage of the costs of the proposed works). Rather, each bid was given an environmental improvement score according to how greatly the proposed project would contribute to improvements in water quality. Bids were therefore evaluated on the basis of a value-for-money measure calculated by dividing the environmental improvement score for a bid by the quantity of money requested as a grant from SWW.

As noted in Section A.6.3.2, farmers were able to augment their bids by committing to take on one or more Farm Management Packages, for which they would receive extra points on their environmental improvement score, thereby increasing the competitiveness of their bid.

The original intention in the Fowey had been to use spatially explicit models to devise the environmental improvement scores, but it became evident that no model existed with the sophistication to accurately score the detailed projects being proposed by different farmers in the auction. Instead, an expert-determined scoring method was developed with the help of the WRT’s team of experienced farm advisors. The input of the farm advisors was formalised into a formula that returned an environmental score for any proposed project. Amongst other things the formula took account of:

- The particular capital works proposed in the bid;
- The farm management packages included in the bid;
- Stocking densities on the farm;
- Crops grown on the farm; and
- Farm location in the catchment.

It is noted by UEA/WRT that the biggest single challenge in implementing the auction was in designing a scoring method that allowed comparison across the diverse range of bids received. The authors further note that it would have been helpful had the expert input of WRT’s advisors been complemented by with more sophisticated tools, perhaps based on hydrological modelling of the catchment, though that was not possible within the timescale of the project.

A.6.3.11 Reserve ‘Price’

A minimum ‘value-for-money’ score was determined (where ‘value-for-money’ is based, as described above, as environmental improvement score divided by grant request). Given the uncertainties inherent in scoring bids based solely on the limited information provided by farmers in their bids (and not by a thorough assessment as part of a farm visit), that minimum value for money threshold was set reasonably high at a figure of 0.5 (the units have no clear interpretation due to the arbitrary scaling of the environmental improvement score).

It was understood that holding the minimum threshold at a high level might mean that the entire budget was not allocated through the auction mechanism. That possible
outcome was seen as desirable by WRT as it left them with the opportunity to allocate some funds through an advisor-led mechanism if the auction failed to deliver projects of a suitable quality.

A.6.3.12 Number of Bidding Rounds

Rather than a one-shot auction, it was decided that the auction should run over three two-week rounds (similar to the format employed in the Georgia irrigation auctions). The rationale centred on a desire to provide feedback to farmers as to the likelihood of their bid receiving funding. At the end of each round bidders were sent feedback on whether their bid was of high, medium or low interest, as follows:

- **High interest** bids were those that had a ‘value-for-money’ score above 1 (twice the minimum threshold);
- **Medium interest** bids were those that had a ‘value-for-money’ score between 0.25 and 1; and
- **Low interest** bids were those that had a ‘value-for-money’ score below 0.25

For bidders in the medium and low interest categories, the feedback sent between rounds detailed a number of ways in which they could improve their bid so as to move it up to the next interest category. Among those suggestions was an indication of how much the grant request would need to be reduced to move up an interest category. Bidders were also informed as to how committing to the farm management packages would improve their bid’s competitiveness.

It was anticipated that farmers might find it difficult to judge where to pitch their bid in order to be competitive, and by providing feedback between rounds it was hoped that farmers would become progressively better informed as to the value-for-money required to be successful.

Furthermore, having multiple rounds gave a justifiable reason for the project team to contact farmers that had not yet participated in the auction. As the auction progressed, letters sent to non-participants related the fact that other farmers were putting themselves in a position to get funding through the scheme, in an effort to encourage increased participation.

A.6.3.13 Participation Fee

By way of inducement to participate in the auction, farmers were offered a participation fee if they entered at least one bid in the auction and participated in the post-auction survey.

A.6.3.14 Projects Identified

Visits to successful bidders’ farms revealed that the projects the farmers had identified for investment would all have been identified by a farm advisor as worthy of funding in an
advisor-led scheme. However, those same visits revealed a large number of additional issues that had not been addressed through the projects included in the farmers’ bids. Indeed, the projects identified by the farmers themselves represented only 54% of the capital items that would have been identified by a farm advisor in an advisor-led scheme. The evidence suggests that the omission of these additional investments from farmers’ bids is usually because the farm business priorities which motivate the farmer do not perfectly coalesce with the environmental objectives of the scheme.

