A consultation on the draft update to the river basin management plan

Part 3: Economic analysis – extended report

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Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH
Email: enquiries@environment-agency.gov.uk
www.gov.uk/environment-agency

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1. Water for life and livelihoods: how much would it cost and who should pay?

The water environment is a common good which means the benefits it provides are available to the whole of society rather than to private individuals. Because of this public good nature of the water environment, the true cost of the uses and benefits it provides are not always captured by the market. This results in problems such as pollution and habitat degradation, which ultimately reduce the benefits society gains from this resource.

The economy relies on a secure supply of water for many different uses such as supplying drinking water, manufacturing food and drink, generating energy, and irrigating crops. River basin management planning seeks to protect and restore the water environment to provide benefits for society, the environment and the economy. However, it is sometimes necessary to consider trade-offs between these three outcomes. In this case, river basin management planning seeks to find the right balance. To achieve this, a wide range of people who use the water environment or whose activities can adversely impact its uses need to be involved in deciding the most appropriate equitable approach to management. The results of the planning process are contained in river basin management plans.

River basin management plans were published in December 2009. We, the Environment Agency, are now consulting on a draft update to the plan. As part of this consultation an economic analysis of scenarios for protecting and improving the water environment has been produced.

The draft updated river basin management plan in this consultation will be refined following consideration by the Environment Agency of updated evidence, responses to the consultation, and further views/decisions of Ministers. The proposed plan submitted by the Environment Agency to Ministers in autumn 2015 will reflect these further considerations. Decisions around priorities and the use of WFD exemptions including disproportionate costs and what each sector is responsible for funding will be made by Ministers based on a range of evidence including, in particular, this economic analysis and a final impact assessment, feedback from this consultation, progress on Defra's parallel policy initiatives to address pressures on the water environment from diffuse agricultural pollution and diffuse pollution from urban areas, Defra’s research on affordability, and the government’s wider policies around economic growth.

2. Why use economic analysis

Water is essential for life. It is a critical component of the natural environment, without which it would not flourish. It is a key resource without which businesses, agriculture and the economy would not grow and prosper.

The water environment provides many different benefits to society - from supplying drinking water and supporting fisheries to providing an essential resource for business and agriculture, transport routes and a source of recreation that promotes wellbeing. It is critical that this precious resource is managed properly to ensure that the needs of society, the economy and wildlife can be met and maintained in the long-term. In its assessment of the Environment Agency’s work in regulating water abstraction the National Audit Office

(National Audit Office, 2005) concluded that water is so important that its value to the economy is 'incalculable'.

The Government's Natural Capital Committee recommended the Government prioritise measures to monitor the state of natural assets directly and identified good status under the Water Framework Directive as currently the best available measure for freshwaters, transitional and coastal waters[1].

The Water Framework Directive (WFD) was published in 2000 and implemented into English and Welsh law in 2003 through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 and the Water Environment (Water Framework Directive) (Northumbria River Basin District) Regulations 2003. Its purpose is to achieve sustainable water management by rationalising and integrating various existing policies and regulations designed to protect the water environment in one legal framework. Economic analysis is a core requirement of the WFD and consideration of positive and negative consequences of environmental pressures and management measures is an integral part of the planning process.

As well as integration of water management, the WFD also requires that other environmental priorities, economic considerations and social issues are taken into account when setting objectives in river basin management plans. In developing the plans the Environment Agency aims to ensure public and private money is invested effectively and transparently for the greatest benefit to society as a whole.

River basin management plans (the plans) are the principal statutory mechanism through which the directive is implemented. The plans contain environmental objectives for all groundwater and surface waters (including estuaries and coastal waters) and summarise wide ranging programmes of measures needed to meet those objectives.

We have produced this economic analysis as part of the consultation on the draft update to the river basin management plans. The information it contains will help interested parties to understand the costs and benefits of achieving the proposed water body objectives. It also illustrates the rate of progress that could be achieved towards the proposed objectives under an assumed funding scenario.

An impact assessment will be produced to accompany proposals for updating the current river basin management plans that the Environment Agency will submit to the Secretary of State in the autumn 2015. It will help inform government decisions on whether to approve the updated plans.

The economic analysis includes 4 scenarios to illustrate the costs to society of addressing the issues from 4 sector groups along with the benefits of preventing deterioration, achieving protected area objectives and improving water bodies towards good status. A fifth scenario illustrates a possible initial 6 year funding profile for scenario 4. This scenario allocates costs to specific sectors. As they are illustrative they do not represent discrete options.

[1] The State of Natural Capital – Restoring our Natural Assets. Second report to the Economics Affairs Committee. Natural Capital Committee. March 2014, 86 pages.

3. Basis for this economic analysis

The purpose of the WFD is to deliver sustainable water management[2] which:

- prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems
- promotes sustainable water use based on a long-term protection of available water resources
- aims to enhance protection and improvement of the aquatic environment, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances
- ensures the progressive reduction of pollution of groundwater and prevents its further pollution
- contributes to mitigating the effects of floods and droughts

Progress towards the specific environmental objectives of the WFD[3] will help achieve these aims and will also generate other direct and indirect benefits to society and the environment.

The WFD is a framework that manages water and the water environment within the wider ecosystem. The WFD requires EU Member States to put in place river basin management plans (RBMPs). The river basin management planning process involves setting environmental objectives for all groundwater and surface waters (including estuaries and coastal waters) and devising programmes of measures to meet those objectives.

The objectives of the updated RBMPs are:

- to prevent future deterioration from current status
- to achieve the objectives and standards for protected areas
- to improve as many water bodies as possible towards good status or good potential, within the limitations of natural back ground conditions, technical feasibility and proportionate cost

Through the river basin management planning process, the Environment Agency also aims to ensure public and private money is spent on activities that provide the greatest benefits to society in a transparent and efficient way.

The WFD provides scope for Member States to select measures that will achieve the requirements in accordance with domestic policy objectives. In December 2011 the government published its Water White Paper, 'Water for Life'[4], setting out its vision for future water management to meet the challenges of adapting to climate change and increased pressure on water availability and quality. This further developed government strategy set out in the Natural Environment White Paper, 'The Natural Choice'[5], published in June 2011 which set out the government's commitment to taking an 'ecosystem approach' to

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[2] Article 1, Water Framework Directive 2000/60/EC

[3] Article 4 and Article 7, Water Framework Directive 2000/60/EC 80/778/EEC as amended by Directive 98/83/EC.

[4] Defra, 2011, Water for Life

[5] Defra, 2011, The Natural Choice

environmental management and highlighted the economic and social benefits that can result from managing environmental activities at a larger scale, taking account of impacts across the landscape. 'The Natural Choice' recognised the particular relevance of this approach to management of the water environment across a whole catchment.

The government has adopted an integrated approach to meeting the requirements of the WFD and achieving the strategic objectives set out in 'The Natural Choice' and 'Water for Life'. Actions to meet WFD requirements must also be consistent with the government's approaches on the principles of better regulation, policy on climate change, sustainable development and efficient use of natural resources as well as the polluter pays principle.

Actions taken to improve the water environment now will have consequences far into the future on the benefits society gets from ecosystems. It is important that the costs and benefits of our decisions are understood, so that we can make the best possible decisions for society now and also for future generations. One of the most pressing challenges currently facing policy and decision makers in England (and globally) is how to ensure that economic development delivers sustainable increases in wellbeing into the future[6].

In July 2014 Defra issued updated guidance to the Environment Agency on river basin management planning[7]. The guidance sets out ministerial expectations for the main steps and principles of the river basin management planning process. This includes guidance on the interpretation of the WFD exemptions such as disproportionate cost and undertaking an economic analysis.

In proposing objectives in the RBMPs, the Environment Agency must consider what measures are technically feasible, and whether the benefits brought by carrying out the measures are proportionate to the costs. In addition the WFD includes consideration of distributional impacts (i.e. how costs are distributed between those sectors that pay) and social impacts.

The techniques that underpin this economic analysis for the draft updated RBMPs provide estimated values for an improvement in some ecosystem benefits which, traditionally, have not been monetised or considered in market based systems, for example, the wider services that ecosystems provide for recreation and amenity. Applying these to investment options and predicted outcomes shows that allowing decisions to be guided by market prices alone forgoes opportunities for major enhancements in many benefits[8], with negative consequences for social well-being. Acknowledging the value of traditionally non-monetised or non-market ecosystem benefits more fully in this economic analysis supports England in its move towards a more sustainable future, in which the benefits of water environments are better realised. This is in line with Defra's 'The Natural Choice' policy.

A key test for adopting alternative objectives is a justification that the measures necessary to achieve the default objective would be 'disproportionately costly'. The Secretary of State for the Environment will decide what is disproportionate, based on a range of evidence including this economic analysis.

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[6] The Natural Capital Committee, 2014, The State of Natural Capital: Restoring our Natural Assets

[7] Defra, 2014, River basin planning guidance

[8] UK National Ecosystem Assessment (2011). UNEP WCMC, Cambridge

4. Approach to the economic analysis

4.1. Future management scenarios

Five future management scenarios have been developed. These would require different levels of investment would result in different levels of environmental improvement. The scenarios have been developed and agreed with Defra to help explain the potential impacts from the draft updated river basin management plans and to help improve the evidence that ministers will consider when deciding whether or not to approve the updated plans. The scenarios are presented to inform debate on priorities, objectives, exemptions and who should pay for what. They are not firm discrete choices or options for ministers.

The methods used to collate the costs and benefits under scenarios 1 to 5 are described in this section. The scenarios have been constructed in different ways using information from a number of sources. This inevitably involves a number of assumptions described in section 4 and below in section 12.

Scenarios 1 and 2 are based on nationally held information about programmes of measures, costs and benefits. These figures have then been broken down by river basin district and costs assigned to the 4 sector groups.

Scenarios 3 and 4 build on scenario 2 by including collated information from appraisals undertaken at catchment level. These appraisals considered the costs and benefits of 'bundles' of measures needed to improve and restore most of the catchments in England. The catchment scale economic appraisal process used to do this is described in Part 2 of this consultation and in the economic analysis extended report.

Scenario 5 is a potential short term funding profile for Scenario 4. It is not prescriptive and the costs and benefits of the catchment actions were not optimised. It is designed to illustrate the possible scale of water body improvements and economic benefits that could be achieved under certain funding levels.

The cost of measures for scenarios 2, 3 and 4 has been broadly allocated to the sectors whose activities cause the problem (polluter pays). Scenario 5 shows the measures and improvements which, in this illustration, it is assumed sectors would fund based on Defra guidance.

The assessments relating to chemicals and chemical status used mainly nationally held information. This included information on the costs and effectiveness of sewage treatment (from the water industry's Chemicals Investigation Programme) and of product controls. Minewater impacts were obtained from appraisals undertaken at catchment level.

For chemical status, these substances are already highly regulated and the risk of 'real' deterioration in status is low, so no additional measures are required to prevent deterioration in surface waters and protected area objectives are not relevant for chemical status in surface waters. Therefore scenario 2 is not provided for chemical status in surface waters.

The scenarios considered are:

Scenario 1: No new measures (2013 baseline)

This scenario illustrates the potential effect of not taking action to prevent deterioration. It considers the future impact of pursuing only those ongoing measures in current river basin management plans against a changing environmental baseline resulting from population growth, climate change and the impact of invasive non-native species. Under this scenario

(an increase in environmental pressures against a static set of measures) deterioration in environmental quality is anticipated. Current measures would therefore fail to achieve many of the objectives set in current plans.

Scenario 2: Aim to prevent deterioration and achieve protected area objectives

Scenario 2 considers how the addition of new measures can help prevent deterioration in status and includes additional measures needed to achieve protected area objectives. Protected area objectives include those for:

- drinking water protected areas: surface water and groundwater
- economically significant species (shellfish waters)
- recreational waters (bathing waters)
- nutrient sensitive areas (urban waste water treatment directive)
- Natura 2000: water dependent special areas of conservation and special protection areas for wild birds

Scenario 3: Aim to prevent deterioration, achieve protected area objectives and all technically feasible improvements towards good status. No affordability constraint

In this scenario water bodies would be expected to achieve good status unless natural background conditions prevent it or there is no known technical solution to existing problems. Under this scenario less stringent objectives would be set for water bodies where exemptions for natural conditions and technical feasibility (no known technical solution) apply.

This scenario builds on scenario 2 by including all technically feasible measures needed to achieve good status by 2027. No measures are ruled out on the basis of cost, affordability constraints or available funding. As such, this scenario represents the outcome if there was no use of the disproportionate cost exemption.

Scenario 4: Aim to prevent deterioration, achieve protected area objectives and improvements in status where benefits exceed cost. No affordability constraint

This scenario builds on scenario 2 by including all technically feasible measures needed to achieve good status by 2027 where benefits justify costs. No measures are ruled out on the basis of affordability constraints or available funding.

Under this scenario less stringent objectives would be set for water bodies where exemptions for natural conditions and technical feasibility (no known technical solution) apply. Less stringent objectives would also be set where costs are not justified by benefits. Although the balance of costs and benefits would be taken into account in setting water body objectives, this scenario does not fully take account of all disproportionate cost considerations, for instance distributional impacts (affordability). The analysis for this scenario reflects Defra's statutory guidance to the Environment Agency.

The proposed objectives in Part 1 of the consultation use the assumptions in scenario 4.

Scenario 5: Illustration of potential progress towards scenario 4 by 2021

Achieving all of these proposed objectives of scenario 4 in the short term is not feasible. Scenario 5 has therefore been produced to illustrate just one of the ways that achievement of the proposed objectives could be initially profiled. It illustrates the scale of actions and improvements that might be achieved between 2015 and 2021. It shows the effect of funding constraints on the rate of progress towards the objectives in scenario 4.

The scenario is based on an illustrative level of available national funding (up to and including 2021) related to the most directly relevant programmes and an assumed level of additional voluntary action through local efforts. It follows Defra guidance to consider the largest funding sources and use planning information that has been made public, or provided

by others (for instance the water companies and National Farmers Union), or estimated by the Environment Agency.

The illustrative funding in scenario 5 is not a prediction of funding that will be available in the second cycle. Decisions, including the extent of measures to be taken forward over the period 2016 to 2021, will be made by the Secretary of State when considering the approval of the updated plans in 2015.

Under this scenario less stringent objectives would be set for water bodies where exemptions for natural conditions and technical feasibility (no known technical solution) apply. Less stringent objectives would also be set where costs are not justified by benefits. Where a water body objective cannot be achieved by 2021 (based on the assumed level of funding and taking into account natural recovery time) an objective with an extended deadline of 2027 would be set.

In practice, all the requirements of WFD Article 4.5 must be met before a less stringent objective is set. In addition, all the requirements of WFD Article 4.4 must be met before an objective with an extended deadline is set.

4.2. Scenario 1 methodology

In England, businesses and the public sector jointly spend about £5 billion per year to protect the water environment. This includes;

- water industry maintenance and operational costs to collect and treat sewage of approximately £3 billion
- industry and businesses investment of around £1 billion to mitigate their potential impact on the water environment and meet basic regulatory requirements
- £450 million by agriculture to meet basic regulatory requirements and further reduce impacts on the water environment. This includes payments under the Common Agricultural Policy and voluntary industry initiatives
- expenditure by government and the voluntary sectors to mitigate historic damage and provide water related benefits for people and wildlife

Against this background, scenario 1 considered the future impact (beyond 2015) of ongoing measures in current river basin management plans against a changing environmental baseline resulting from population growth, climate change and the impact of invasive non-native species.

Scenario 1 has been developed from the existing cycle 1 economic analysis data, RBMP1 measures, additional Defra grant in aid (GiA), Catchment Sensitive Farming (CSF) and information received from Ofwat.

Under scenario 1 there would be a completion of existing ongoing measures but no new measures or adaptation of existing measures introduced to alleviate any negative impacts to the freshwater environment from predicted trends and changes in population growth and climate change.

To estimate likely changes in each of the significant water management issues[9] (SWMIs) and the consequent effect on water body status and protected areas to 2027, projections of future population, climate and agricultural land use have been considered where

[9] The SWMIs considered are Phosphorus from Sewage Treatment Works, Sediment, Physical modification, Abstraction and flow, Groundwater chemical and quantitative, Chemicals and metals, Sanitary pollutants, Eutrophication, Invasive non-native species

appropriate[10]. For scenario 1 each SWMI pressure is considered on an individual basis for its likelihood of causing a change in status within each water body by 2027.

For rivers, lakes, transitional and coastal water bodies individual SWMI assessments (excluding invasive non-native species) have been combined. Any water body, with status currently better than bad, that is impacted by at least one SWMI pressure is identified as deteriorating. An additional assessment that was included to account for the wide geographical impact of rivers, lakes, transitional and coastal water bodies, invasive non-native species are estimated to cause an extra 5% deterioration for each planning cycle (2015 to 21 and 2021 to 27). This invasive non-native species deterioration is calculated in addition to those water bodies estimated to fail from the combined SWMI assessment. This invasive species impact is assumed to be evenly distributed across river basin districts and status classes, with the assumption that all currently high status water bodies would deteriorate as a result of invasive non-native species by 2027. A groundwater SWMI assessment for water quality and quantity is used to estimate those ground waters currently at good status that would deteriorate to poor.