In summary the authors feel that the auction-based mechanism has been reasonably successful in identifying capital investments that will improve water quality without the need for detailed intervention from farm advisors. At the same time, the advisor-led system has the advantage of being able to identify all projects and prioritise these from the perspective of the funder rather than the farm business. Likewise, using a remotely calculated formula to judge the benefits of a project may do a poor job in picking up the specific local conditions that determine the value of a project to the funder.

In terms of identifying appropriate investment opportunities, the authors suggest that an auction-based mechanism will fare relatively well when the range of projects under consideration is small, and the benefits of those projects are less dependent on highly specific features of the local environment in which they are executed. By contrast, where projects are diverse in nature, and the benefits they generate are highly site-specific, the identification of appropriate projects may be better achieved through the on-site inspection allowed by an advisor-led system.

A.6.4 Conclusions on PES Mechanism Design

The Fowey project team consider that auction-based and advisor-based mechanisms are best employed in different situations:

- **Advisor-led PES Mechanisms** - The strength of this mechanism is the ability of the farm advisor to identify the exact set of projects requiring investment on each farm visited. That ability is likely to be needed most when there are a large variety of different investments that might yield ecosystem service benefits and where the size of those benefits differ across farms according to site-specific considerations. However, superior identification of projects comes at a cost, particularly in advisor time. Furthermore, an entirely advisor-led approach limits the number of farms that can be approached to participate in the scheme. Accordingly, advisor-led mechanisms are likely to fare best where:
  - The scale of the scheme is relatively small; and
  - Advisors have good local knowledge with which to target farms that are likely to yield good investment opportunities.

- **Auction-based PES Mechanisms** – The primary strength of the auction-based mechanism is that it has the potential to deliver funders with better value-for-money. That result, however, depends primarily on:
  - how accurately the environmental benefits of projects can be identified without the on-site intervention of a farm advisor; and
how well competitive pressures in an auction act to drive down the level of grant requests from farmers. Accordingly, auction mechanisms are likely to fare best when:
- there are a large number of farmers competing for funding; and
- where the benefits of projects can be estimated reasonably accurately without detailed site-specific knowledge.

In addition, auction-based mechanisms offer the possibility of greatly widening participation, and since responsibilities for project identification and bid formulation are passed over to the farmer, the auction has lower costs of administration. As the scale of a scheme increases these features of allowing wide participation while maintaining low administrative costs are likely to greatly favour auction-based mechanisms.

The Winford Brook catchment is ten times smaller (at 17km²) than the Fowey catchment (at 177.5km²).\textsuperscript{52} Given the issues noted above, this would seem to suggest that an advisor-led approach would be more suitable.

Also, connectivity is key, i.e. the links between sediment sources and pathways, and these can more readily be identified by an expert advisor.

\textsuperscript{52} See \url{http://www.cornwallriversproject.org.uk/education/ed_cd/background/cornish_rivers/b04g.htm}
A.7.0 Walkover Survey

A.7.1 Approach

The main objective of the survey was to identify the extent and causes of diffuse pollution and in particular diffuse sediment pollutions sources. This was achieved as follows:

- Where access allowed, a walkover survey of the full extent of the river was used to identify potential sources of diffuse urban pollution. Sources were graded according to their severity and extent of impact. An attempt was made to trace the sources of the pollution;
- Wet weather sampling was used to verify the findings of the walkover survey. This provided a greater evidence base when evaluating the severity of identified pollution sources; and
- Based on the findings of the surveys, a number of measures are proposed which will help to mitigate the impact of diffuse catchment pollution and sediment sources.
The survey involved a team of trained field scientists who undertook standardised and systematic walkover surveys along continuous reaches of the Winford Brook catchment. Where critical sources of runoff, sediment or nutrients were found entering the
watercourse, a grade and category were assigned, based on the observed severity and source type respectively.

Impacts were graded on a scale of Grade 1 to Grade 3, with Grade 1 being the most severe, as shown in Table A7-2.

**Table A7-2: Definition of Grades as Classified in Walkover Survey**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Observed (or potential for) widespread propagation of sediment, polluted discharge or effluent, which may cause localised and widespread impacts more than 100m from the point or diffuse source.</td>
</tr>
<tr>
<td>2</td>
<td>Observed (or potential for) local deposition of in-stream sediment or effluent release which may cause noticeable impacts within 100m of the point or diffuse source.</td>
</tr>
<tr>
<td>3</td>
<td>Minimal observed (or potential for) deposition of in-stream sediment or effluent with very localised effects in the immediate vicinity of the input.</td>
</tr>
</tbody>
</table>

**A.7.2 Diffuse Pollution Sources**

Diffuse pollution locations within the catchment are shown in Figure A7-1. The report identifies that livestock causes were responsible for two of the nine Grade 1 sources (one being overland runoff associated with livestock, and the other classified as farmyard runoff. Conduits were responsible for the other seven Grade 1 sources (six of these being either from track or road runoff and one from a drainage ditch).