Future risk of deterioration for Bathing Water and Shellfish Water Protected Areas is also estimated using an available faecal contamination SWMI assessment. Deterioration of groundwater drinking water protected areas (DrWPAs) by 2027 is available as a unique output from the groundwater SWMI assessment. Potential for deterioration of surface water DrWPAs was determined using a separate surface water assessment[11].

4.3. Scenario 2 methodology

Scenario 2 includes all costs of measures needed to prevent deterioration in status and achieve protected area objectives - including Natura 2000 sites (under Habitats and Birds Directive), Shellfish Waters (SfW), Bathing Waters and Drinking Water Protected Area objectives.

Costs to prevent deterioration are for short term (cycle 2, projected to cycle 3) foreseeable measures (e.g. for the water industry PR14 measures to prevent deterioration) rather than possible measures needed to counter potential long term (2050) issues caused by climate change and/or population growth.

The following sub-sections describe how the costs for measures have been collated for scenario 2 under each sector.

Government

Natura 2000 sites

The costs provided by Natural England[12] include: physical habitat restoration; diffuse water pollution remediation and estimates of costs under NELMS for on site management to

[10] Population projections are at an RBD level and informed by Office National Statistics trend projections from 2010. Agricultural projections are based on Defra projections to 2020; and extrapolated to 2027. Climate projections for each RBD are informed by UKCP09 regional climate messages.

[11] Risk_Assessment_Methods: https://ea.sharefile.com/d/sbdae032840d49c08 Risk Assessment Results: https://ea.sharefile.com/d/s7b2d35d7bd94651a

[12] Cost estimates provided by Natural England for restoration of Protected Areas are explained and caveated with the assumptions described in 'Cost estimates for Natura 2000 measures RBMP2. V2 (September 2014)'.

maintain the recovering condition for Natura 2000 protected area WFD related sites and to implement new actions identified over the Common Agricultural Policy period to 2020.

Invasive non-native species

The cost of measures to prevent deterioration due to invasive non-native species (INNS) are based on measures required for water bodies designated as 'at risk' in the Environment Agency's water body risk assessment for INNS[13]. Costs of these measures fall mainly to the government sector and there are no significant costs to other sectors, with the exception of a small ongoing cost to the water industry sector. The benefit values do not include the benefits from preventing deterioration; they include the wider, non Water Framework Directive benefits such as reductions in flood risk and maintenance costs and avoiding negative impacts on angling, amenity and public health.

The cost of measures to achieve Natura 2000 protected area objectives, where INNS are an issue, have been calculated using information from Natural England's site information system (ENSIS) database. Whilst every effort has been made to keep the information updated, Natural England is aware that the threat to site condition from invasive non-native species has been incompletely recorded on this database. In many cases the true scale or nature of the INNS programme is not known through this information source. Transitional and coastal water body habitats in particular are underrepresented in current estimates. The costs provided here are very broad preliminary estimates, and are likely to change as more information is updated on ENSIS and as the improvement programme for England's Natura 2000 sites (IPENS) on the scale of impact of INNS on Natura 2000 protected areas are concluded during autumn 2014.

Shellfish waters

In the 2009 river basin management plans, shellfish waters were designated as protected areas under the Shellfish Waters Directive (2006/113/EC) (SfW). The Directive was repealed at the end of 2013 and its requirements transferred to the Water Framework Directive. New directions under WFD are being prepared and will afford equivalent protection to the SfW. Under the WFD, measures to achieve the SfW guideline standards are subject to the same tests of technical feasibility and disproportionate cost as other WFD objectives.

The Environment Agency has undertaken a preliminary assessment of the costs and benefits of the proposed packages of measures for the SfW required to achieve protected area standards for shellfish waters, using the catchment based economic appraisal methodology described in section 4.4. The water industry improvement measures proposed for SfW are taken from the National Environment Plan[14].

The proposed packages of improvement measures will be included in draft SfW action plans for consultation with stakeholders during the consultation on the updated RBMPs, particularly the shellfish industry, the water industry and agricultural sector.

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[13] Risk_Assessment_Methods: https://ea.sharefile.com/d/sbdae032840d49c08 Risk Assessment Results: https://ea.sharefile.com/d/s7b2d35d7bd94651a

[14] The National Environment Plan (NEP) forms part of a water company's business plan and sets out the statutory requirements that ensure that water companies meet European and national environmental standards related to water

Bathing waters

There are 416 designated bathing waters in England[15]. The revised Bathing Water Directive (2006/7/EC) (rBWD) will come into force in 2015, replacing and updating the current Directive (76/10/EEC). It sets more stringent water quality standards for the protection of public health and places stronger emphasis on beach management and public information.

The rBWD defines 2 main parameters for analysis of bathing water quality ('intestinal enterococci' and 'escherichia coli') instead of the 19 parameters in the original Directive. These will be used to monitor the quality of waters and classify them according to the status levels of poor, sufficient, good or excellent. A core requirement of the Directive is that Member States should attain sufficient status or better for all bathing waters by the end of the 2015 season at the latest.

To appraise the costs and benefits for improving bathing waters to 'sufficient' under scenario 2, the costs of measures were estimated using past studies and expert judgement. The benefit values of meeting sufficient status, provided by the Bathing Water Valuation Study (2013) willingness to pay survey[16], and supporting local information[17] are used in comparison with costs.

The cost data[18] are provided at the individual site level for the proposed package of measures to ensure an at-risk site meets sufficient status. Measures include investments related to public water supply, private sewerage, local councils and agriculture.

Rural land management sector

The cost of water quality measures to achieve Natura 2000 protected area site objectives has been calculated based upon modelled 50% uptake of five New Environmental Land Management Scheme (NELMS) style resource protection measures across 2.8m ha of Natura 2000 catchment.[19]

The costs to address pesticides in Drinking Water Protected Areas include cost assumptions for voluntary initiatives. Any consideration of further measures will be the subject of a government consultation. For nitrate additional NELMS style payments might be made in addition to the nitrate vulnerable zone action programme. Measures may include some land use change or encouraging crops that require fewer nitrates.

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[15] 2014 figure

[16] Report for the Environment Agency, 2013. Bathing Water Valuation Study – National Survey Summary Report (Draft). Economics for the Environment Consultancy Ltd (eftec), in association with Ipsos Mori and The South West Research Company.

[17] Including Environment Agency bathing water profiles (April 2014), Environment Agency regions, beach managers, Local Authorities (tourism officers or the local tourism bureau), online beach directories

[18] Draft Technical Report for the Environment Agency (April 2014). Bathing Water Valuation Study. Economics for the Environment Consultancy Ltd (eftec), in association with Ipsos Mori and The South West Research Company.

[19] Under scenarios 2, 3 and 4 the costs of improving water bodies from diffuse agricultural pollution are allocated to the rural land management sector (a 'polluter pays' scenario). Under scenario 5 part of these costs are allocated to the government sector, where grant funding would actually be coming from.

Industry, services and infrastructure sector

The only protected area costs and therefore the resulting benefits, for the industry, services and infrastructure sector are those for mitigation measures (in Natura 2000 sites) and bathing waters. Costs for mitigation measures are described under scenario 3. The cost data[3] are provided at the individual bathing water site level for the proposed package of measures to ensure an 'at risk' site meets sufficient status. Measures include investments related to public water supply, private sewerage, local councils and agriculture. As before, the benefit values of meeting sufficient status, provided by the Bathing Water Valuation Study (2013) willingness to pay survey[20], and supporting local information[21] are used in comparison with costs.

Water industry sector

Cost information for all water industry sector water quality measures are based on the cost of measures to prevent deterioration and those to achieve protected area objectives in phase 4 of the National Environment Programme. Water companies provided the Environment Agency with cost estimates for these measures. Depending on the level of information provided, some assumptions were applied to ensure a realistic and consistent approach was applied to complete any unknown information.

The cost of water resources measures to achieve Natura 2000 protected area site objectives has been estimated based on standard unit costs for changes to abstractions under the Environment Agency's restoring sustainable abstraction programme.

There is currently an ongoing cost of INNS biosecurity measures by those who manage water bodies containing 'Dikerogammarus villosus' (the 'killer shrimp') and any other species that may arrive.

Some non-monetised benefit information is available for measures to achieve protected area objectives. This is based on the number of sites aimed to be improved, the km of rivers, km^2 of coastal waters and number of lakes to be improved by the measures. The monetised benefit values resulting from measures to prevent deterioration and achieve the urban waste water treatment Directive, sensitive area objectives have been calculated using the National Water Environment Benefits Survey willingness to pay values (see section 4.4).

All four sectors

The cost Environment Agency's mitigation measures programme for artificial and heavily modified water bodies contributes to achieving Natura 2000 protected area site objectives. The cost of these measures have been calculated based on information from an Environment Agency project; the Evidence for significant water management issue project that considers pressures on the water environment including physical modification, and compares a range of cost effective measures that could be implemented to address them. The costs and number of water bodies improving were derived by applying the information and evidence from this project to those modified water bodies which are currently failing to

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[20] Report for the Environment Agency, 2013. Bathing Water Valuation Study – National Survey Summary Report (Draft). Economics for the Environment Consultancy Ltd (Eftec), in association with Ipsos Mori and The South West Research Company.

[21] Including Environment Agency bathing water profiles (April 2014), Environment Agency regions, beach managers, Local Authorities (tourism officers or the local tourism bureau), online beach directories.

achieve good potential, have a designated use (why they are modified[22]) and importantly, which intersect with a Natura 2000 protected area site. The designated use; the reason a water body is designated as modified has been used to split the cost between the four responsible sectors, as described below:

- The cost of mitigation measures for water bodies which have the following designated uses have been assigned to the government sector: "flood and coastal risk management" and "urbanisation". Other river and lake restoration costs have been included based on the Natura 2000 river and lake restoration programmes which are jointly managed by Natural England and the Environment Agency.
- The cost of mitigation measures for water bodies which have the following designated uses have been assigned to the rural land management sector; "rural land use management".
- The cost of mitigation measures for water bodies which have the following designated uses have been assigned to water industry sector; "water supply", "regulation and hydropower".
- The cost of mitigation measures for water bodies which have the following designated uses have been assigned to the industry, infrastructure and services sector; “navigation”, “ports and harbours” and “power generation”.

4.4. Scenario 3, 4 and 5 methodology

This section deals with the detailed methodology we used to create scenarios 3, 4, and 5 (for description of these scenarios see section 4.1).

The data that underpins scenarios 3, 4 & 5 in the draft economic analysis were collated at a catchment level by local Environment Agency environmental planning experts. We took a proportionate approach in assessing and monetising benefits resulting from predicted improvements in the status of water bodies.

The results of the economic appraisal are included in the catchment summaries on the consultation web pages[23] and more detail is available on request[24]. More information about how the Environment Agency is using economic appraisal as a tool for river basin management planning, including a training package, can be downloaded via the DataShare service[25].

We identified a ‘bundle of measures’ to improve and restore the water environment for each operational catchment in England, using evidence from programmes of investigations to understand why some water bodies are not meeting the default objective of good status or potential. The appraisals have been conducted at an ‘operational catchment’ scale

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[22] There are designated uses that don't map well to the four responsible sectors. The cost of mitigation measures for water bodies which have recreation as their designated use have been assigned to the industry, services and infrastructure as the majority of these modified waters are covered by ports and harbours. Associated measures were not considered in the project and therefore are not included in the cost benefit calculations for scenario 2.

[23] http://ea.objective.co.uk/portal/ho/wfd/draft_plans/consult?pointId=s1406201401809#section-s1406201401809

[24] Catchment economic appraisals are available on request via the National Customer Contact Centre on 03708 506506.

[25] https://ea.sharefile.com/i/ia2938a7e56f442aa

(operational catchments are typically made up of 5 to 40 water bodies with logical hydrological boundaries). Appraising measures at this scale enabled Environment Agency staff to better engage with the people living within the catchments and identify the benefits of implementing measures to local communities. There has been both local and national level engagement on economic appraisals carried out at the catchment scale. Local engagement has been through River Basin District Panels, with specific stakeholders such as water companies and with catchment partnerships, and has been planned and undertaken by local Environment Agency staff. We grouped measures together into a 'bundle' for appraisal so all costs and benefits could be assessed together. This avoids double counting of benefits, as improvements in water body status are assessed at the 'per km or km^2' scale.

In appraisals for surface waters the Environment Agency used the National Water Environment Benefit Survey (NERA 2007, updated for 2012 values[26]) willingness to pay values to estimate some of the benefits (in pounds sterling per km) of improvements to the water environment from society's perspective. For groundwater appraisals, we transferred values from previous peer-reviewed economic assessments to monetise some ecosystem service benefits[27]. Benefits are monetised in this way in order to compare like-with-like (costs in pounds sterling with benefits in pounds sterling). This method of valuation is a proportionate approach that monetises some of the benefits expected to result from applying a bundle of measures to a catchment and compares these benefits to the costs of implementing the measures.

The changes in benefits that have been monetised in this economic assessment mainly fall under the category of 'cultural and quality of life benefits'. This includes recreation, aesthetic value and existence value[28]. Recreation includes all recreational uses of rivers, lakes and coastal areas, for example walking, and sports such as fishing, rowing and kayaking. People value water environments that look clean with varied wildlife: this is described as aesthetic value. People also derive value from knowing that such environments exist in a healthy state, irrespective of whether they use it; this is known as 'existence value'.

Where they have been identified as significant in the qualitative and quantitative stage of the assessment, monetary benefits for the provision of fresh water from actions to improve groundwater and biodiversity benefits from agricultural environment schemes have also been included.

Where benefits cannot be monetised they have been captured qualitatively in an appraisal summary table for each catchment. These tables are based on the ecosystem services framework to assessing benefits, as specified in the recently updated Government Guidance on Appraisal (Treasury Green Book). The results from these tables have been aggregated to produce the summary tables below, 'changes to multiple benefits under scenario X'. In these tables, if the change to a benefit or use is likely to be significant, two arrows are shown pointing up for a positive change (benefit) and down for a negative change (disbenefit). If the change is likely to be noticeable but not significant, then one arrow is shown, again pointing up for benefits and down for disbenefits. If there is likely to be no net change, a 'o' is shown.

Once the benefit to cost ratio (BCR) has been estimated, we conducted a 'sensitivity analysis' for each catchment appraisal to better understand how assumptions on the key

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[26] P. Metcalfe (2012). Update of CRP WFD Benefit Values – Economic Component. A Draft Report for the Environment Agency.

[27] Groundwater Appraisal Guidance, Environment Agency, 2013

[28] These values were obtained from the updated 'National Water Environment Benefit Survey' (NWEBS): 'Update of CRP WFD Benefit Values – Economic Component. A Draft Report for the Environment Agency', Paul Metcalfe, June 2012.

inputs affect the results and therefore how sensitive the results are to changing those assumptions. They can help highlight the significance of key assumptions and uncertainties on the results of the appraisal. We tested the thresholds of the results , for example by doubling the benefits and halving the costs, to see where the tipping point lies to ensure that no additional costs or benefits which may have been overlooked in the appraisal might tip the benefit to cost ratio to one that is no longer cost beneficial.

The 'stage 1 valuation sheet', the main appraisal tool for assessing the costs and benefits of bundles of measures over a 37 year appraisal period (scenarios 3 and 4), is designed to be both easy to use for non-economists and credible identifying bundles of measures which are clearly cost beneficial (BCR greater than 1) and bundles of measures which are clearly not cost-beneficial (BCR less than 1). If there is more than one viable bundle of measures the bundle with the highest Net Present Value (NPV) is recommended.

The appraisal methodology used to assess the costs and benefits of measures to improve water bodies to good status, feeding into Options 3, 4 & 5, adhere to the appraisal instructions set out within the Treasury Green Book and associated supplementary guidance 1.

This appraisal methodology has also been developed by drawing on best practice and influenced by:

- Valuing environmental impacts: practical guidelines for the use of value transfer in policy and project appraisal (Eftec, 2010)
- Benefits Assessment Guidance (BAG); used to assess water related impacts since 2003 (Environment Agency, 2003).
- The Appraisal Summary Table accompanying the Flood and Coastal Risk Management Appraisal Guidance (FCERM-AG) (Environment Agency, 2010)
- Package 7 of the Long Term Investment Strategy (Environment Agency and Royal Haskoning, 2012)
- Project case studies such as the Benefits Assessment on the River Wandle (Environment Agency, 2012, unpublished)
- The Strategic Environmental Assessment process

Additional points to note in scenarios 3, 4 and 5

Rural and land management sector costs

The costs associated with the rural land management sector for scenarios 3, 4 and 5, were produced using the Cost of Agricultural Measures (CAM) tool. This is a simple spreadsheet that considers 61 agricultural measures that would give a positive response to water quality pressures at a catchment scale. The measures were bundled into a number of suggested mechanisms for ease of understanding and implementation, for example, agri-environment or voluntary initiatives. For some river basin districts costs were based on locally derived evidence.

One of the challenges in producing economic evidence was to understand the uptake of measures at catchment scale to make enough difference to ensure that the water bodies affected reach good status. The most cost effective measures have been selected and so low cost measures were preferred against much higher cost land use change that incurred greater costs to the rural economy. The effectiveness of measures at a catchment scale in reducing diffuse water pollution from agriculture is not well understood. If the less costly measures do not result in the predicted benefits, more costly land use change measures may be required in future to achieve more ambitious objectives. Therefore, whether the CAM

tool or an alternative method was used, it is possible that the extent of action to achieve good in scenario 3 and 4 is considerably underestimated for most river basin districts.