In total, 20 examples of road runoff were identified in the walkover survey. By mapping the potential road pathways based on identified diffuse pollution points and observation in the catchment, it was shown that the total effective length of drainage channel within the catchment increases by 50%.

Track runoff was identified in seven locations in total, with the two main causes being regular use by heavy vehicle and the movement of cattle over narrow tracks or bridges.
A.7.3 Mitigation Measures

The following mitigation measures were proposed.
A.7.3.1 Livestock Poaching

The report identifies that the most effective way to mitigate the impact of poaching is, to the extent possible, to prevent unrestricted access of livestock to the river and river banks. This can be achieved through the construction of fences and designated watering locations or ‘cattle drinkers’. These watering locations limit the area of river that can be reached by livestock. Although some nutrient and sediment contributions will still result from the use of prescribed watering locations, the size of the impact will be reduced considerably.

A.7.3.2 Track Runoff

The report recommends that the first option for the prevention of track runoff would be to change the use of the tracks, avoiding their use following rain events or during winter months. While this may be possible in some areas, due to their current regular use it is likely that they provide necessary access to agricultural land. An alternative would be the addition of hard standing material along the tracks which will help to prevent erosion and therefore reduce the input of sediment into watercourses.

A.7.3.3 Road Runoff

In terms of reducing road runoff, the report recommends that it is important to improve the road drainage in locations where it has been identified as a problem. More specifically, it is important to design a drainage system that both increases the lag time between agricultural fields and the streams and provides suitable locations where pollutants and fine sediments can be deposited and stored. For example, low gradient ditches containing some low level vegetation, such as grasses, would help to reduce the velocity of runoff and provide a form of filtration.

The report further notes that in some locations, particularly those identified as Grade 1 severity, the volume of runoff along the roads would far exceed the limits of most viable road drainage systems. In these examples it may be suitable to divert the runoff away from the road, increasing the distance required to travel before reaching a watercourse. Alternatively, stilling wells/ponds could be constructed in locations where road runoff and pollutant discharge is considered to be very severe.
A.8.0 Report relating to the legal structure for a multi-beneficiary PES scheme

1 Background

1.1 This report relates to the Defra-funded pilot research project for Payments for Ecosystem Services (PES) being conducted at the Winford Brook catchment.

1.2 The pilot project involves engagement with stakeholders – including, amongst others, Bristol Water, Wessex Water, local authorities, the West of England Local Enterprise Partnership, the Environment Agency and Avon Wildlife Trust - to investigate opportunities, explore the appropriate financing mechanisms, and develop a practical, cost-effective and highly replicable approach to multiple-benefit, multi-beneficiary PES schemes, using the Winford Brook catchment to the south of Bristol as a test-bed.

1.3 A typical model for a PES scheme involves payments for the PES being made by only one organisation. However, an alternative model for a PES scheme involves funding from multiple organisations (the Beneficiaries) with the intention of ultimately delivering a range of benefits to the Beneficiaries (e.g. flood risk reduction).

1.4 The purpose of this report is to advise on the legal structure to facilitate the delivery of a multiple-benefit, multi-Beneficiary PES scheme. In particular we have been asked to advise on an effective and efficient legal structure through which the Beneficiaries can work together, pool their funds with the aim of achieving common or complementary objectives.

1.5 The Beneficiaries’ funding is used to commission land interventions (e.g. tree planting, sediment ponds, improved drainage) which are intended to deliver the benefits. There are already well established legal mechanisms for commissioning land interventions from land owners/occupiers (Providers). We have not been asked to provide advice on the legal mechanisms for imposing obligations on the Providers, except to the extent relevant to the following specific queries:

1.5.1 if/how obligations could be imposed on the Providers to require the maintenance of the interventions in perpetuity; and

1.5.2 what kind of structure and provisions would be required to accommodate a “backloading” of payments to Providers, whereby a proportion of the overall payment is retained, to be paid to the Provider at a later date.

1.6 This report does not consider any potential impact of public procurement law or State aid law on the proposed legal structures.

1.7 We understand that this report will be published by DEFRA as a case study. We hope it acts as a useful initial guide. Participants and stakeholders will need to take legal advice in relation to their own PES proposals or projects.

2 Use of an Intermediary to act on behalf of the Beneficiaries

2.1 One of the key objectives in designing a legal structure for a multi-beneficiary PES scheme is to create an effective and efficient method for pooling the financial contributions of a wide range Beneficiaries, which will then be used to commission the interventions.

2.2 A simple way of achieving this would be through establishing a pooled fund, with a governance committee, composed of representatives of the Beneficiaries, to decide which interventions are funded.

2.3 Having established the fund and decided on the appropriate interventions, a contract would need to be entered with a Provider by or on behalf of the Beneficiaries in order to
impose obligations on the Provider to deliver the intervention. Broadly speaking, there are two contractual structures that could be adopted by the Beneficiaries to contract with a Provider:

**Lead Beneficiary model**

2.3.1 Under this model, one of the Beneficiaries (the **Lead Beneficiary**) acts as the lead on behalf of all the Beneficiaries. The Lead Beneficiary enters the contract with the Provider. There would be a separate contract between the Beneficiaries requiring, amongst other things, that each Beneficiary makes the agreed financial contributions to the Lead. The Lead Beneficiary would have the primary legal responsibility for paying the Provider and managing the contract with the Provider.

2.3.2 An alternative approach, considered below, is to establish a separate legal entity to carry out this role on behalf of the Beneficiaries.

**Intermediary model**

2.3.3 This model involves the Beneficiaries establishing a separate legal entity to act as an intermediary (the **Intermediary**) on behalf of all the Beneficiaries. The Beneficiaries pay their financial contributions to the Intermediary and the Intermediary enters the contract with the Provider on behalf of the Beneficiaries. This model brings a number of advantages over the Lead Beneficiary model.

2.3.4 Most significantly, this approach provides a mechanism for sharing responsibilities between the Beneficiaries, so that there is no single Beneficiary that assumes the primary legal liability and the administrative responsibilities under the contract with the Provider.

2.3.5 In addition, although a Lead Beneficiary model may be suitable for delivering an initial tranche of interventions, it is more static and less flexible than the Intermediary model. The potential flexibility of the governance arrangements in the Intermediary model allows for more suitable structure for decision-making in relation to future interventions or PES schemes.

2.4 We recommend that the Intermediary model is the most appropriate for delivering a multi-beneficiary PES scheme.

2.5 We have attached a chart at the Appendix to this report that sets out a legal structure that could be adopted under the Intermediary model. Further explanation regarding some of the main legal issues and relationships that would be relevant to this structure is set out in the remainder of this report.

3 **The legal form of the Intermediary**

3.1 The Intermediary could take a wide range of legal forms. The scope of this report does not include a detailed analysis of all these options. However, we consider that the two most suitable options are a company limited by shares (**CLS**) or a limited liability partnership (**LLP**). Each of these options has the following characteristics, which would be desirable for a multi-beneficiary PES scheme:

3.1.1 The entity has its own legal personality that is separate from the Beneficiaries, so it can enter contracts in its own name.

3.1.2 The liability of each of the Beneficiaries would be limited, in that, generally, the Beneficiaries would not need to meet the Intermediary's liabilities. This enables the Beneficiaries to ring fence their exposure to financial risk in the PES scheme.

3.1.3 There is flexibility regarding the governance structure for decision-making by the Beneficiaries.

3.1.4 It is relatively straightforward to add new Beneficiaries to the structure, which enables the possibility of additional financial contributions to the PES scheme.
over time. It is also relatively straightforward for a Beneficiary to exit the structure.

3.2 In addition, each of these legal forms is capable of performing other functions, which although not necessarily relevant at the commencement of the PES scheme, may become desirable over time. In particular, the following functions could be performed by either a CLS or LLP:

3.2.1 Commissioning or carrying out feasibility studies in relation to potential PES schemes including gathering information on potential benefits.

3.2.2 Running workshops and engaging with potential Providers or developers to promote innovative approaches and to explain the concepts and opportunities of PES.

3.2.3 Leveraging in other sources of funds/grants or through obtaining commercial loans based on the credit rating of the Beneficiaries.