Water industry sector costs

The water resources (WR) costs (in the water industry sector) for scenarios 3 and 4 use the WR UKWIR RG08[29] costs rather than the figures from the catchment based approach methodology.

For scenarios 3 and 4 the total water industry sector costs are represented using a range of -/+30% of the catchment appraisal costs and UKWIR RG08 costs to reflect uncertainty in the costs of measures.

National level funds and for water industry river basin district level funds, were estimated for the 6 year period 2016 – 2021 (see Section 14, Annex A for more detail on water industry funding allocation). These were then allocated to the costs of measures on a catchment-by-catchment basis. From this allocation, bundles that could be fully funded, partially funded or not funded at all were identified. Funds were allocated to the relevant measures, with catchments with higher NPVs having priority for funds over catchments with lower NPVs. The assumed level of funding for the different types of measures was allocated first to measures to prevent deterioration and achieve protected areas objectives (that is measures for scenario 2 were funded first), with the remaining funds allocated to measures to improve water body status. The illustration is optimistic in terms of water bodies improving because it is unlikely that funds would be allocated solely on the basis of best NPV outcomes.

Costs for chemicals relevant to good ecological status

Scenarios 3 and 4 include the costs of measures to control 3 chemicals that affect good ecological status (see Table 1). These costs represent 1-2% of the total cost.

4.5. Risk assessments for assessing chemical status

The assessments relating to chemicals used mainly nationally held information. This included information on the costs and effectiveness of sewage treatment (from the water industry's Chemical Investigation Programme) and of product controls. Minewater impacts were obtained from appraisals undertaken at catchment level. The detailed assumptions made for estimating costs for reaching good chemical status under different scenarios are described in the paper 'Draft economic analysis for river basin planning: National chemicals assessment (England) (2014)[30], although the main methodology and chemicals considered are described below.

For scenarios 2, 3 and 4, the costs represent the expenditure that would be required to mitigate the damaging activities of the sector group. Costs for historic activities where there is no current responsible sector (for example abandoned mines) have been allocated to government. The costs in scenario 5 are the cash costs which, in this illustration, it is assumed sectors would fund.

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[29] UKWIR, Water Framework Directive (WFD), Disproportionate Costs, RG08, draft report, in press.

[30] 'Draft economic analysis for river basin planning: National chemicals assessment (England) (2014). Available on request

For chemical status in surface waters, no additional measures are required to prevent deterioration or have been identified at this stage or have been identified to achieve protected area objectives. Therefore scenario 2 is not provided for chemical status in surface waters.

It has only been possible to assess the costs and benefits of achieving certain chemical standards and not the monetary benefit of improvements in chemical status as a whole. For this reason the costs of measures for chemical status are presented separately to those for achieving the other environmental objectives.

For a water body to achieve good status both good ecological status (GES) and good chemical status (GCS) must be achieved. To achieve GES all UK 'Specific Pollutants' (SP) must be at levels below the Environmental Quality Standard (EQS) in addition to a number of ecological parameters. To achieve GCS all EU "Priority Hazardous Substances" (PHS) and "Priority Substances" (PS) must be at levels below the relevant EQS.

Significant new additional information about chemicals in the environment comes from the UK Water Industry Research (UKWIR) which identifies chemicals as a significant emerging issue for WFD[31].

The Environment Agency have identified 13 chemicals that are of national concern with respect to meeting good status in England's water bodies as per Table 1. Of these chemicals, 10 impact on water body good chemical status (GCS) and 3 on good ecological status (GES).

Table 1 Chemicals of national concern in meeting good status in England's water bodies

Substance	Uses/sources	Responsible Sector	Good Chemical Status	Good Ecological Status
Brominateddiphenyl ethers (PBDE)	Flame retardant - banned for use in the EU now but a persistent bio accumulative and toxic substance prevalent in domestic environments from furnishings etc, a significant legacy issue	Industry (subsector: Domestic/ general public)	u-PBT	
Mercury	Metal with multiple sources including trade effluent, mines, domestic use	Industry Government	u-PBT	
PAHs	Polycyclic aromatic hydrocarbons - persistent bio accumulative and toxic substances arising from combustion, oil and other	Industry Water Industry	u-PBT	
Fluoranthene			PS	

[31] UKWIR CIPi (Chemicals Investigations Programme): Volume 1 – Main Report (Ref. No. 13/EQ/01/6) https://www.ukwir.org/site/web/content/reports/reports 1st phase options appraisal for the Water Industry. Report looking at concentrations of chemicals in sewage treatment effluent and compartments of raw sewage as well as piloting treatment processes to remove these chemicals.

Substance	Uses/sources	Responsible Sector	Good Chemical Status	Good Ecological Status
	products.			
Tributyl tin compounds (TBT)	Biocide - many uses banned; Persistent bio accumulative and toxic chemical giving rise to legacy issues in sediment etc	Industry Water Industry	u-PBT	
Nonylphenol	Many uses, some banned in the EU; imported textiles may contribute to failures	Industry (subsector: Domestic/ general public)	PHS	
Di(2-ethylhexyl)phthalate (DEHP)	Plasticiser used in building / electrical goods. Significant legacy issue from existing products	Industry Water Industry	PHS	
Cadmium	Metals with multiple sources including trade effluent, mines, domestic use	Industry Government (abandoned mines) Water Industry	PHS	
Lead			PS	
Nickel			PS	
Copper				SP
Zinc				SP
Triclosan[32]	Biocide included in personal care products and household plastics from where it enters sewers	Industry (subsector: Domestic/ general public)		SP

u-PBT: ubiquitous persistent, bioaccumulative toxic (all PHSs)

PHS : Priority Hazardous Substance

PS: Priority Substance;

SP: Specific Pollutant

Substance shaded in table are not included in the risk assessment

There is currently only adequate data to perform risk assessments for 9 of the 13 chemicals. Those shaded in Table 1 are not included in the risk assessment.

For 4 chemicals (Brominateddiphenylethers (PBDE), Fluoranthene, Mercury, and PAHs) owing to recent changes in the WFD chemical standards, there is currently insufficient information to produce a reasonable estimate of compliance and the potential cost of any measures. Environmental monitoring is being carried out that will inform the update to the river basin management plans and final impact assessment in 2015.This omission is significant as current indications are that non-compliance will be widespread and which, when known, would significantly increase the costs of remediation. For these substances we believe that costs for measures additional to those already in place are likely to be high, significantly adding to the costs under scenario 3 (e.g. EU wide strategy to reduce mercury

[32] Proposed as a specific pollutant, but EQS still to be set so for the purposes of the economic analysis the standards proposed by UKTAG have been used

emissions[33] under POPs Regulations[34] and enforcement of a ban on use of brominated flame retardants under REACH[35]). For the remaining 9 chemicals, classification has used modelling as well as monitoring, for the first time. Risk assessments (RAs) have been generated using modelling such as:

- SAGIS modelling (calculates source apportionment),
- SIMCAT flow models (impact of continuous discharges in a catchment) and
- EA and UKWIR monitoring data

These RAs have been used to "fill in the gaps" for water bodies where monitoring data is unavailable. Water bodies "at risk" or "probably at risk" of failure classification will be "less than good" and therefore measures targeted towards the sector responsible for resolving the problem.

This classification shows that, for these 9 chemicals, urban water bodies are the worst affected, often failing for more than one chemical, with rural areas dominated by mining also failing for metals.

Objective setting on a water body basis has been carried out at a national level using a "reduce first" strategy – whereby measures to reduce use are considered first, with pathway control (e.g. urban drainage), and end-of-pipe treatment measures considered only where source control will not deliver WFD objectives.

Additionally for all chemicals if there is local evidence of a failure and local investigation giving rise to appropriate measures, these measures must be included.

The output of this exercise is the development of an indicative[36] programme of action to manage each of the chemicals of national concern.

This economic analysis concentrates on river water bodies. There are some transitional and coastal (TraC) waters which are not compliant with some of these nationally significant chemicals based on 2013 classification data (42%). Many measures in upstream freshwater environments (such as source control treatment and sewage treatment works) will have a knock-on effect on the TraC waters as they will improve water quality entering estuaries and coastal environments. The more persistent chemicals are, by their very nature, likely to be more prevalent in TraC waters. As noted above these chemicals are omitted from the economic analysis currently due to lack of data.

In the scenario cost tables for costs of chemical measures, the water industry costs for treatment processes are net present values (based on CIPi options appraisal) with a discount rate of 3.5% applied over 20 years. All other costs, including water industry costs, for CIPii are undiscounted.

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[33] Mercury strategy http://ec.europa.eu/environment/chemicals/mercury/index_en.htm

[34] Persistent Organic Pollutants Regulation (EC) No 850/2004 as amended http://ec.europa.eu/environment/pops/

[35] Use of brominated flame retardants under REACH http://www.bsef.com/reach/

[36] For example, where SAGIS modelling suggests that over 50% of the contribution of a chemical to a water body is from a single source (e.g. STW) then we have assumed that measures targeted at that sector would be most effective to reduce levels to be compliant with the EQS.

4.6. Managing uncertainties in the catchment based economic appraisal process

Uncertainties are inherent in understanding and managing any complex and interconnected system such as the water environment. The general assumptions used in the appraisal process are outlined in section 12.

There are also unavoidable uncertainties and assumptions required in aggregating local level appraisal information to present a national scale analysis. In this economic analysis the catchment-level data is aggregated up to river basin district and sectoral level summaries which reduces some of the risk of any data variability at the measure level affecting the final results. Errors at an individual measure level are less likely to be significant at the aggregate level as sectoral and river basin district level costs are orders of magnitude higher than any individual measure; there are usually multiple measures in a catchment and multiple catchments in a river basin district. Systematic errors, which would not be removed by aggregation, have been dealt with through a quality assurance programme. As the purpose of the economic analysis is to give a reasonable indication of the likely scale of impact rather than an exact figure, any errors arising will not be significant in affecting this.

To manage other uncertainties present in the appraisal data e.g. in monetising some ecosystem services and not others, the Environment Agency has built a number of rules into the economic appraisal process, e.g. sensitivity analysis is included for each catchment based appraisal; and that bundles of measures are not deemed to fail the cost benefit test without a consideration of their wider benefits.

In order to carry out the economic appraisal required by the WFD, we needed to design a proportionate approach. It would not have been feasible or proportionate to carry out economic analysis at the water body scale for c5000 water bodies or to do a detailed cost-benefit analysis for each operational catchment.

We therefore used a framework that captured the broad range of impacts of the measures descriptively against a baseline of 'do nothing', and then goes on to monetise the costs and (most of the) benefits.

An analysis[37] based on Environment Agency data has shown that results from this proportionate appraisal methodology are usually the same as more resource intensive economic appraisal methodologies which monetise more benefits. Results from the appraisal methodology have been compared to results from more detailed valuations to see whether the different methodologies produced different results in terms of whether schemes are cost beneficial or not (BCR of greater than 1). This study shows that ‘less information in combination with sensitivity testing’ allowed for 94% accuracy at around 25% of the cost of the ‘full information’ method.

The most important non-market benefits for water environment improvements and those for which we have the most information have been selected for valuation in the economic appraisals. In addition to existence values and recreational and aesthetic services, the ecosystem services provided by wetland creation are also monetised for the economic appraisal.

As described above, automated sensitivity tests are built into the economic appraisal tools, which allow the users to see where the thresholds for bundles of measures lie. Sensitivity testing allows the user to assess uncertainties in the economic appraisal data e.g. what happens if the benefits are doubled? What does the benefit cost ratio look like if the costs

[37] Shamier, N. (2013). Does deriving more information lead to better decision making? Report for MSc Economics, London Metropolitan University.

are halved? The sensitivity test highlights any data sets that are close to the tipping point and this information is considered in the final appraisal recommendations.

Where, after sensitivity testing of the costs, the appraisal results are close to unity (particularly where BCR equal to 0.5 to 1.0) the appraisal methodology allowed the option of monetising additional benefits or costs. For example, if the appraisal identifies additional benefits associated with positive impacts on biodiversity through implementing agricultural measures beyond the water environment or any the benefits from measures resulting in an increase in abstraction for public water supply these can be monetised and added to the appraisal. This addition of further monetised benefits is known as a stage 1+. These results have also been aggregated and incorporated into options 3, 4 & 5 of this economic analysis.

5. Description of sectors

This economic analysis illustrates the costs to each of 4 sector groups and the benefits of 5 scenarios for the future management of the water environment. The economic analysis will consider 5 scenarios for the sector groupings in **Table** 2.

For the purpose of this economic analysis, the sectors whose activities can impact on the water environment have been placed in one of four groups. The groups are: 1. Government; 2. Rural land management; 3. Industry, services & infrastructure; and 4. Water industry. A description of each of the sectors and how they impact on the water environment is provided below.

Table 2 Sector grouping used in the economic analysis

Sector groups	Sectors
Government (the public sector)	Local government Central government (including Environment Agency flood and coastal erosion risk management and environment and business Grant in Aid)
Rural land management	Agriculture and farming Forestry
Industry, services and infrastructure	Industry, manufacturing and other business (including chemicals) Angling and conservation Non-Governmental Organisations Recreation Mining and quarrying Urban and transport Navigation (including ports) Internal Drainage Boards Waste treatment, transfer, storage and disposal Domestic/general public
Water industry	Water industry

Benefits and uses across sectors are strongly interrelated due to a shared dependence on a healthy functioning water environment. The actions of one sector may benefit the others in a number of different ways. For example, actions to improve the water environment by the government sector will have social and economic benefits that are shared by all other sectors. In turn, the public will benefit from the wide range of services delivered by different sectors, either as direct or indirect users of those services.

The main uses and benefits provided by the water environment to each sector are set out in Table 3 below. The National Ecosystem Assessment[38] describes in more detail the vital role of freshwater and marine habitats in supporting human wellbeing, which is the basis for this list.

Table 3 Main uses and benefits of the water environment to the 4 sectors

Abstracted water		
	Domestic use and public health	Uses and benefits: Drinking, cooking and preparing food, sanitation laundry and cleaning. Sector: Water industry
	Farming	Uses and benefits: Irrigation, drinking water for animals and farm processes (for example milking), horticulture. Sector: Rural land management
	Industrial, commercial and civic	Uses and benefits: Manufacturing including food and drink, power generation, mining, recreation or leisure, public buildings. Sector: Industry, service and infrastructure; government
Water environment		
	Waste dispersal and treatment	Uses and benefits: Waste dispersal (for example treated sewage, industrial effluent). Sector: Water industry; industry, service and infrastructure
	Transportation	Uses and benefits: Transporting people and goods. Sector: Industry, service and infrastructure
	Commercial fisheries	Uses and benefits: Shellfisheries, fin fisheries, aquatic plants (for example harvesting seaweed), aquaculture (for example fish farms). Sector: Industry, service and infrastructure
	Leisure, amenity, health and tourism	Uses and benefits: Boating; canoeing, angling, bathing, surfing, physical exercise and mental health, watching wildlife. Sector: Industry, service and infrastructure

[38] http://uknea.unep-wcmc.org/

	Wildlife	Uses and benefits: Genetic diversity, ecosystem resilience, compliance with biodiversity targets and other environmental legislation. Sector: Government; rural land management; industry, service and infrastructure; water industry
	Natural hazard regulation	Uses and benefits: Reducing the impact of floods and droughts. Sector: Government; rural land management; industry, service and infrastructure; water industry
	Life sustaining processes	Uses and benefits: Water flow regulation, soil formation, composition and fertility, atmospheric and climate regulation, nutrient cycling. Sector: Government; rural land management; industry, service and infrastructure; water industry
Economic growth and environmental performance		
	Economic development and security	Uses and benefits: Water and water environment supporting future economic development, drought resilience and national security (dependable water supplies). Sector: Government; rural land management; industry, service and infrastructure; water industry
	Resilience, Inter-generational legacy and sustainability	Uses and benefits: Uses and benefits identified above provided for future generations and growing population, short and long term resilience to market changes and global changes such as climate change. Sector: Government; rural land management; industry, service and infrastructure; water industry

5.1. Government

Sector overview

The government sector undertakes or sponsors a wide range of activities that contribute to achieving WFD outcomes. This 'baseline' regulation contributes significantly towards meeting the 'no deterioration' objective that underpins scenario 2. The funding for this sector comes from the public purse. Activities on the ground are managed by various organisations and their partners to provide a range of environmental benefits. These are summarised in Table 4 below along with the organisations involved.

Table 4 Government sub-sectors and their activities to achieve good status

Activities	Examples of benefits	Organisation
Managing flood risk	Creating/restoring habitat Improving biodiversity Improving fish passage	Environment Agency (EA) Lead Local Flood Authorities (LLFAs)
Managing surface water drainage	Reducing pollution by road run-off Sustainable surface water	Highway Authority

Activities	Examples of benefits	Organisation
	management Improving biodiversity	Local Councils
Restoring catchments[39]	Restored rivers Controlling invasive non-native species (INNS)	Defra/ EA Local Councils
Managing impacts on protected areas	Cleaner bathing waters Improving biodiversity Protecting drinking water	EA/ Natural England (NE) Local Councils
Local planning and development control	Biodiversity/habitat improvement Sustainable water management	Local Councils
Addressing unsustainable abstraction	Sustainable water management Biodiversity/habitat improvement	EA/ Natural England
Addressing historic pollution	Reducing abandoned mines pollution	Coal Authority EA
Managing rural land	River restoration Facilitating new woodland Managing adverse impacts of pesticides, nutrients and soil erosion Reduced acidification	Forestry Commission (FC) Defra Rural Payments Agency (RPA) Natural England Environment Agency
Managing land and assets in urban areas	Creating/restoring habitat Improving local environments Reducing environmental impacts from the public estate	Local Councils

Invasive non-native species (INNS)

Many invasive non-native species spread rapidly and once they are established control is often prohibitively expensive or technically infeasible and ultimately unsuccessful. INNS cost the economy in England at least £1.3billion[40] every year. The cheapest, most effective measure is to apply good biosecurity, which reduces the introduction of new species and slows the spread of those already present. Where it is possible to control some species by

[39] Environmental non-governmental organisations such as Rivers Trusts and Wildlife Trusts also carry out these types of action.

[40] The Economic Cost of Invasive Non-Native Species on Great Britain, Defra commissioned report from CABI 2010.

reducing their extent or density, Invasive Species Action Plans are developed to help co-ordinate the response across all sectors.

Mines

Some water bodies are not meeting good status due to the ongoing impacts of leaching of chemicals from abandoned mines. Metal and coal mines cause up to 4% of surface water body failures in England[41]. Abandoned metal mines damage the health of fish and other aquatic life for many kilometres downstream. Rising coal mine waters threaten some drinking water supply aquifers. They also cause localised orange staining in rivers that harms invertebrates and prevents fish spawning. The Coal Authority works with government (Department of Energy and Climate Change and Defra) and the Environment Agency to manage pollution from abandoned mines and help improve the status of water bodies subject to available funds.

Flood and coastal risk management

The government sector includes flood risk management functions carried out by the Environment Agency. It does not include other flood risk management authorities such as Internal Drainage Boards[42]. Flood risk management often leads to the physical modification of water bodies and physical modifications are one of the top three pressures causing water body failures, reported in the first river basin management plans.

WFD recognises that physical modification of water bodies may provide multiple benefits to society (e.g. navigation, flood risk management, water supply and hydropower purposes) but can also limit the diversity of habitats, animals and plants and consequently cause disbenefits (i.e. aesthetics, recreation, natural water purification etc). Where carefully designed to work with natural processes, flood risk management schemes can protect people from flooding and mitigate the impact of physical modifications on ecology. The impacts of maintenance activities can be reduced by changing the way watercourses and the land around them are managed.

Funding and mechanisms

In April 2011, DEFRA announced the allocation of £92m additional funding to deliver Water Framework Directive (WFD) objectives over the course of the Spending Review period. Defra provided funding to the Coal Authority through the Environment Agency (EA) to undertake work on abandoned metal mines. Funds are also provided through Defra WFD Grant in Aid (GiA) to the EA to enable the management of invasive non-native species and to address flood defence issues. The total flood defence grant in aid set aside for 2015 to 2020 is £3.9 billion (HM Treasury National Infrastructure Plan 2013).

[41] Source: Catchment Planning System extract (May 2014). https://ea.sharefile.com/d/s7e378d3187741f2b

[42] Whilst Internal Drainage Boards (IDBs) are public bodies which manage a significant portfolio of waters, their income is predominantly raised directly from the local beneficiaries of their work in managing water levels and their contribution is included under the industry, services and infrastructure sector.

5.2. Rural land management

Sector overview

The agriculture sector in England manages about 69% of the land[43] and so has a very significant contribution to make towards sustainable management and protecting the quality of England's waters. Forestry covers only about 10% of land in England but has a significant role in impacting or improving the quality of the water environment, especially in upland areas. In 2013 agriculture contributed £7.1bn (0.6%) of national Gross Value Added of England's economy[44] and forestry a further £200m[45].

Some rural land management activities are polluting and deplete natural resources. Environment Agency investigations have shown that most pollutants in rural environments result from farming activities, but other sources such as roads, stables, golf courses, rural sewage works and household septic tanks also contribute. These are covered in the narrative for "industry, services and infrastructure". Individual sources of pollution are often small, but collectively can have a significant impact on the quality of surface water and groundwater.

Water abstracted by the sector can cause reduced river flows and low water levels that affect wetlands, impact ecology directly and can compound water quality impacts in rivers.

A large proportion of the land managed by this sector is associated with water bodies that need some degree of action to meet environmental objectives. Consequently, most rural land managers in England could take some steps to reduce their impact on the water environment. For example, agriculture is the second largest sector for water use in the country. Integrated catchment approaches and good farming practices would help to reduce the impact on river flows and groundwater levels.

Catchment Sensitive Farming (CSF) has brought about significant improvements within some catchments. Based on the first four years (2006-2010) of CSF in England pollutant loadings from agricultural sources were generally predicted to decrease by between 5 and 10 per cent across Target Areas (total phosphorus, orthophosphate, sediment, faecal indicator organisms, and total oxidised nitrogen)[46].

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[43] England land area is just over 13 million ha. Utilised agricultural area on holdings in England is 9 million ha (2013)

Dept. For Communities and Local Government (2011). Land use change statistics in England: 2011.

Defra (2013). Farming statistics. Final Land Use, Livestock populations and Agricultural Workforce at 1 June 2013 – England

[44] Defra statistics - Productivity 2013. Note: Gross Value Added (GVA) measures the contribution to the economy of each individual producer, industry or sector in the United Kingdom

[45] UK Non-Financial Business Economy (Annual Business Survey), 2012 Regional Results. See http://www.ons.gov.uk/ons/rel/abs/annual-business-survey/2012-regional-results/index.html

[46] Environment Agency, 2011. Catchment Sensitive Farming – ECSFDI Phase 1 & 2 Full Evaluation Report. http://publications.naturalengland.org.uk/publication/5329340644458496

Industry led campaigns such as the Campaign for the Farmed Environment and the Voluntary Initiative give advice to farmers resulting in action that helps reduce water pollution and improve biodiversity.

Agriculture and forestry management practices can work with natural processes to reduce flood risk. Slowing the flow of surface water and storing water on the flood plain during periods of high flows in rivers will help reduce risk to people and property. Farming and managing rural land in an environmentally sensitive manner will help prevent deterioration in the quality of drinking water, improve bathing water standards, protect the most sensitive environments and support healthier aquatic ecosystems.

Sustainable farming is vital to maintain a high quality environment, a vibrant rural economy and to increase food production to feed a growing population. By farming in an environmentally sensitive manner, farming can help maintain the quality of drinking water, the cleanliness of beaches and healthier ecosystems.

Funding and mechanisms

Historically, agri-environment schemes have provided additional action over and above a baseline of good practice. The baseline is in part given impetus by regulation, but the farming industry also plays an important role in advising on regulatory compliance and encouraging uptake of best practice where it economically adds value to the farm business.

During the last river basin management cycle the rural sector has continued to adapt and develop to the challenges of delivering WFD objectives. Ownership of environmental issues within the sector has grown significantly and is now integrated into sector strategies, action plans and recognised through continuous professional development training.

Nutrient management planning on farms has greatly improved and has been adopted by over 60% of farms. These will help farmers manage valuable resources to their business, meet regulatory demands and protect the environment. Trends show that less fertiliser is being applied across the country and that soil nutrient surpluses are decreasing.

Industry initiatives such as the Voluntary Initiative and the Metaldehyde Stewardship Group have played a key role in communicating environmental issues and best practice messages to farmers and in some pilot catchments, failures have reduced significantly[47].

Section 10.2 describes the Common Agricultural Policy (CAP) contribution to measures to improve the water environment. Government sponsored advice schemes such as Catchment Sensitive Farming (CSF) have brought about many improvements but funding has been limited to those catchments where benefits are most valued.

Safeguard zones have been developed to focus action on drinking water that may be at risk from nitrate or pesticides. Some water companies have been working directly with farmers and in some cases have been paying for ecosystem services over and above “good” practice to protect drinking water sources.

The UK Forestry standards (UKFS) provide guidance on forests and water to all forestry and woodland managers and form part of sustainable forest management. The guidance is in part advisory and in part a legal requirement.

[47] Catchment Sensitive Farming Evaluation Report Phases 1 to 3 (2006-2014), Environment Agency, 2014

5.3. Industry, services and infrastructure sector

Sector overview

There are many sub-sectors within the industry, services and infrastructure sector that have a wide range of impacts on the water environment. In general this sector is not as significantly affected by the public spending and policy decisions as the other three sectors discussed here. However, the sector has a valuable contribution to make to effective catchment management. For example, in the 75 failing bathing waters and shellfish water sites[48] pollution from urban sources contributes to the failures.

Some of the significant activities undertaken by this sector include:

- the power generation sector abstracts 24 billion litres of water for cooling every day and discharges a similar amount back into the environment[49]
- the pulp and paper industry abstracts 0.5 billion litres a day and generates large volumes of contaminated effluent that requires treatment[50]
- the food and drink sector also uses large amounts of water as a raw material and in the manufacturing process resulting in large amounts of effluent along with solid waste and sludge that are often spread on agricultural land
- management of solid waste from industry and households also has the potential to pollute groundwater and surface waters either as a result of discharges from landfills and treatment plants or as a result of recycling organic materials to land
- run-off from the country's transport infrastructure (road, rail and airports) can be contaminated resulting in pollution of both surface and groundwater
- pollution arising from urban areas which ultimately runs off into the water environment and causes up to 10% of all water bodies to fail environmental objectives[51]
- physical modifications made to water bodies to enable navigation and land drainage also have a significant impact on the quality of the water environment

The following sector activities have a broad range of positive and negative effects on the water environment which include:

- using water for processing or manufacturing goods
- discharging substances directly or indirectly into the water environment
- making use of water bodies for transport and recreation enhancing wildlife and habitat conservation[52]

Most of the major sites operated by this sector are subject to regulations that require some form of environmental permit aimed at limiting negative impacts on the environment.

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[48] FIO Evidence Summary (2011 for bathing waters and 2010 for shellfish waters). Sharefile link to pressure narratives is: https://ea.sharefile.com/d/sae688784f7946fcb

[49] Annual water abstraction estimates for England and Wales

https://www.gov.uk/government/statistical-data-sets/env15-water-abstraction-tables

[50] Paper and pulp sector plan 2012:http://ams.ea.gov/ams_root/2013/51_100/95_13.pdf

[51] Source: Catchment Planning System extract (May 2014) https://ea.sharefile.com/d/s7e378d3187741f2b

[52] Although NGOs will not be directly impacted by the costs associated with measures in the river basin management plans they are key to delivering major improvements.

This sector grouping also contains the many national and local voluntary groups with an interest in protecting and improving the environment. Through partnership working or the management of their own land holdings, these groups have a significant and increasingly important role in the sustainable management of the water environment. This has been recognised in the government's sponsorship of the Catchment Based Approach (CaBA) and catchment based partnerships.

Funding and mechanisms

The sub-sectors in the industry, services and infrastructure sector are privately funded and not generally reliant on government funding or subsidies.

The impact of many industrial activities is controlled using the Environmental Permitting Regulations (EPR) and/or water abstraction licences. Often the primary mechanism for controlling the impact of industry is when permits are issued or reviewed. Monitoring compliance with permit conditions helps the Environment Agency to ensure people and the environment are protected. Site based management systems are important for minimising the impact of industrial operations on the environment.

Thermal power stations must balance maximising energy efficiency, reducing CO_2 emissions and environmental impact. This is done through UK legislation that implements EC Directives and Regulations, including the Industrial Emissions Directive, the Habitats Directive, the Water Framework Directive and Eels Regulations. Projections for freshwater demand by this sector are variable and could increase or decrease depending on the future electricity generation mix (including the uptake of Carbon Capture and Storage), the future location and the cooling technology used.

Since the 1990s, landfill sites have been designed and built on containment principles to prevent or minimise leachate to groundwater. Since 2002, the implementation of the Landfill Directive has required consistent standards of site engineering, monitoring and waste input control at all new and operational landfills. It is unlikely that WFD will significantly affect operators in the landfill sector.

5.4. Water industry

Sector overview

The water industry provides wastewater services and water to households, the public sector and industrial and commercial sectors. There are 10 regional water and sewerage companies (WaSCs) that are responsible for the treatment and disposal of sewage in England and Wales, 9 of which operate primarily within England. There are an additional 9 regional companies that only supply clean water. These services are paid for by the water companies' customers through their water bills.

The water industry takes about 15 billion litres of water a day from rivers, canals, reservoirs, lakes, estuaries and groundwater[53]. The Environment Agency regulates how much is taken through abstraction licences. Too much abstraction can reduce the amount of water available for other activities such as agriculture, industry and recreation. Over abstraction can also affect the wildlife and aesthetic quality of river environments.

Sewage and dirty water from households and businesses is collected via the sewerage system. Water and sewerage companies in England collect about 9 billion litres of sewage

[53] Water Company WRMP Annual Reviews

every day and treat it before releasing it to the environment. Sewage effluent contains a number of organic and inorganic contaminants along with bacteria and viruses. Discharge of effluent is regulated through environmental permit regulations.

Actions taken by the water industry can have a significant influence on the quality of the environment and often result in wider benefits to society. For example:

- maintaining adequate river flows by taking less water from surface waters and groundwater at environmentally sensitive locations helps protect ecosystems and ensures that more water is available for dilution of treated sewage effluent
- removing more pollutants from wastewater helps protect ecosystems and supports the use of water for a wide range of purposes including drinking water supply, irrigation, water sports, angling, conservation, and wider aspects such as tourism and quality of life
- water companies own and manage tens of thousands of acres of land and do so in a way that ensures that the water that is taken from these catchments is of as good a quality as possible before it gets treated and supplied to households and businesses

Phosphorus is the most common water quality reason for not achieving good ecological status, with 45% of river water bodies and 74% of lake water bodies in England exceeding the P standard[54] for good ecological status. Reasons for not achieving good status data indicate that the water industry is solely, or partly, responsible for around 38% of the failures of the standards of phosphorus in the environment nationally[55]. Apportionment studies suggest that despite the major reductions in the last 2 to 3 decades, waste water remains the largest source of phosphorus in rivers nationally (about 70% of total phosphorus inputs) and the second largest source of phosphorus in lakes. Much of cost of measures that the Water Industry can take to achieve good status are for improved treatment of sewage to remove more phosphorus.

The National Environment Programme[56] includes a national programme of technology trials to determine how much phosphorus sewage treatment works can remove from sewage. This national trial is looking to change the current understanding of best available technology for removing phosphorus from sewage. The full cost implication of meeting WFD good status following the completion of the phosphorus trials is difficult to predict. Nationally there is not a good understanding of the cost of treating phosphorus in sewage effluent to less than 1mg/l P.

Funding and mechanisms

The quality of the water environment has been steadily improving, mainly through investment by water companies, funded by their customer's bills. Over the last 20 years the water industry has invested about £20 billion into protecting rivers and other water courses. This equates to roughly £1,300 for every household[57].

Investment by the water industry in water management is reviewed at regular intervals. Every 5 years Ofwat, the economic regulator for water and sewerage, sets limits on the prices water companies can charge their customers in a process referred to as the Periodic Review. In 2014, Ofwat will agree the limits for 2015 to 2020 based on its scrutiny of water

[54] 2013 classification data, Environment Agency, 2013

[55] Challenges and Choices, June 2013.

[56] Environment Agency (December 2013) National Environment Programme.

[57] Severn Trent Water (November 2013). Changing Course through the sustainable implementation of the Water Framework Directive.

company business plans. The Periodic Review is the principal mechanism for agreeing and funding action that the water industry must take to carry out its responsibilities, including protection of the environment. The cost of improvements required will be reflected in customers' bills. Ofwat ensures through its determinations that water company plans offer customers the best value for money.

The Environment Agency works with water companies, Ofwat, and others (including Natural England and the Drinking Water Inspectorate) to ensure that investment protects the water environment, increases resilience and secures long-term benefits for society and the economy. The Environment Agency sets out the environmental obligations in the National Environment Programme which water companies incorporate into their business plans. It specifies the work required to manage protected areas, prevent deterioration and achieve long term objectives in the water environment.

6. Scenario 1 – No new measures (2013 baseline)

6.1. Introduction

Under this scenario there would be a completion of existing ongoing measures but no new measures or adaptation of existing measures introduced to alleviate any negative impacts to the water environment from predicted trends and changes in population growth and climate change (see section 4.2 for methodology).

This scenario assumes that all commitments that may still be outstanding from previous plans, for example, any outstanding commitments from water company business plans or any unrealised benefits from measures funded by the Catchment Restoration Fund would happen. The scenario also assumes continued compliance rates with existing environment permits and regulations, and continued Environment Agency pollution prevention activities.

Scenario 1 involves no direct additional costs because it is a continuance of existing commitments. Because of increasing pressures on the water environment existing measures may prove insufficient to deliver long term objectives or ensure there is no deterioration. Under scenario 1 there would be no additional cost on the sectors to meet environmental requirements. However, due to a deteriorating environment, there would be increased operational costs to those sectors which use water as part of their normal activities.

Under scenario 1, the projections for England show that with no new measures beyond 2015 there would be a general deterioration in water body status; with notable increases in the overall percentage of water bodies at moderate or poor ecological status by 2027.

Changes to water body status

Under scenario 1, the number of water bodies that are predicted to deteriorate by a single class from current status by 2027 (e.g. good to moderate) if no new measures are added to river basin management plans has been estimated.