3.3 Although either a CLS or an LLP would be a suitable legal form for the Intermediary, we consider that the most appropriate model is an LLP. The main reasons for this are as follows:

3.3.1 There is greater scope for flexibility in the governance arrangements of an LLP, thus making it easier to accommodate the relatively novel and bespoke nature of a multi-beneficiary PES scheme. Although a suitable governance arrangement could also be achieved through a CLS, the basic structure and operation of a CLS does not naturally lend itself to a multi-beneficiary PES scheme, which would therefore complicate the drafting of the governance documents.

3.3.2 An LLP is more straightforward to establish in terms of the required documentation and process. The only document that is required is the LLP Agreement – see paragraph 4 below for a summary of the main provisions that would be included in this document for the purposes of a multi-beneficiary PES scheme. However, it should be noted that, regardless of whether an LLP or a CLS is used, bespoke drafting would be required to create an appropriate governance structure that takes account of the relatively novel nature of the multi-beneficiary PES scheme.

3.4 It should be noted that section 235 of the Financial Services and Markets Act 2000 (FMSA) may apply as a result of the pooling of the Beneficiaries’ funds. This could potentially apply regardless of which form of legal form is adopted for the Intermediary. Under this legislation the Intermediary could be classified as a Collective Investment Scheme (CIS). If this is the case the CIS must be set up, operated and wound up by an authorised person in accordance with the formalities of the FMSA. The potential application of the FMSA and any implications for the Intermediary are outside the scope of this report.

3.5 The tax position in relation to the legal form of the Intermediary would need to be considered. Although further consideration would be required in respect of the specific circumstances of any project, the general position regarding the tax treatment of an LLP or CLS is set out below. This general position explains, amongst other things, the tax position in respect of any profit that may be generated by the Intermediary. However, for the avoidance of doubt, it is not anticipated that any profit will be generated by the Intermediary through the pilot project at Winford Brook.

3.6 The principal advantage of using an LLP rather than a CLS is the way that it is treated from a UK tax perspective.

3.7 For the purposes of UK corporation tax, an LLP is regarded as “transparent”. This means that in general terms the activities and property of the LLP are attributed to the members of the LLP. Each member of the LLP (i.e. a Beneficiary) will be subject to UK corporation tax on their proportionate share of the LLP’s profits. Similarly, the members of the LLP
are liable for any tax in respect of the chargeable gains accruing to the LLP. In this way, the LLP is not generally subject to tax in its own right (thus avoiding tax leakage at the Intermediary level (when compared to a CLS, please see paragraph 3.13).

3.8 The profits or gains of the LLP will be taxable whether or not they are in fact distributed to the members of the LLP.

3.9 It should be noted that the tax transparency of an LLP can be "switched off" in certain circumstances, such as the permanent cessation by the LLP to carry on a business with a view to profit or when an LLP is in liquidation or being formally wound up by order of the Court. When an LLP is not regarded as tax transparent, it will be treated for UK corporation tax purposes as if it was a limited company (so potentially giving rise to additional tax).

3.10 By comparison, a CLS is, for tax purposes, treated as a separate legal entity from its shareholders. When a company is UK tax resident, it is subject to UK tax on its worldwide profits and gains. On the assumption that the Intermediary is to be incorporated in the UK, then it will therefore be UK tax resident.

3.11 To the extent that any profits and/or gains arise in the Intermediary, it will be required to pay corporation tax (at 20% from the 1 April 2015) on those profits and/or gains.

3.12 The Beneficiaries may wish to extract profit out of the Intermediary via the payment of dividends.

3.13 UK dividends paid to a UK company, or a UK permanent establishment, are subject to corporation tax unless the dividend falls within a number of exemptions. The exemptions are broadly drafted and the general effect of the rules is to exempt all dividends from corporation tax unless they fall within certain anti-avoidance rules.

3.14 Therefore dividends paid by the Intermediary to the Beneficiaries are likely to fall within one of the exemptions (subject to anti-avoidance rules). However, this will need to be confirmed once the Beneficiary entities are confirmed.

4 The LLP Agreement

4.1 The agreement that establishes an LLP is generally referred to as the LLP Agreement. This is an agreement between the members of the LLP (in this case, the Beneficiaries) and records the matters agreed between the members in relation to the internal workings of the LLP.

4.2 In the context of a multi-beneficiary PES scheme, one of the main issues to be addressed in the LLP Agreement is the governance arrangements that deal with the decision-making processes by the members.

4.3 The LLP Agreement would set out the matters on which unanimity of the members is required or where a particular majority is required. For example, the members may decide that unanimity is required for any change to the agreed objectives of the pooled fund (the PES Fund), or for the admission of a new member.