This deterioration would increase costs and reduce the value of the uses and benefits that society gains from the water environment. The loss of benefits is estimated to be £-6.8 billion (PV). This is likely to be an underestimate because it is based on willingness to pay values rather than willingness to accept compensation for loss, which research has shown is generally higher.

Predicted pressure from significant water management issues (SWMIs)[58] - abstraction and flow, physical modification, invasive non-native species, sanitary pollutants, chemicals and metals, phosphorus from sewage treatment works, and sediment have been used to estimate where deterioration in class by 2027 could occur. A different set of SWMIs were considered for each water body category. Eutrophication risk for rivers, lakes, estuaries and coastal waters has not been considered as there is insufficient data to provide any level of certainty about the possible extent of the deterioration it would cause.

The risk of each SWMI pressure changing (increasing or decreasing) in the future is driven by population increase, land use change and predicted changes in climate. The headline projections for each of the key drivers are:

- Office for National Statistics 2010 population trend projections show an overall increase of 12.5% for England by 2030; with increases of 7% to 17% across all river basin districts[59], increasing point source pollution and demand for abstraction.
- Defra 2020 agricultural projections for England, extrapolated to 2027, show a general reduction of 10% across all livestock numbers and a general small reduction (<5%) in arable land area[60].
- Climate projections for each river basin district are informed by UK Climate Projections (UKCP09) regional climate scenarios. Projections are generally qualitative at this stage but the current understanding is that future summers will be warmer and drier (with intense rain events) and winters will be wetter. These conditions would increase risk of pollutant transport to water while reduced summer flows may exacerbate the impact of pollutant loadings on water quality.

The impact of the spread of invasive non-native species was also considered.

Scenario 1 estimates that there would be a general deterioration in the status of 40% of water bodies across all surface water body categories by 2027. For surface water bodies, the percentage at good ecological status or potential would fall from 29% (2013) to 18% (2027). For groundwater, the percentage at good status would fall from 41% (2013) to 28% (2027)[61]. The main reasons for the predicted deterioration in surface waters are an increase in the physical modification of rivers and the spread of invasive non-native species. The increase in physical modification is driven by climate change and population growth resulting in the need for increased flood protection and land drainage, the spread of urban areas and more water storage (impoundments).

Figure 1 below shows 2013 and predicted 2027 classification for scenario 1 for England. The differences across the river basin districts are:

- Anglian, Solway Tweed (England only), Dee (England only) and Northumbria would see the biggest percentage deterioration for rivers, each with more than 55% of water bodies deteriorating by a class
- Humber, Northwest, Solway Tweed (England only) and South East would see the biggest percentage deterioration for lake water bodies, each with more than 37% deterioration in class

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[58] Risk Assessment Methods: https://ea.sharefile.com/d/sbdae032840d49c08 Risk Assessment Results: https://ea.sharefile.com/d/s7b2d35d7bd94651a

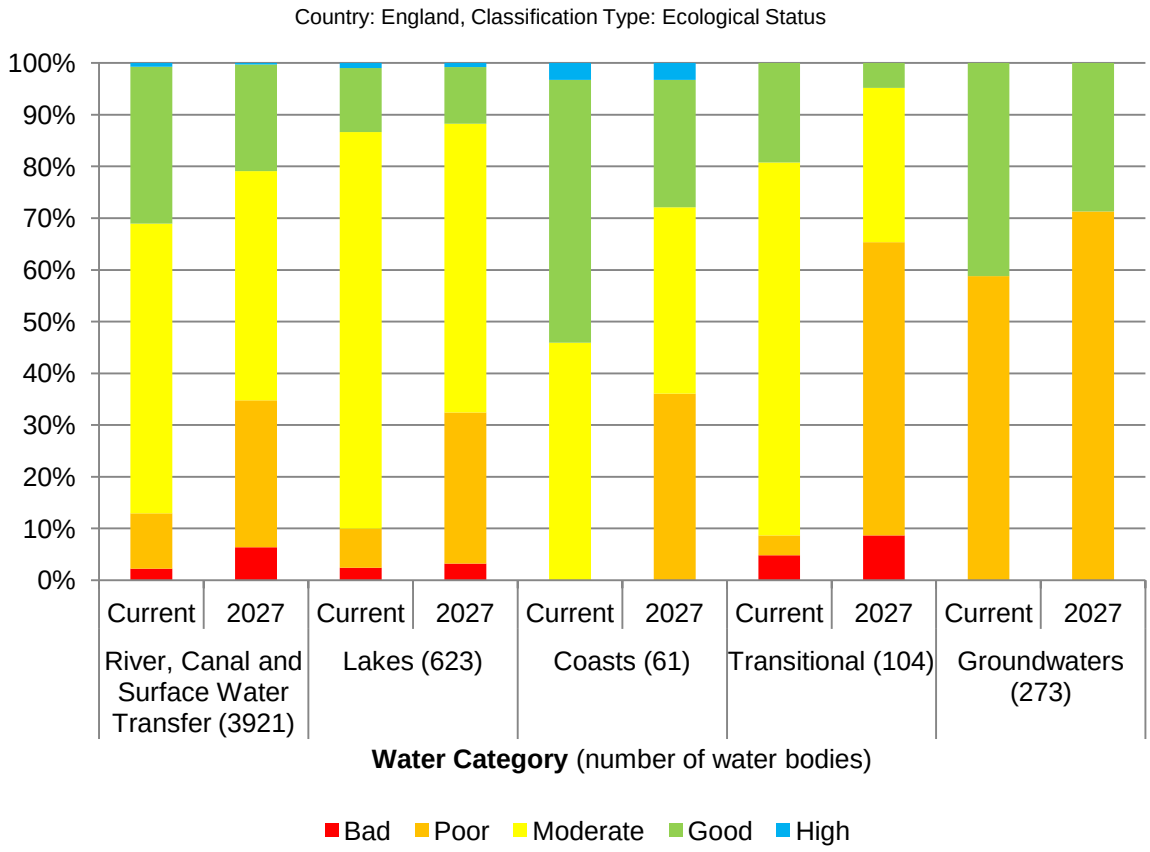
[59] Anglian, South East, Thames and Southwest RBDs have the highest projected increases of 13% to 17%.

[60] Derived from Defra FAPRI UK 2020 Land use projections

[61] Economic analysis, water body outcomes: https://ea.sharefile.com/d/s3f211ee337040b9a

- Anglian, Solway Tweed, South East, South West and Thames see the biggest percentage deterioration for transitional water bodies (estuaries), each with more than 30% deterioration by a class
- Anglian, Northumbria, South West and Thames would see the biggest deterioration in coastal waters, each with more than 30% deterioration in class
- For groundwater North West, Northumbria, Solway Tweed and Thames would see the biggest largest deterioration from good to poor status at 28%, 20%, 40% and 19% respectively

Figure 1 Percentage of water bodies in each class by water category 2013 and predicted 2027 classification



The SWMI pressures with the biggest negative impact on water body status by 2027 are physical modification and invasive non-native species.

The risk from invasive non-native species has a wide geographical coverage for all surface waters. It is assumed that the risk would be manifested in an additional 5% of water bodies in each of 2015-21 and 2021-27 on top of those water bodies impacted by other SWMI pressures.

The impact of physical modification on surface waters is also expected to be high across all surface waters. Rivers in Anglian, Humber, Northumbria, Solway Tweed and Thames river basin districts are expected to be the worst impacted, with more than 27% of water bodies predicted to deteriorate due to this pressure alone. Flood protection, urban areas and land management associated sediment present the highest pressure (each impacting >80% of the overall water bodies impacted by physical modification pressure). Impoundments,

barriers to fish and land drainage are next worst representing between 28% and 38% of overall water bodies impacted by physical modification pressure.

Table 5 below shows the SWMI pressures relevant to each surface water category and the percentage of the water bodies in each water category for which a SWMI pressure is expected to cause deterioration by 2027.

Table 5 Percentage of water bodies that would deteriorate due to SWMI pressure by 2027

	Abstraction and Flow	Physical Modification	P from STW	Sanitary Pollutants	Sediment	Chemicals & Metals	Invasive non-native species
Rivers, Canals & Surface Water Transfers	4	26	3	3	7	0	43
Lakes	1	25	n/a	n/a	n/a	n/a	33
Estuaries	n/a	24	n/a	n/a	n/a	n/a	32
Coastal waters	n/a	23	n/a	n/a	n/a	n/a	31

Changes to compliance with protected area objectives

17% of bathing waters are predicted to be at medium or high risk of deterioration by 2030 and 29% by 2050. The corresponding figures for risk of deterioration at shellfish waters are 0% by 2030 and 18% by 2050, but these figures must be viewed in the context of the lower baseline compliance for shellfish waters. In 2011, 71% of shellfish waters did not comply with the guideline shellfish flesh standard; these waters are also at risk of non-compliance in future in addition to those that comply but the current assessment has determined may be at risk of deterioration.

195 (40%) of 485 currently designated surface water Drinking Water Protected Areas (DrWPA) are considered at risk of not complying with protected area objectives. The Humber and North West river basin districts are most at risk with 52 (27%) and 50 (26%) water bodies respectively, of the 195 water bodies at risk. The actual area and number of DrWPA under designation can increase or decrease by 2027. The situation is similar for groundwater DrWPA. 130 (48%) of 271 groundwater bodies are considered at risk of deteriorating drinking water quality by 2027.

There is currently no estimate of deterioration by 2027 for Nitrate Vulnerable Zones (NVZs) and Nutrient Sensitive Areas (NSAs) due to lack of appropriate method to reliably forecast the geographical designations of these Protected Areas.

6.2. Changes to multiple benefits for scenario 1

The appraisal of the draft river basin management plan included an assessment of how the benefits derived from the water environment are likely to change in the absence of the update to the plan. This qualitative assessment was used to develop a summary of the anticipated trends in response to the pressures detailed in Table 6. There are no improvements expected in the benefits provided by the water environment. Some types of benefits would be expected to remain at current levels, but the overwhelming picture would

be a likely deterioration, leading to further indirect effects on the wider environment and the economy.

Table 6 Changes to multiple benefits for scenario 1

Significant benefit	^^	Significance of change between baseline and scenario 1
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	
Benefits and uses	Scale	Benefits to sectors
Provisioning services		
Fresh water	v	Water industry: less, and less clean water available for abstraction All sectors: less sustainable supplies due to rising demand
Food	o	No net change, although deterioration would undermine sustainable intensification of agriculture long term
Water for non-consumptive use	o	No net change, although the spread of INNS would clog waterways and prevent inland navigation long term
Regulating services		
Climate regulation and adaptation	v	All sectors: insufficient adaptation to predicted climate change effects
Water regulation	v	Government; Rural land management: increasing flood risk from changing rainfall patterns and high runoff rates
Erosion regulation	vv	Rural land management: Increasing loss of agricultural topsoils from changing rainfall patterns Water industry: increased treatment costs due to high sediment loads
Water purification and waste treatment	v	Water industry; Industry, Services and Infrastructure: lower quality water environment; increasing treatment costs to remove pollutants prior to use
Cultural services		
Cultural heritage	o	
Recreation and tourism	v	Industry, Services and Infrastructure: Bathing waters failing; decreasing opportunities for nature based recreation

Significant benefit	^^	Significance of change between baseline and scenario 1
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	

Benefits and uses	Scale	Benefits to sectors
		such as angling and bird-watching
Aesthetic value	v	Industry, Services and Infrastructure: INNS and high nutrient levels reduce water clarity and views of waters
Existence value	vv	Government: Species loss and deteriorating water environment impact on public/individuals sense of wellbeing
Supporting services		
Provision of habitat	vv	All sectors: Habitat quality in protected areas declines. Habitat quantity in wider landscape reduces. Biodiversity reduces correspondingly, with negative impacts on all other benefits.

6.3. Government: current activity assumed to continue

The Defra WFD Grant in Aid (GiA) for England fund and the Catchment Restoration Fund (CRF) have enabled actions that have supported the improvement of water bodies to good status. These improvements have been created by the Environment Agency working in partnership with other arms length bodies, environmental non-governmental organisations and with communities.

In the Defra WFD GiA fund there are 464 projects covering 1,209 water bodies addressing 1,400 elements. It is expected that 300 water bodies will be moved to good status as a result of this fund, 36 of those by 2015. Of 131 applications to CRF (May 2012), 42 were approved with a total value of £24.5 million, with a further £5.25 million worth of partnership funding, volunteer activity and benefit in kind having been secured. As a result of these projects, over 300 water bodies in England will receive habitat improvement works, improved access for fish or reductions in diffuse pollution, making significant steps towards achieving WFD water body objectives[62]. Future funding and programmes under the CRF have yet to be announced for 2015 onwards.

[62] Catchment Restoration Fund: Environment Agency Summary Report 2013-2014. Defra, July 2014.

National management of the problem of invasive non-native species (INNS) is organised under the Invasive non-native Species Framework Strategy for Great Britain[63]. Government funded measures in cycle 1 have helped reduce the risk of deterioration by slowing the spread of certain species through better biosecurity, by working to eradicate others and by developing biological controls to Japanese knotweed and Himalayan balsam. Invasive non-native species currently cost England's economy more than £1.3 billion each year[64] and this cost would rise under scenario 1. In addition, the adoption of the EU regulation on the prevention and management of the introduction and spread of invasive non-native species, while helping meet WFD objectives, may also increase costs to Government.

Whilst improvements to the water environment have been made through government investment future improvements to water body status under scenario 1 is very limited and there is likely to be deterioration in water bodies that have and have not received previous investment.

6.4. Rural land management: current activity assumed to continue

Action to improve the water environment within the agriculture and farming sector has always been through a combination of regulation, voluntary approaches, advice and incentives.

Regulation and voluntary action are the baseline for achieving many WFD objectives. Current regulation focuses on reducing nitrate in targeted water bodies and standards for the storage of slurries, silage and fuel oils. Other regulations focus on the disposal of pesticides, and compliance with abstraction licenses. Cross compliance[65] delivers some benefits in reducing soil erosion and riparian management to protect water and hedges.

The catchment based approach has been successful in finding additional funding to supplement Government and industry investments. There are also many voluntary actions taken by farmers that help prevent water quality deteriorating, for example the uptake of pesticide advice from the Voluntary Initiative, especially in water safeguard zones around drinking water abstractions. Voluntary action by farmers (£13 million per cycle) through Campaigned for the Farmed Environment (CFE) has prevented further deterioration of water[66]. Nearly half of arable farmers in lowland areas in 2012/13 have voluntarily installed measures including; a total of 17,000ha of buffer strips and the maintenance of 6,700km of fencing next to watercourses.

[63] Defra, May 2008 (available at the GB Non-Native Species Secretariat website http://www.nonnativespecies.org/). The strategy is currently being updated and reviewed, and will be published in late 2014.

[64] https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=488

[65] An audit by the Rural Payments Agency of farmers who claim the Single Farm Payment (SFP)

[66] Defra Campaign for the Farmed Environment Survey. Survey of land managed voluntarily in 2012/13 (England). https://www.gov.uk/government/statistics/campaign-for-the-farmed-environment-survey-of-land-managed-voluntarily-in-201213-england

Advice programmes such as Catchment Sensitive Farming[67] (CSF) have brought about significant improvements within some catchments. Reductions in phosphate, sediment or pesticides from the first four years (2006-2010) of CSF in England were predicted to be between 5 to 10% on average but up to 36% in places. CSF is currently funded until March 2015.

The Rural Development Programme for England (RDPE) provides funds of about £3 billion which are delivered by Natural England as part of the New Environmental Land Management Scheme (NELMS) to 2020. Whilst this focuses on biodiversity, water is an important priority. Over 60% of farms are currently in some form of environmental stewardship (ES), but with less money from the Rural Development Programme in cycle 2 of the river basin management plans this proportion is likely to reduce. The current environmental stewardship scheme has a number of measures to protect water quality but water quality had a lower priority in that scheme and there was limited targeting at this issue.

Woodland creation delivered through the Forestry Commission has also contributed to preventing deterioration, with about 12,000ha of new woodland created since 2009[68]. A programme of targeting woodland creation to reduce diffuse water pollution has recently delivered more than 1,500ha of extra woodland and will help to improve surface and groundwater[69].

However, the rural sector requires further investment to prevent losing current benefits received from the water environment. Future pressure on farming and rural communities will come from climate change, increased population, increased costs, and the threat of animal diseases and invasive non-native pest species. The long-term benefits of acting and investing now would not be secured under scenario 1. The benefits to the long-term health of the environment and the value of farmers' holdings would not be retained or improved.

6.5. Industry, services and infrastructure: current activity assumed to continue

The Defra 'Environmental Protection Expenditure by Industry, 2012' (Defra, 2014) report estimates that the total spending by UK business in 2012 on environmental protection was £3.1 billion. The lead spending industry was energy production and distribution (22%). To calculate how much the industry, services and infrastructure sector spends on protecting the water environment in England, water industry high-level sector costs (termed 'water supply and treatment') were removed and then the total figure was proportionally reduced using the population of England compared to the UK, and the reported expenditure on actions that are assumed to protect the water environment compared to total environmental expenditure. This indicates that the sector spends £1.2 billion annually on protecting the water environment in England.

The Industry, services and infrastructure sector contributes to England's economy and benefits from a supply of clean water. Some of the sub-sectors including power generation, pulp and paper, and food and drink industries depend upon a supply of water. Under scenario 1 many organisations would incur greater costs in the long term as the quality and availability of fresh water in England deteriorates.