4.4 Where there are a large number of members it may be decided that the LLP is managed on a day-to-day basis by a streamlined management board, consisting of specified LLP members that are elected/nominated as board members. In these circumstances the LLP Agreement should specify which decisions are to be taken by the members and which are to be taken by the management board.

4.5 One of the most important governance issues for the Beneficiaries will be the decision-making process regarding the use of the PES Fund. The Beneficiaries will require confidence that their financial contributions will be applied towards particular types of intervention.

4.6 The way in which this decision-making process will operate will depend on the specifics of any particular PES scheme. However, one option is for the overall objectives of the PES Fund to be agreed between the members and then for the management board to have
delegated authority to approve proposed projects that meet those overall objectives. As part of this process, a third party consultant could have a role in proposing a portfolio of appropriate projects, which meet the overall objectives of the PES Fund, for consideration by the management board.

4.7 In the event that certain members are likely to provide a significant majority of the funding (i.e. in the context of the Winford Brook pilot, Wessex Water and Bristol Water), those members are likely to require a higher level of control over which interventions are commissioned. Therefore, it may be appropriate for such members to be appointed to the partnership board.

5 **Intervention Contract between the Intermediary and the Provider**

5.1 Once the Beneficiaries (via the decision-making processes of the Intermediary) have decided which interventions will be funded, the Intermediary will enter a contract with the Provider (the **Intervention Contract**).

5.2 There are already well established legal and contractual mechanisms for commissioning land interventions from Providers so a detailed analysis of the provisions of the Intervention Contract is outside the scope of this report.

5.3 However, it is anticipated that the Intervention Contract would create a robust, legally binding relationship between the Intermediary that will specify the interventions to be provided by the Provider and the payment that it will receive in return. It is likely that the Intervention Contract would include provisions regarding, amongst other things:

5.3.1 Remedies for non-performance by the Provider (e.g. suspension or repayment of funding).

5.3.2 Provisions setting out the circumstances in which the Intervention Contract would come to an end, and the consequences of this.

5.3.3 Obligations on the Provider to allow the Intermediary (or its nominated representative) to access the Provider's land to monitor the delivery of the interventions and to gather data for the purposes of assessing the ultimate achievement of the Beneficiaries desired benefits.

5.3.4 Provisions to enable the renegotiation and review of the interventions over time to reflect different ways of achieving the desired benefits and potential changes of use in the land.

5.4 Comments regarding the payment provisions in the Intervention Contract are included in paragraph 7 below.

5.5 Depending on the nature and value of the intervention being funded, it is possible the Provider may require a guarantee from one or more of the Beneficiaries in respect of the payment obligations of the Intermediary under the Intervention Contract. This is more likely to be the case if the Provider is carrying out any capital works at risk in advance of payment.

6 **Consultant Contract**

6.1 There are a number of functions that will need to be performed by or on behalf of the Intermediary in order to deliver a PES scheme.

6.2 The Intermediary may choose to outsource certain functions to a third party under a separate contract (a **Consultant Contract**), in particular where the function requires additional expertise or resource beyond that which the Beneficiaries are prepared or able to commit. The services that could potentially be commissioned under a Consultant Contract include:

6.2.1 The identification, based on the available evidence and discussions with potential Providers, of a portfolio of proposed interventions that will potentially meet the objectives of the PES Fund.
6.2.2 Contract management of the Intervention Contract, including monitoring the delivery of the interventions by the Provider and managing any remedial process for non-performance.

6.2.3 Gathering data in relation to the benefits ultimately achieved by the Beneficiaries as a result of the interventions delivered by the Provider.

6.3 Any costs incurred by the Intermediary in commissioning services from a consultant would need to be borne ultimately by the Beneficiaries. A mechanism for apportioning such costs could be specified in the LLP Agreement or alternatively could be agreed by the Beneficiaries on a case-by-case basis.

7 Phasing of payments

7.1 There are a number of issues that will affect the phasing of payments under a PES scheme, both in relation to the phasing of funding contributions by the Beneficiaries and the phasing of payments to the Providers.

Phasing of funding contributions by the Beneficiaries

7.2 Some Beneficiaries may prefer to make their financial contribution upfront whereas other Beneficiaries might prefer to contribute a steady stream of annual payments. The potential flexibility in operating the PES Fund through an LLP would allow the Beneficiaries to adopt these different approaches.

7.3 It is possible that any significant funding contributions from the Beneficiaries at the outset of a PES scheme may remain in the PES Fund for some considerable time before being paid out to the Providers. In these circumstances, the Beneficiaries would require confidence that their money will be secure in the interim. This security could be achieved through the governance structures in the LLP Agreement regarding the application of the PES Fund, as described in paragraph 4 above.

Phasing of payments to Providers

7.4 A proposed intervention may involve an element of upfront costs being incurred by a Provider so the Provider may require the “frontloading” of a significant proportion of the funding to meet some or all of these costs. Notwithstanding this, the Beneficiaries/Intermediary may decide that some element of payment is deferred until later in the project or is conditional upon, for example, maintenance of an intervention, to incentivise ongoing performance by the Provider. Therefore the structure of the payment profile to a Provider could involve the bulk of the payment in the early years of the project with bullet payments in future for ongoing maintenance.

8 Obligations to maintain interventions in perpetuity

8.1 The nature of the interventions funded under a PES scheme are such that, in many cases, in order to achieve the intended benefits, ongoing maintenance obligations will be placed on the Provider over a reasonably long period of time (perhaps 25 years).

8.2 It is possible the landowner/occupier may change during such a period of time. This raises the issue of the extent to which the maintenance obligations imposed on the Provider can be created in such a way as to continue even if that Provider is no longer the landowner/occupier. Essentially, is there a way in which the obligation can run with the land and continue in perpetuity?

8.3 At first sight there are a number of mechanisms that could potentially be employed to achieve this objective:

The landholder providing a covenant

8.3.1 At its most simple, a covenant is a promise by one person (the Covenantor) to another (the Covenantee) to do or not do something. The Covenantor has the burden of performing the promise and the Covenantee has the benefit of being able to enforce it. Where the Covenantor is a landowner and the covenant
relates to the use of the land, the burden of the covenant can run with that land, allowing the Covenantee to enforce it against the future owners of the land. However there are two major limitations on this:

(a) only negative obligations can run with the burdened land – positive obligations (such as the obligation to maintain an intervention) cannot; and

(b) the Covenantee must own neighbouring land, and those negative obligations must "touch and concern it" by enhancing its usefulness or amenity.

8.3.2 These two limitations, in particular the second, would mean that the provision of a covenant by the Provider would not be sufficient to ensure the maintenance obligations in relation to the intervention could be enforced against any new landowner(s) in perpetuity.

A chain of covenants

8.3.3 In view of the limitations described above, a number of workarounds legal mechanisms have been devised to allow long-lasting positive obligations to be created for conservation purposes. In terms of a PES scheme, the only workaround that, on the face of it, could be relevant is through establishing a chain of covenants.

8.3.4 Under a chain of covenants, the Provider would make a covenant with the Intermediary, imposing positive duties to maintain the intervention. Although any successor landholder would not be bound by this covenant (as described above) an indemnity chain could be established to ensure that the original obligation continues to be enforceable even after the landholder sells the land.

8.3.5 The chain of indemnity would work as follows: When the Provider sells the land it would still be personally bound by the covenant. The Intermediary could sue the Provider if the new landowner does not perform the duties in the covenant. However, this risk to the Provider can be minimised if the new landholder agrees to indemnify the Provider against losses incurred under the covenant. The process can be repeated each time the land is sold, creating a chain of indemnity covenants.

8.3.6 There are some general concerns regarding the effectiveness of a chain of covenants, in particular that the chain is only as strong as its weakest link. Subsequent purchasers may not want to make an indemnity covenant with the seller. Even if they do enter a covenant, there is a risk that when called upon to pay the indemnity they will be unwilling or unable to do so. The result could be that an innocent intermediary in the chain, who may have sold the land some time ago, is forced to bear the loss.

8.3.7 However, in the context of PES schemes, there is a more fundamental issue that means that the chain of covenants approach is unlikely to enable the enforcement of the maintenance obligations. The chain of covenants approach is based on the assumption that any non-compliance with the obligation will result in a loss to the initial covenantee (i.e. to the Intermediary/Beneficiaries).

8.3.8 However, in the case of the PES scheme it may be difficult to establish a sufficiently clear and direct causal link between the failure to maintain the intervention and any financial losses incurred by the Beneficiaries (e.g. the costs incurred by the Beneficiaries caused by flooding). As such, there may be little incentive for the extant landholder to fulfil the maintenance obligations if there is no realistic possibility of a claim (via the indemnity chain) for significant financial losses.