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[67] CSF is a joint project between the Environment Agency and Natural England, with targeted action to improve the status of Protected Areas

[69] Personal communication, M. Broadmeadow, Forestry Commission, October 2014

6.6. Water industry: current activity assumed to continue

For the water industry, scenario 1 means there would be no additional measures beyond those funded from water company business plans for 2010 to 2015[70]. No additional measures would be put in place. The water environment would deteriorate due to pressures such as population growth, resulting in increased sewer discharges reducing the benefits to society that have been gained from investment over previous asset management planning periods.

In the short-term, water company customers would experience slightly lower bills under scenario 1, than under scenario 2. Environmental improvements for 2010 – 2015 added approximately £15 to water bills over this period[71]. It is reasonable to assume that this would be the saving to water companies' customers' bills between 2015 and 2020 if no new measures were put in place.

For the Asset Management Planning[72] (AMP) period, which runs from 2015 to 2020, the forecast spend for business as usual activities for the wastewater aspect of water companies is about £15 billion (at 2012 to 2013 prices) which equates to about £3 billion per year on average for the 5 year period. These are estimates and will be subject to further decision making as part of the PR14 determination process. The majority of this cost is in ongoing operational and maintenance of assets to maintain the environmental improvement achieved over the last 25 years including (in order of size – largest first)[73]:

- ongoing operational costs for wastewater assets
- capital maintenance of wastewater assets
- ongoing costs for sludge treatment and disposal
- carry over or ongoing environmental work outside of WFD includes 'First Time Sewerage', transferred private sewers and UWWTD work including the Thames Tideway tunnel

These reflect business as usual activities and are required outside of WFD.

The water resources spend is relatively small in comparison to water quality. It consists of the cost of water company abstraction licences, which is about £114 million per year; the environmental protection costs associated with water supply and treatment, which is about £64 million per year[74]; the marginal costs of more expensive water supply options where the Environment Agency's licensing policy prevents a cheaper option; the cost of river support schemes operated and paid for by water companies; and the cost of reservoir compensation releases, which are made for environmental reasons.

Over the longer-term, it would be reasonable to assume that deterioration in water quality under this scenario would lead to increased treatment costs for any abstractor that required potable quality water. The additional costs to the sector would depend on the degree of deterioration, the quality required and the current treatment. Under this scenario costs are likely to rise for the water industry sector.

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[70] i.e. Asset Management Plan (AMP) 5

[71] Covering both water quality and water resources costs of improvement. Ofwat Final Determination 2009

[72] AMP periods are accompanied by Price Reviews where Ofwat, the economic regulator for water and sewerage, sets limits on the prices water companies can charge their customers.

[73] Communication from Ofwat, June 2013.

[74] Environmental Protection Expenditure by Industry, 2012. Defra, 2014.

6.7. Measures and mechanisms to achieve good chemical status

The Environment Agency has identified 13 chemicals that are of national concern with respect to meeting good status in England's water bodies as per Table 1. Of these chemicals, 10 impact on water body good chemical status (GCS) and 3 on good ecological status (GES)[75].

There is currently only adequate data to perform risk assessments for 9 of the 13 chemicals. The actions per sector to address these chemicals under this scenario are listed in Table 7. Overarching measures, such as the Industrial Emissions Directive, is applicable to all Priority Substances and Priority Hazardous Substances not just the ones listed.

Table 7 Measures to achieve good chemical status under scenario 1

Sector[76]	Chemical(s)	Action under scenario 1
Government	Metals (cadmium, copper‡, nickel, lead, zinc‡)	Mine water remediation schemes under CA would be operated and maintained.
Industry, services and infrastructure	Tributyl tin compounds (TBT) Nonylphenol Metals (cadmium, copper, nickel, lead, zinc)	The Industrial Emissions Directive (IED)[77] and permitting under EPR would support the reduction of the emission of specific chemicals into water bodies
	Di(2-ethylhexyl) phthalate (DEHP)	REACH regulations[78] is the EU system for controlling chemicals. Compliance should reduce hazardous DEHP entering water courses.
	Triclosan‡	Triclosan is being voluntarily removed from a range of uses (e.g. domestic[79]). There is a forecast of continuing declining use for triclosan.
Water industry	Tributyl tin	For all chemicals if there is local evidence of a

[75] Environment Agency (2014). Draft economic analysis for river basin planning: National chemicals assessment (England). Available on request.

[76] This table is not applicable for the rural land management sector

[77] http://www.defra.gov.uk/industrial-emissions/eu-international/industrial-emissions-directive/ IED came into force in early 2013 streamlining previous legislation by replacing seven existing directives.

[78] REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) is the system for controlling chemicals in the EU. For more information visit: www.hse.gov.uk/reach/index.htm

[79] http://ec.europa.eu/health/scientific_committees/opinions_layman/triclosan/en/index.htm#3

Sector[76]	Chemical(s)	Action under scenario 1
	compounds (TBT) Di(2-ethylhexyl) phthalate (DEHP) Metals (cadmium, copper, nickel, lead, zinc)	failure and local investigation giving rise to appropriate measures, these measures must be included. Including the 4 STWs included in PR14 indicative programme. Permitting under EPR would support the reduction of the emission of specific chemicals into water bodies.

[f] chemical impacts on ecological status rather than chemical status (copper, zinc, triclosan)

In addition to the risk assessment for chemicals there is a potential[80] PR14 programme for the water industry which is based upon sample data from the recently concluded water industry chemicals investigation programme[81] (CIP) and Environment Agency sampling.

7. Scenario 2 – Aim to prevent deterioration and achieve protected area objectives

7.1. Introduction

Scenario 2 considers how the addition of measures can help prevent deterioration in status and includes measures needed to achieve protected area objectives.

Scenario 2 includes all measures needed to prevent deterioration in status and achieve protected area objectives, including Natura 2000 sites (under Habitats and Birds Directive), Shellfish Waters (SfW), Bathing Waters, Drinking Water, and Nutrient Sensitive Areas. There are no new measures for Nutrient Sensitive Areas (Nitrate Vulnerable Zones). Costs and benefits have been assessed using a range of methods detailed in section 4.4.

The costs of preventing deterioration are for the short term (cycle 2, projected to cycle 3) for foreseeable measures (e.g. for the water industry PR14 measures to prevent deterioration) rather than possible measures needed to counter potential long term (2050) issues caused by climate change and/or population growth.

[80] Where it is shown by sample data from CIP and EA sampling that the site is causing failure of the EQS in the receiving water and therefore treatment should be included in the Periodic Review 2014.

[81] UKWIR CIP (Chemicals Investigations Programme): Volume 1 – Main Report (Ref. No. 13/EQ/01/6) https://www.ukwir.org/site/web/content/reports/reports 1st phase options appraisal for the Water Industry.

7.2. Scenario 2 predicted cost and water body status outcomes

Table 8 Scenario 2: A summary of the costs (£million) to prevent deterioration in England's water bodies and achieve protected area objectives.

River basin district	Government	Rural land management	Industry, services & other	Water industry	Overall Total
Anglian	90	860	20	350	1,320
Dee	1	6	0	0	6
Humber	50	440	8	80	570
North West	90	910	20	1,020	2,050
Northumbria	10	100	2	50	170
Severn	10	140	3	40	190
Solway Tweed	20	190	3	80	290
South East	20	220	4	140	380
South West	140	1,300	20	250	1,710
Thames	20	150	3	180	350
England total	**400**	**4,300**	**100**	**2,200**	**7,000**

Notes

Appraisal period is 37 years (2015-2052). This is the appraisal period Defra has asked the Environment Agency to use for WFD analysis. This was 43 years in 2009 (the start of cycle 1), made up of the three 6 year cycles of the planning process, plus 25 years.

Severn, Dee and Solway Tweed River Basin Districts are England only costs.

Numbers may not sum to totals due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

7.3. Scenario 2 estimated benefits

The main assumptions used to estimate the monetised benefits for no deterioration and each protected area are summarised in Table 9.

Table 9 Assumptions made to calculate benefits in scenario 2

Cost driver	Benefit assumption
No deterioration	Benefits of preventing deterioration are assumed to be at least equal to the benefits of improving status. Benefits monetised using the NWEB values[82].
Natura 2000	Evidence on the benefits is not available because different characteristics are used to assess the conservation status of Natura 2000 sites, than those used to assess the ecological status of water bodies. It was assumed that benefits are at least equal the cost of measures[83] of improving and maintaining Natura 2000 sites.
Drinking Water	DrWPA monetised benefits are not available. For the water industry sector, it was suggested that these could be represented by water company's cost savings due to reduced treatment costs. This data is not something that is currently collected. There is a consultation being run by Defra which indicates potential cost savings for these measures however, it indicates very low cost savings overall, so not likely to change any baseline significantly. These numbers can't be used yet as only out for consultation.
Bathing water	The benefit values of meeting sufficient status, provided by the Bathing Water Valuation Study (2013) willingness to pay survey[84], and supporting local information[85] are used in comparison with costs.
Shellfish waters	The Environment Agency has undertaken a preliminary assessment of the costs and benefits of the proposed packages of measures for SfW required to achieve protected area standards for shellfish waters, using the NWEBS values.
Nutrient sensitive areas (UWWTD)	To calculate a monetised benefit value for water quality, water industry sector measures (specifically no deterioration and UWWTD protected area, sensitive area measures), the non-monetised benefits (km of rivers, number of lakes and km2 of coastal water bodies improved) have been calculated using NWEBS values (all 6 categories) for £000/km(2)/year, status improvement from poor to

[82] See section 'Approach to the economic analysis' for detail

[83] Cost estimates for Natura 2000 measures RBMP2. V1 (26 June 2014).

The costs include: physical habitat restoration of 16 Natura 2000 sites; diffuse water pollution remediation for Natura 2000 sites; lake restoration on Sites of Special Scientific Interest lakes; and estimates of costs under NELMS for on site management to maintain the recovering condition for Natura 2000 (N2K) WFD related sites and to implement new actions identified over the Common Agricultural Policy period to 2020.

[84] Report for the Environment Agency, 2013. Bathing Water Valuation Study – National Survey Summary Report (Draft). Economics for the Environment Consultancy Ltd (Eftec), in association with Ipsos Mori and The South West Research Company.

[85] Including Environment Agency bathing water profiles (April 2014), Environment Agency regions, beach managers, Local Authorities (tourism officers or the local tourism bureau), online beach directories.

Cost driver	Benefit assumption
	moderate (to represent no deterioration and a lower estimate than 'to good' for UWWTD compliance so as not to over-estimate benefits). The number of lakes was converted to an average using km2 area of all WFD lakes nationally; average 0.43km2. The yearly values were multiplied by 12 and halved for each 6 year cycle.

Table 10 Estimated monetised benefits of measures (NPV £m) and water body outcomes for scenario 2

River basin district	Total present value costs	Total present value benefits	Net Present Value £m	No. of water bodies improved to good or better	Total no. of water body improvements
Anglian	860	1,080	+220	10	10
Dee	4	10	+9	0	0
Humber	370	1,140	+770	5	5
North West	1,420	3,980	+2,560	15	15
Northumbria	110	320	+210	<5	<5
Severn	120	470	+350	0	0
Solway Tweed	180	390	+210	15	20
South East	270	800	+530	<5	<5
South West	1,070	2,000	+920	10	10
Thames	220	670	+450	0	0
England total	**4,600**	**10,900**	**+6,200**	**60**	**70**

Notes

Numbers may not sum to totals due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

7.4. Changes to multiple benefits for scenario 2

Measures to prevent deterioration and meet protected area objectives under scenario 2 would result in the provision of stable and in some areas, improved ecosystem services (Table 11). However, in the medium to long term an enhanced programme to counter the

effects of population pressure and climate change would be required to prevent deterioration.

Table 11 Changes to multiple benefits for scenario 2

Significant benefit	^^	Significance of change between baseline and scenario 2	
Noticeable benefit	^		
No net change	o		
Noticeable disbenefit	v		
Significant disbenefit	vv		
Benefits and uses		Scale	Benefits to sectors
Provisioning services			
Fresh water		^	Water industry: cleaner water available for abstraction All sectors: more sustainable supplies
Food		o	
Water for non-consumptive use		^	Industry, Services and Infrastructure: more reliable flows; fewer INNS clogging navigable waters
Regulating services			
Climate regulation and adaptation		v	All sectors: insufficient adaptation to predicted climate change effects
Water regulation		^	Government; Rural land management: some local reduced flood risk as runoff reduced, some floodplains reconnected and water stored in upper catchments
Erosion regulation		o	
Water purification and waste treatment		^	Water industry; Industry, Services and Infrastructure: cleaner water environment; reduced treatment costs
Cultural services			
Cultural heritage		o	
Recreation and tourism		^	Industry, Services and Infrastructure: Bathing waters protected
Aesthetic value		o	
Existence value		^	Government: wellbeing benefits felt by public/individuals due to improved water environment and protected species

Significant benefit	^^		Significance of change between baseline and scenario 2
Noticeable benefit	^		
No net change	o		
Noticeable disbenefit	v		
Significant disbenefit	vv		
Benefits and uses		Scale	Benefits to sectors
Supporting services			
Provision of habitat		^	All sectors: quality of Natura 2000 sites improved; biodiversity supports all other sector benefits

7.5. Government measures to prevent deterioration and achieve protected area objectives

Measures in scenario 2 to prevent deterioration and reduce the effects from invasive non-native species (INNS) on water bodies would be undertaken at a national and local scale as appropriate and include:

- species impact assessments
- action groups with local partnership initiatives and plans
- rapid responses to contain and eradicate new invasions
- raising public awareness, particularly with water users, to contain and eradicate new invasion
- promoting the “Check, Clean, Dry” messages
- continue to improve knowledge of species distribution and new and established species, including via online and smart phone applications

The Great Britain Non-Native Species Secretariat would continue to commission assessments of the risk posed by potential impact of INNS. These are used to inform appropriate responses, including the need for INNS action plans to coordinate measures specific to priority species. This group also draws together an online resource of information, advice and local action that raises awareness and shares learning.

To protect and improve bathing waters and shellfish waters, additional measures such as bird controls, seaweed clearance, dog controls, gully pot cleaning[86], maintenance of drainage systems, beach cleans and beach monitoring are required.

[86] A gully has a concrete pot under the road surface and water collects in the pot and is then channelled through a series of pipes before connecting into the main sewer network. Sometimes these pipes and channels become blocked with soil, dead leaves and rubbish, preventing the free flow of water to the main sewer. Therefore, the pots need cleaning from time to time.

The water environment has been physically altered in some protected areas for flood risk management purposes and urban development. However, in some places, the modification is no longer required or, where it is still in use, it could be changed to ensure any negative impacts on the environment are sustainably reduced. Mitigation measures include for example, the removal of hard bank reinforcement and bank re-profiling. For a full list of possible mitigation measures please see section 8.5.

7.6. Rural land management measures to prevent deterioration and achieve protected area objectives

A growing population and the addition of some incentives running counter to water environment objectives (e.g. for maize and other energy crops) and variability in commodity prices are predicted to put further pressure on land use over the next decade. This would continue to cause risk of deterioration to water bodies from sediment. Measures to prevent deterioration in the rural sector would be through improved targeting of all good practice measures; smarter regulation, integrated farm advice and through appropriate land management. Measures to meet protected area standards would depend on the cause of failure.

For Natura 2000 sites, measures that prevent the spread of phosphate and sediment from the land to water bodies would protect resources and benefit farm businesses in the longer term.

For example, by containing slurry and manure during the winter months; better uptake of nutrient planning and efficient use of fertiliser and manures; and improved awareness and management of soil loss from fields.

For failing bathing waters, measures that prevent faecal contamination entering water bodies either directly or from rainfall run-off are essential. A measure to support this would be fencing watercourses to reduce access to surface waters from livestock. Other measures include the batch storage of slurry and killing faecal organisms before slurry is applied to the land.

To protect and improve drinking water standards, industry advice would be required. Government will be consulting on additional pesticides measures. For excess nitrate, in addition to the nitrate vulnerable zone action programme, some land use change may be appropriate. Land that is managed differently, for example where targeted upstream land has been set aside for woodland creation, would better protect sensitive sites from diffuse pollution. Woodland is known to be a physical barrier to run-off and has the ability to soak up nutrients before they reach surface or groundwater. Integration of regulatory, voluntary and agri-environment schemes are required to achieve the goals of meeting no deterioration and protected area objectives. As new evidence is collated on the effectiveness of measures, delivery would require adaptive management. It is unlikely, due to results from recent classifications data, that regulation in its current form would be sufficient alone to address phosphate and sediment pressures and ensure protected areas meet current standards.

7.7. Industry, services and infrastructure measures to prevent deterioration and achieve protected area objectives

Many industrial activities are subject to Environmental Permitting Regulations (EPR) and/or water abstraction licences. These regulations help to control the impact of industrial activities on protected areas and reduce the risk of deterioration. Often the primary mechanism for controlling the impact of industry is when permits are issued or reviewed. Permit conditions help monitor compliance and ensure people and the environment are protected. Site based

management systems are important for minimising the impact of industrial operations on the environment.

The urban and transport sub-sector (within this sector) principally impacts bathing and shellfish waters. Investigations have shown that, of the 75 failing bathing and shellfish waters sites, 60 have some contribution from urban sources (including from misconnections and contaminated run-off)[87]. Seven of these sites have urban contributions greater than 50%.

Additional measures are needed to tackle misconnections and urban run-off (both of which convey faecal contaminants). Measures to prevent deterioration and reduce the effects of industry and business activities on protected areas are those that are private concerns and would include the responsibility for septic tank controls, private sewerage systems, private drainage systems and caravan park or holiday camp pollution controls.

The water environment has been physically altered in some protected areas for the purposes of a variety of industries and services for example, ports and navigation. In some cases, where the modifications to the water environment are no longer required or there are opportunities to reduce any negative impacts on the environment from modification, mitigation measures are possible, for example, removal of hard bank, riparian planting or riparian re-profiling to improve hydromorphology.

7.8. Water industry measures to prevent deterioration and achieve protected area objectives

Discharge permits and abstraction licences are already in place to help to reduce the risk of water quality and resource deterioration. Water company abstraction of water from rivers, canals, reservoirs, lakes, estuaries and groundwater, is regulated through abstraction licences. The treatment of wastewater is also regulated through discharge permits which provide the level of protection required by legislation. These regulations help to control the impact of water industry activities on protected areas and help reduce the risk of deterioration. Water companies should also ensure that any planned changes to abstractions within existing licence quantities do not cause deterioration of water body status.

Measures to prevent deterioration and reduce the effects of water industry activities on protected areas include tightening of sewage discharge permit limits with associated improvements to sewage treatment, reduction in combined sewer overflow spills, removal of discharges when appropriate, increases in storm tank capacity, changes to abstraction licences and changes to catchment management practices.

The water environment has been physically altered in some protected areas for water industry use, for example, for flow and level management and impoundments. In some cases, where the modifications to the water environment are no longer required or where there are opportunities to reduce any negative impacts on the environment from modification, mitigation measures are possible such as bank re-profiling, weir removal and re-introduction of more natural riparian habitat.

[87] Source apportionment data from EA actions database (June 2014)

7.9. Measures and mechanisms to achieve good chemical status

Measures for achieving good chemical status in scenario 2 are as per scenario 1. Further measures relating to good chemical status are not required for scenario 2. The National Risk Assessment for deterioration[88] concludes low risk of real deterioration in chemical status due to existing chemical use restrictions.

8. Scenario 3 – Aiming to implement all technically feasible measures to get water bodies to good status

8.1. Introduction

Scenario 3 includes the costs of achieving Protected Area objectives and no deterioration as per scenario 2; in addition it includes the costs and benefits of achieving good status, through adoption of all technically feasible measures, in all water bodies. In this scenario all water bodies (where technically feasible) in England would be at good status and no measures would be ruled out on the basis of cost. Availability of funding is not taken into consideration.

It is worth noting that technical infeasibility and natural conditions mean that almost 20% of water bodies would not attain good status.

8.2. Scenario 3 predicted cost and water body status outcomes

Table 12 Scenario 3: A summary of the costs (£ million) to prevent deterioration, achieve protected area objectives and all technically feasible improvements towards good status. No affordability constraint.

River basin district	Government	Rural land management	Industry, services & other	Water industry	No sector identified	Overall Total
Anglian	460	960	180	2,580	100	4,280
Dee	<1	10	<1	5	0	15
Humber	410	770	300	2,390	110	3,980

[88] National Risk of Deterioration Assessment Chemicals 14 Mar 2013, Environment Agency

River basin district	Government	Rural land management	Industry, services & other	Water industry	No sector identified	Overall Total
North West	170	1,080	400	3,000	30	4,680
Northumbria	110	100	120	320	10	660
Severn	100	420	100	990	70	1,680
Solway Tweed	20	280	10	90	0	400
South East	250	270	20	760	40	1,340
South West	230	2,270	80	960	40	3,580
Thames	900	600	410	3,070	70	5,050
England total	**2,700**	**6,800**	**1,600**	**14,200**	**500**	**25,800**

Notes

Scenario 3 is an extension of and therefore includes the costs of scenario 2. Costs are not in addition to scenario 2.

Appraisal period is 37 years (2015-2052). This is the appraisal period Defra has asked the Environment Agency to use for WFD analysis. This was 43 years in 2009 (the start of cycle 1), made up of the three 6 year cycles of the planning process, plus 25 years.

Severn, Dee and Solway Tweed River Basin Districts are England only costs.

Numbers may not sum to totals due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

Cost of chemicals' measures that affect good ecological status are included.

All sector costs are subject to uncertainty. Water industry costs are mid-point estimates. They have at least +/- 30% range reflecting the uncertainty of the estimates which should be considered when reading this information.

8.3. Scenario 3 estimated benefits

Benefits were calculated using the catchment based economic appraisal methodology. For details please see section 4.4 of this document.

Table 13 Estimated monetised benefits of measures (NPV £m) and water body outcomes for scenario 3

River basin district	Total present value costs	Total present value benefits	Net Present Value £m	No. of water bodies improved to good or better	Total no. of water body improvements
Anglian	3,120	2,520	-600	299	330
Dee	4	10	+9	3	3
Humber	2,850	2,740	-100	574	606
North West	3,030	5,320	+2,290	357	362
Northumbria	390	610	+220	192	204
Severn	940	1,280	+340	253	265
Solway Tweed	250	480	+230	72	73
South East	710	1,410	+690	199	206
South West	2,260	3,420	+1,150	357	395
Thames	2,550	3,310	+760	239	275
England total	**16,100**	**21,100**	**+5,000**	**2,545**	**2,719**

Notes

The river basin district Net Present Value (NPV) is derived from the aggregated catchment present value costs and present value benefits. Therefore these NPV do not take account of the subsequent adjustments made to the catchment costs in order to present them for the four sector groups. These adjustments were to add in the costs of measures to address chemicals, and a range to the Water Industry costs estimates. The sector totals also do not include costs of measures not identified to sectors.

Numbers may not sum to totals due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

8.4. Changes to multiple benefits for scenario 3

The quality of water would be expected to improve significantly, benefiting both people and nature as urban and rural diffuse and point source pollutants are excluded and treatment of waste water is enhanced. The volume of fresh water for drinking and food production would increase over time as abstraction is made more sustainable, demand reduces through efficiency of use and the water industry benefits from more good quality water sources available. In addition, those benefits that people get direct enjoyment from such as aesthetics, recreation and tourism, would be expected to improve significantly which could have far reaching benefits for public health and wellbeing (Table 14).

Technical infeasibility of measures is likely to limit improvements to levels of phosphate and prohibit the removal of some invasive non-native species where they are well established. This would have localised impacts on biology where achieving good status is not possible.

The timescales which it would take to realise the benefits described above would vary, depending on the rate at which physical and biological ecosystems respond.

Table 14 Changes to multiple benefits for scenario 3

Significant benefit	^^	Significance of change between baseline and scenario 3
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	

Benefits and uses	Scale	Benefits to sectors
Provisioning services		
Fresh water	^^	Water industry: more, cleaner water available for abstraction All sectors: more sustainable supplies
Food	^	Rural land management: sustainable businesses supported by wider benefits (soil, pollinators, climate resilience); potential changes to actual productivity/ yields unknown
Water for non-consumptive use	^	Industry, Services and Infrastructure: more reliable flows; fewer INNS clogging navigable waters
Regulating services		
Climate regulation and adaptation	^	All sectors: Adaptation to predicted climate change effects such as drought and flooding; some carbon storage local regulation of microclimate from habitat creation and restoration; reduced GHG emissions from agricultural sources
Water regulation	^^	Government; Rural land management: reduced flood risk as runoff reduced, sustainable drainage systems used, floodplains reconnected and water stored in upper catchments
Erosion regulation	^^	Rural land management: agricultural topsoils retained; upland peat restored; mining spoil stabilised
Water purification and waste	^^	Water industry; Industry, Services and Infrastructure: cleaner water

Significant benefit	^^	Significance of change between baseline and scenario 3
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	

Benefits and uses	Scale	Benefits to sectors
treatment		environment; reduced pollutant concentrations; reduced treatment costs
Cultural services		
Cultural heritage	v	Government: potential for engineering and excavation works to negatively impact heritage; mitigation is possible
Recreation and tourism	^^	Industry, Services and Infrastructure: bathing waters protected; more and better quality angling, walking and bird-watching opportunities
Aesthetic value	^^	Industry, Services and Infrastructure: improved water clarity as sediment and nutrients reduced; aesthetic improvement in restored landscapes
Existence value	^^	Government: wellbeing benefits felt by public/individuals due to improved water environment and protected species; species more able to move through landscape as climate changes as habitat quality and quantity increase[89]
Supporting services		
Provision of habitat	^^	All sectors: Natura 2000 sites improved; habitat quality and quantity increased in wider landscape; biodiversity supports all other sector benefits

8.5. Government measures for ecological status/ potential

Under scenario 3 the programme of improvements would include the following measures associated with flood defence works:

- Enabling fish passage (e.g. creating fish passes)
- Managing risk of fish entrainment

[89] Lawton, J. et al. (2011). Making space for nature. Report for Defra.

- Modifying and/ or removing structures
- Managed realignment
- Improving longitudinal connectivity
- Removing or replacing hard bank reinforcement with soft engineering solutions
- Reprofiling or rehabilitating riparian banks
- Implementing channel maintenance strategies
- Protecting and maintaining natural sediment processes
- Increasing in-channel morphological diversity
- Creating and managing habitat, protecting existing vegetation
- Improving floodplain connectivity
- Preserving and restoring habitats
- Changing operational regime (locks weirs etc)
- Implementing water level management strategies
- Reducing the extent of invasive non-native species by operations

The principle ways in which the EA flood risk management department can take action to address physical modifications are:

- Production of long-term plans and strategies (including Catchment Flood Management Plans, Shoreline Management Plans, Flood Risk Management Plans & Estuary Strategies)
- The implementation of capital flood risk management schemes which achieve multiple outcomes
- Regulation, through the issuing of flood defence consents and the enforcement of conditions etc.
- Implementation of routine and intermittent maintenance activities that mitigate the impacts of flood risk management and contribute to the enhancement of water body status.

8.6. Rural land management measures for ecological status/ potential

Measures to reduce the effects of farming activities on all water bodies would extend wider than the measures presented in scenario 2. Larger changes to business as usual practices would need to be made by the rural land management sector, including improved soil and nutrient management and application, and targeted land use or crop change, for example, woodland creation or restrictions on some crops. The degree of land use change is important in the balance of food and energy production versus the health of catchments. In scenario 3, land management measures such as creation of buffer strips would play an important role in meeting scenario 3 targets, as well as time limited abstraction licences and licensed trickle irrigation and measures to control septic tank discharges that may have an impact on controlled waters. In some surface waters with high sediment, mitigation dredging would be required

A diverse variety of mechanisms to tackle the impact of the rural land management sector would need to be deployed in order to achieve the aims of scenario 3.

The mechanisms used to deliver the measures described above, would include:

- new approaches to improve baseline environmental performance and to reduce phosphate and sediment loss to the environment for farmers, domestic properties and highways
- new approaches to reduce pesticides in drinking water
- review of abstraction licensing
- targeted compensatory payments for measures beyond baseline good practice
- integrated and targeted advice from government and voluntary sector

Much reliance has been put into agri-environment measures as a means of achieving water quality objectives. However, action is voluntary through compensatory payments and not incentives to farmers.

8.7. Industry, services and infrastructure measures for ecological status/ potential

Waste

The main impact of the waste treatment, transfer, storage and disposal sub-sector on the water environment is the leaching of chemicals from landfill sites into local water courses. The cost to the sub-sector of treating leachate from landfill sites would depend on the target level quality of discharge required. As the regulatory body, the Environment Agency could impose more stringent limits on discharge consents for discharge to the water environment, or water companies could pass on the cost of higher standards at Waste Water Treatment Works (WwTW) through tighter trade effluent consents. As an additional measure new sites could have better containment engineering. However, this may exceed current Landfill Directive minimum standards. It is not technically feasible to upgrade containment engineering sites where the containment engineering has been buried under waste. There are a total of 280 permitted non-hazardous waste sites, 25 permitted hazardous waste sites, and 1400 permitted closed landfill sites. Treating leachate to a higher standard to meet more stringent costs could cost £10k to £100k per site, assuming capital costs of £50k, plus additional operating costs of £5k per site for 100 sites affecting the water environment would require approximately £8m additional investment[90]. The range of options includes; tankering neat leachate to WwTw, treatment and discharge to sewer, and treatment and discharge to surface water. Where a reduction in discharge to groundwater is required, interventions would depend on individual site's leachate quality, liner design and proximity to groundwater and would require detailed site specific assessment.

Urban and Transport

In the urban and transport sub-sector contaminated runoff from surface water outfalls is the principal source of pollution. There are many technically feasible ways to prevent or treat this runoff. Green sustainable urban drainage systems (SuDS) can be designed into new buildings and infrastructure or retro-fitted, at greater cost, to reduce pollutants to surface waters from run-off[91].

[90] High level estimates based on expert judgment provided by Environment Agency Senior Advisors, Regulated Industry Department.

[91] As supported by the Flood and Water Management Act 2010.

Domestic

The domestic sub-sector contributes to pollution in water bodies through drainage misconnections to the wrong sewer. For example, wastewater misconnected into surface water sewers can discharge directly into rivers or onto beaches, or clean rainwater connected to foul sewers can cause overflows to rivers or seas. To meet the aims of scenario 3 and prevent water body pollution from misconnections water companies need to include plans for dealing with misconnections in business plans. The Environment Agency can support water company business plans in stopping this issue by running public advice and guidance campaigns about the issue for the general public.

Navigation

Ports and harbours are designated as heavily modified. Investment would be required to improve 2 water bodies, currently at moderate, to good potential, plus to address any actions from ongoing investigations by provision of mitigation measures.

8.8. Water industry measures for ecological status/ potential

Potential water industry measures are the same type as those outlined in scenario 2. The measures under this scenario have a wide spread geographical distribution and include more restrictive conditions on discharge consents and changes to abstraction licences.

The UKWIR RG08 project concluded that to restore flow in all river water bodies in England to environmental flow indicators (EFI) conditions in proportion to the impact would cost the water industry sector £4.6 billion. This estimate was based on the cost of closing the gap fully between present flow conditions and the EFI (at low flows) as a proxy for the required flows to support good status. Results of recent investigations on some river water bodies indicate that in practice flow recovery to a lower threshold may be sufficient to support good ecology. Also some investigations have not been able to identify an ecological problem linked to the flow deficit, implying that no action on flow deficit is needed for these cases.

8.9. Measures and mechanisms to achieve good chemical status

The Environment Agency has identified 13 chemicals that are of national concern with respect to meeting good status in England's water bodies as per Table 1. Of these chemicals, 10 impact on water body good chemical status (GCS) and 3 on good ecological status (GES)[92].

There is currently only adequate data to perform risk assessments for 9 of the 13 chemicals. The actions per sector to address these chemicals under this scenario are listed in Table 15. Overarching measures, such as the Industrial Emissions Directive, is applicable to all Priority Substances and Priority Hazardous Substances not just the ones listed. Estimated costs to improve chemical status under this scenario are in Table 16.

[92] Environment Agency (2014). Draft economic analysis for river basin planning: National chemicals assessment (England). Available on request.

Table 15 Measures to achieve good chemical status under scenario 3

Sector[93]	Chemical(s)	Action under scenario 3
Government	Metals (cadmium, copper†, nickel, lead, zinc†)	Under scenario 3 each water body reported as failing EQS due to emissions from mines would be treated
Industry, services and infrastructure	Tributyl tin compounds (TBT) Nonylphenol Metals (cadmium, copper, nickel, lead, zinc†)	The Industrial Emissions Directive (IED)[94] and permitting under EPR would support the reduction of the emission of specific chemicals into water bodies. In addition to the Industrial Emissions Directive, measures to reduce urban/road run off would be implemented under scenario 3.
	Di(2-ethylhexyl)phthalate (DEHP)	REACH regulations[95] is the EU system for controlling chemicals. Compliance should reduce hazardous DEHP entering water courses.
	Triclosan†	In addition to the decline in use of triclosan in some products (e.g. domestic[96]) a national campaign for the voluntary reduction of use would accelerate the reduction of triclosan in the environment.
Water industry	Tributyl tin compounds (TBT) Di(2-ethylhexyl)phthalate (DEHP) Metals (cadmium, copper, nickel, lead, zinc)	For all chemicals if there is local evidence of a failure and local investigation giving rise to appropriate measures, these measures must be included. Including the 4 STWs included in PR14 indicative programme. Permitting under EPR would support the reduction of the emission of specific chemicals into water bodies. In addition under scenario 3 all treatment options that have been determined to be technically feasible should be carried out (CIP options appraisal[97]) Nitrifying filtration (NTF) for DEHP, nonylphenol,

[93] Table not applicable for rural land management sector

[94] http://www.defra.gov.uk/industrial-emissions/eu-international/industrial-emissions-directive/ IED came into force in early 2013 streamlining previous legislation by replacing seven existing directives.

[95] REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) is the system for controlling chemicals in the EU. For more information visit: www.hse.gov.uk/reach/index.htm

[96] http://ec.europa.eu/health/scientific_committees/opinions_layman/triclosan/en/index.htm#3

[97] UKWIR CIP (Chemicals Investigations Programme) 1st phase options appraisal for the Water Industry (not yet published) looking at concentrations of chemicals in sewage treatment effluent and compartments of raw sewage as well as piloting treatment processes to remove these chemicals.