8.3.9 It is therefore unlikely that a chain of indemnities would be an effective way of ensuring that the maintenance obligations are carried out following any disposal of the land by the Provider.
8.4 Therefore, it is difficult under the mechanisms that current law makes available, to create a robust or effective obligation to maintain an intervention in perpetuity. There is a risk therefore that if the ownership of the land changes hands, the new landowner may not agree to retain and/or maintain the intervention.

8.5 From a practical perspective, the risk to the Beneficiaries could be mitigated by selecting interventions that are more likely to be desirable from the landholders own perspective, to increase the likelihood that a new owner will agree to the continued maintenance. In addition, the maintenance payments to the Provider could be phased on an ongoing basis rather than as a lump sum early in the project to incentivise the Provider to continue to deliver the services throughout the life of the project. The payment profile could be sculpted in such a way that the payments to the Provider increase (in real terms) over time to provide an increased incentive. In this way, if the landownership changes hands, then the unpaid maintenance costs could be used to pay the new landowner or simply retained by the Beneficiaries to minimise the costs expended on the project.

8.6 Finally, it should be noted that the Law Commission recommended in June 2014 that a system of conservation covenants should be introduced in view of the current deficiencies in this regard under English law. Under this recommended scheme, a conservation covenant would:

8.6.1 be formed by the agreement of two parties: a landowner (a person with a freehold estate or leasehold estate of more than seven years), and a responsible body drawn from a limited class of organisations;
8.6.2 be able to contain both restrictive and positive obligations;
8.6.3 be capable of binding the landowner’s successors in title (that is, all subsequent owners) after he or she has disposed of the land; and
8.6.4 be made for the public good.

8.7 In an interim response in February 2015, the then coalition Government welcomed the Law Commission’s proposals but stated that they did not form part of their current legislative programme. However it was indicated that the Government would keep the proposals under review before providing a full response later in 2015.

8.8 It remains to be seen whether these proposals will result in a change in law and, if so, the extent to which such a change would be relevant to PES schemes.

9 Conclusion

9.1 We recommend that the most effective legal structure for delivering of a multi-benefit, multi-beneficiary PES scheme is through the Beneficiaries establishing a separate legal entity (the Intermediary) to administer the PES Fund and to contract with the Providers for interventions.

9.2 We recommend that an LLP is the most suitable legal form for the Intermediary. All Beneficiaries would be members of the LLP although the members may decide to delegate certain decisions to a streamlined management board. An LLP provides limited liability for the members; is relatively easy to establish; and would offer significant flexibility regarding the governance arrangements for operation of the PES Fund. The tax implications should also be considered when deciding on the form of the Intermediary; this issue is outside the scope of this report.

9.3 The contract between the Intermediary and a Provider (the Intervention Contract) would establish a robust, legally binding relationship requiring the Provider to carry out specified interventions on its land.

9.4 The Intermediary may also decide to enter contracts with third parties consultants to support the delivery of a PES scheme if the Beneficiaries are unable to provide the necessary additional expertise or resource.
9.5 This proposed structure enables flexibility regarding the phasing of payments, both in terms of the funding contributions from the Beneficiaries and in terms of the payments to the Providers. The LLP Agreement could therefore specify that certain Beneficiaries provide their contributions upfront whereas other Beneficiaries may contribute a steady stream of annual payments. The payments by the Intermediary to the Provider could involve a payment being made to fund some/all of the capital costs at the outset of the project, with further payments, e.g. for ongoing maintenance costs, paid at specified intervals and conditional on the Provider's compliance with its obligations under the Intervention Contract.

9.6 In view of the potential long term maintenance obligations under a PES scheme, there is a chance that the Provider may dispose of the land during the term of the scheme. Under current law there is no effective and robust mechanism to ensure that any new landowner would be obliged to continue to maintain the intervention. The Law Commission has recommended the introduction of a conservation covenant, which could potentially address this issue. The Government welcomed this recommendation but it remains to be seen if any change in law will follow and, if so, the extent to which it would be relevant to PES schemes. On a practical level, the risk to the Beneficiaries could be mitigated by selecting interventions that are more likely to be desirable from a landowner's perspective, to increase the likelihood of a new owner agreeing to take on those obligations. Maintenance payments could also be held back until later in the scheme, which, in the event of a change of ownership, could be used to incentivise the new landowner to carry out the maintenance.

TLT LLP

13 August 2015