Sector[93]	Chemical(s)	Action under scenario 3
		copper, zinc, triclosan Rapid gravity filtration (RGF) for TBT Membrane filtration/reverse osmosis (MF/RO) for nickel

[‡] chemical impacts on ecological status rather than chemical status (copper, zinc, triclosan)

In addition to the risk assessment for chemicals there is a potential[98] PR14 programme for the water industry which is based upon sample data from the recently concluded water industry chemicals investigation programme[99] (CIPi) and Environment Agency sampling. Under scenario 3 treatment options are at 3 sites where sampling suggests that treatment is required.

Table 16 Scenario 3: Estimated costs to improve chemical status (£million). Improvements in status where technically feasible.

	Government[(1)]	Industry[(2)], services, and infrastructure[(3)]	Rural land management[(4)]	Water industry	Total PV Costs[(5)]
£million	120	Not quantified	n/a	1360	1,500

Notes

These are primarily Present Value costs from the Chemicals Investigation Programme (CIP). The PVs were calculated for a 20 year appraisal period using a discount rate of 3.5%.

(1) Government includes investment in metal mine remediation

(2) Investment by industry has not been quantified at this stage as this is largely driven by Industrial Emissions legislation, which is being implemented separately.

(3) There is no specific allocation of investment on infrastructure to tackle urban diffuse pollution to chemicals as this is part of an ongoing Defra consultation on diffuse urban pollution

(4) There is no estimate for rural land management. EQS compliance is generally not an issue for agricultural chemicals. The main driver relating to pesticides is protection of drinking water protected areas, this does not relate to priority chemicals. Risks to drinking water protected areas for other pesticides are covered in scenario 2 and consider measures currently available.

(5) Numbers may not sum to totals due to rounding.

[98] Where it is shown by sample data from CIPi and EA sampling that the site is causing failure of the EQS in the receiving water and therefore treatment should be included in the Periodic Review 2014.

[99] UKWIR CIPi (Chemicals Investigations Programme): Volume 1 – Main Report (Ref. No. 13/EQ/01/6) https://www.ukwir.org/site/web/content/reports/reports 1st phase options appraisal for the Water Industry.

9. Scenario 4 – Aiming to achieve worthwhile objectives in the long term

9.1. Introduction

Scenario 4 includes the costs and benefits of achieving Protected Area objectives, no deterioration and good status in all water bodies[100] where measures are technically feasible and where benefits justify the costs.

Scenario 4 differs from scenario 3 in that the cost and benefit data from measures to improve water bodies to good status is only included if a bundle of measures for a catchment has a benefit cost ratio of more than one; in other words the benefits of the bundle of measures equal or exceed the costs and are considered economically worthwhile. In scenario 4 no measures are ruled out on the basis of affordability or availability of funding.

This scenario illustrates the costs and benefits to the sector groups of achieving the proposed long-term water body objectives that are included in the consultation on updating river basin management plans. These are the objectives that the catchment based economic appraisal methodology has assessed as being worthwhile to achieve the long term.

9.2. Scenario 4 predicted cost and water body status outcomes

Table 17 Scenario 4: A summary of the costs (£million) to prevent deterioration, achieve protected area objectives and improvements in status where benefits exceed cost. No affordability constraint

River basin district	Government	Rural land management	Industry, services & other	Water industry	No sector identified	Overall Total
Anglian	350	960	140	1,070	100	2,620
Dee	<1	10	<1	<1	0	10
Humber	200	690	210	570	70	1,740
North West	120	1,080	240	1,650	20	3,110
Northumbria	90	100	110	220	10	530
Severn	90	450	70	360	50	1,020
Solway	20	280	10	90	0	400

[100] Technical infeasibility and natural conditions mean that at least 20% of water bodies will attain less than good status.

River basin district	Government	Rural land management	Industry, services & other	Water industry	No sector identified	Overall Total
Tweed						
South East	250	270	20	380	40	960
South West	270	2,050	100	560	40	3,020
Thames	880	580	420	1,020	70	2,970
England total	**2,300**	**6,500**	**1,300**	**5,900**	**400**	**16,400**

Notes

Scenario 4 is an extension of and therefore includes the costs of scenario 2. Costs are not in addition to scenario 2.

Appraisal period is 37 years (2015-2052). This is the appraisal period Defra has asked the Environment Agency to use for WFD analysis. This was 43 years in 2009 (the start of cycle 1), made up of the three 6 year cycles of the planning process, plus 25 years.

Severn, Dee and Solway Tweed River Basin Districts are England only costs.

Cost of chemicals' measures that affect good ecological status are included.

Numbers may not sum to totals due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

All sector costs are subject to uncertainty. Water industry costs are mid-point estimates. They have at least +/- 30% range reflecting the uncertainty of the estimates which should be considered when reading this information.

9.3. Scenario 4 estimated benefits

Scenario 4 represents the measures outlined in the proposed updates to the river basin management plans. Changes to ecosystem services were assessed as part of the catchment based economic appraisal in order to provide wider context to the monetisation of costs and benefits.

Table 18 Estimated monetised benefits of measures (NPV £m) and water body outcomes for scenario 4

River basin district	Total present value costs	Total present value benefits	Net Present Value £m	No. of water bodies improved to good or better	Total no. of water body improvements
Anglian	2,050	2,360	+310	251	287
Dee	10	20	+10	3	3
Humber	1,690	2,710	+1,020	484	531
North West	2,190	5,130	+2,940	339	347
Northumbria	300	600	+300	182	197
Severn	730	1,260	+530	231	246
Solway Tweed	250	480	+230	71	73
South East	700	1,410	+710	190	198
South West	1,850	3,300	+1,450	296	354
Thames	2,370	3,300	+930	209	248
England total	**12,100**	**20,600**	**+8,400**	**2,256**	**2,484**

Notes

The river basin district Net Present Value (NPV) is derived from the aggregated catchment present value costs and present value benefits. Therefore these NPV do not take account of the subsequent adjustments made to the catchment costs in order to present them for the four sector groups. These adjustments were to add in the costs of measures to address chemicals, and a range to the Water Industry costs estimates. The sector totals also do not include costs of measures not identified to sectors.

Numbers may not sum to total due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

9.4. Changes to multiple benefits for scenario 4

Many of the types of benefits for scenario 3 would be seen with scenario 4, although overall benefits may be fewer. The main measures considered not to be economically worthwhile are those that aim to reduce levels of phosphate and ammonia. These pressures have impacts on the quality of water and the fish, plants and animals that it can support. The extent of some measures, such as sustainable urban drainage and rural land use change, has been reduced to ensure benefits outweigh costs. Change may be significantly positive in

particular locations, but the overall picture across England is for a noticeable improvement to most benefits (Table 19).

Table 19 Changes to multiple benefits for scenario 4

Significant benefit	^^	Significance of change between baseline and scenario 4
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	

Benefits and uses	Scale	Benefits to sectors
Provisioning services		
Fresh water	^^	Water industry: more, cleaner water available for abstraction All sectors: more sustainable supplies
Food	o	Rural land management: sustainable businesses supported by wider benefits (soil, pollinators, climate resilience); pattern of change is complex and varies based on local situations
Water for non-consumptive use	^	Industry, services and infrastructure: more reliable flows; fewer INNS clogging navigable waters
Regulating services		
Climate regulation and adaptation	^	All sectors: Adaptation to predicted climate change effects such as drought and flooding; some carbon storage and local regulation of microclimate from habitat creation and restoration; reduced GHG emissions from agricultural sources
Water regulation	^	Government; Rural land management: reduced flood risk as runoff reduced, some sustainable drainage systems used, floodplains reconnected and water stored in upper catchments
Erosion regulation	^	Rural land management: agricultural topsoil loss reduced; upland peat restored; mining spoil stabilised
Water purification and waste treatment	^	Water industry; Industry, Services and Infrastructure: cleaner water environment; some reduced pollutant concentrations; reduced treatment costs

Significant benefit	^^	Significance of change between baseline and scenario 4
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	

Benefits and uses	Scale	Benefits to sectors
Cultural services		
Cultural heritage	v	Government: potential for engineering and excavation works to negatively impact heritage; mitigation is possible
Recreation and tourism	^	Industry, Services and Infrastructure: bathing waters protected; some improvements to angling, walking and bird-watching opportunities
Aesthetic value	^	Industry, Services and Infrastructure: improved water clarity as sediment and nutrients reduced; local aesthetic improvement in restored landscapes
Existence value	^	Government: wellbeing benefits felt by public/individuals due to improving water environment and some protected species; species more able to move through landscape as climate changes as habitat quality and quantity increase[101]
Supporting services		
Provision of habitat	^^	All sectors: Natura 2000 sites improved; habitat quality and quantity increased in wider landscape; biodiversity supports all other sector benefits

9.5. Government measures for ecological status/ potential

Under scenario 4 the programme of improvements would include the mitigation measures to flood risk management assets listed in scenario 3 but only those where the recommended works in operational catchments are considered to be economically worthwhile. Initial analysis of the catchment based economic appraisals shows that worthwhile mitigation measures constitute 1,121 measures at a cost of more than £800million. Of this figure just

[101] Making space for nature. Report for Defra, Lawton, 2011.

11 measures impacting positively on 125 water bodies[102] make up more than 50% of the total cost.

9.6. Rural land management measures for ecological status/ potential

Measures would be the same as presented in scenario 3, but with a reduced contribution from the sector as scenario 4 only includes measures that are considered economically worthwhile with benefits of measures exceeding costs. Significant land use change is not considered as socially worthwhile due to the costs involved in switching to alternative crops or livestock in addition to losing income from the crop or livestock already present. Fewer examples of land use change and phosphate reduction by the more expensive measures may be present in scenario 4, as compared to scenario 3. While changes in baseline practices would be less substantial in this sector than to meet the aims of scenario 3, most measures would be cost beneficial to the land manager in the short or medium term.

9.7. Industry, services and infrastructure measures for ecological status/ potential

The number of measures for the industry, services and infrastructure sector in scenario 4 would be reduced as compared to scenario 3.

The only solution to contaminated runoff from the urban and transport sector that is likely to economically worthwhile[103] is the use of green sustainable urban drainage systems (SUDs). Green sustainable urban drainage systems (SuDS) can be designed into new buildings and infrastructure to reduce pollutants to surface waters from run-off[104]. Costs for retro-fitted SuDS may be greater than the economic benefits.

Ports and harbours investment would be needed to improve two water bodies, currently at moderate, to good potential, plus to address any actions from ongoing investigations, constrained by affordability.

9.8. Water industry measures for ecological status/ potential

Hard engineering measures put in place by the water industry to improve effluent released from sewage treatment works can have a high capital cost. Therefore, for a large proportion of technically feasible measures the cost of implementation would not exceed the benefits. The majority of measures excluded from scenario 4 bundles due to high costs which exceed benefits are those for limiting phosphate emissions. The Environment Agency would need to collect and collate environmental monitoring data to verify inclusion of these schemes into any river basin management plan programme.

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[102] In The Lower Lee (river), Upper Lee (river), Tidal Thames (TraC), Colne (river), Sussex TraCs, Medway Swale Estuary and Parrett (river).

[103] Please note, not all SUDS will be economically worthwhile as their costs and benefits are very site specific, this is very broad estimate.

[104] As supported by the Flood and Water Management Act 2010

9.9. Measures and mechanisms to achieve good chemical status

The Environment Agency has identified 13 chemicals that are of national concern with respect to meeting good status in England's water bodies as per Table 1. Of these chemicals, 10 impact on water body good chemical status (GCS) and 3 on good ecological status (GES)[105].

There is currently only adequate data to perform risk assessments for 9 of the 13 chemicals. The actions per sector to address these chemicals under this scenario are listed in the Table 20. Overarching measures, such as the Industrial Emissions Directive, is applicable to all Priority Substances and Priority Hazardous Substances not just the ones listed. Estimated costs for improvement to chemical status under this scenario are in Table 21.

Table 20 Measures to achieve good chemical status under scenario 4

Sector[106]	Chemical(s)	Action under scenario 4
Government	Metals (cadmium, copper[†], nickel, lead, zinc[†])	Cost beneficial schemes to reduce pollution from abandoned mines identified through the catchment based appraisals would be included.
Industry, services and infrastructure	Tributyl tin compounds (TBT) Nonylphenol Metals (cadmium, copper, nickel, lead, zinc)	The Industrial Emissions Directive (IED)[107] and permitting under EPR would support the reduction of the emission of specific chemicals into water bodies. In addition to the Industrial Emissions Directive, measures to reduce urban/road run off would be implemented under scenario 4 (assuming these measures are cost beneficial).
	Di(2-ethylhexyl)phthalate (DEHP)	REACH regulations[108] is the EU system for controlling chemicals. Compliance should reduce hazardous DEHP entering water courses.

[105] Environment Agency (2014). Draft economic analysis for river basin planning: National chemicals assessment (England). Available on request.

[106] Table not applicable for rural land management sector

[107] http://www.defra.gov.uk/industrial-emissions/eu-international/industrial-emissions-directive/ IED came into force in early 2013 streamlining previous legislation by replacing seven existing directives.

[108] REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) is the system for controlling chemicals in the EU. For more information visit: www.hse.gov.uk/reach/index.htm

	Triclosan[ŧ]	In addition to the decline in use of triclosan in some products (e.g. domestic[109]) a national campaign for the voluntary reduction of use would accelerate the reduction of triclosan in the environment.
Water industry	Tributyl tin compounds (TBT) Di(2-ethylhexyl)phthalate (DEHP) Metals (cadmium, copper, nickel, lead, zinc)	For all chemicals if there is local evidence of a failure and local investigation giving rise to appropriate measures, these measures must be included. Including the 4 STWs included in PR14 indicative programme. Permitting under EPR would support the reduction of the emission of specific chemicals into water bodies. Under scenario 4 all treatment options that have been assessed to be technically feasible and cost beneficial should be carried out (CIP options appraisal[110]): Nitrifying filtration (NTF) for DEHP, nonylphenol,copper, zinc, triclosan

[ŧ] chemical impacts on ecological status rather than chemical status (copper, zinc, triclosan)

In addition to the risk assessment for chemicals there is a potential[111] PR14 programme for the water industry which is based upon sample data from the recently concluded water industry chemicals investigation programme[112] (CIPi) and Environment Agency sampling. Under scenario 4 treatment options are at 2 sites where sampling suggests that treatment is required.

Table 21 Scenario 4: Estimated costs to improve chemical status (£million). Improvements in status where benefits exceed cost

	Government	Industry(2), services, and infrastructure(3)	Rural land management(4)	Water industry	Total PV Costs(5)
£million	110	Not quantified	n/a	80	200

109

http://ec.europa.eu/health/scientific_committees/opinions_layman/triclosan/en/index.htm#3

[110] UKWIR CIP (Chemicals Investigations Programme) 1st phase options appraisal for the Water Industry (not yet published) looking at concentrations of chemicals in sewage treatment effluent and compartments of raw sewage as well as piloting treatment processes to remove these chemicals.

[111] Where it is shown by sample data from CIP and EA sampling that the site is causing failure of the EQS in the receiving water and therefore treatment should be included in the Periodic Review 2014.

[112] UKWIR CIPi (Chemicals Investigations Programme): Volume 1 – Main Report (Ref. No. 13/EQ/01/6) https://www.ukwir.org/site/web/content/reports/reports 1st phase options appraisal for the Water Industry.

Notes

These are primarily Present Value costs from the Chemicals Investigation Programme (CIP). The PVs were calculated for a 20 year appraisal period using a discount rate of 3.5%.

(1) Government includes investment in metal mine remediation

(2) Investment by industry has not been quantified at this stage as this is largely driven by Industrial Emissions legislation, which is being implemented separately.

(3) There is no specific allocation of investment on infrastructure to tackle urban diffuse pollution to chemicals as this is part of an ongoing Defra consultation on diffuse urban pollution

(4) There is no estimate for rural land management. EQS compliance is generally not an issue for agricultural chemicals. The main driver relating to pesticides is protection of drinking water protected areas, this does not relate to priority chemicals. Risks to drinking water protected areas for other pesticides are covered in scenario 2 and consider measures currently available.

(5) Numbers may not sum to totals due to rounding.

10. Scenario 5 - Illustration of potential progress towards scenario 4 by 2021

10.1. Introduction

Achieving all of these proposed objectives of scenario 4 in the short term is not feasible. Scenario 5 has therefore been produced to illustrate just one of the ways that achievement of the proposed objectives could be initially profiled. It illustrates the scale of actions and improvements that might be achieved between 2015 and 2021. It shows the effect of funding constraints on the rate of progress towards the objectives in scenario 4.

This scenario is based on guidance from Defra to consider just the largest funding sources and to use planning information that has been made public, provided by others, or estimated by the Environment Agency. The funding assumptions are summarised below in section 10.2.

Scenario 5 is a ‘top down’ adjustment of scenario 4 outputs based on an assumed level of available national funding (up to and including 2021). The assumed level of funding for the different types of measures was allocated first to measures to prevent deterioration and achieve protected areas objectives, with the remaining funds allocated to measures to improve water body status. For this illustration, priority was given to improving water body status in those catchments that would give the best return on investment (highest net present value). This should not be seen as pre-empting the decision on how funding for measures would be prioritised in the updated plans.

Scenario 5 has been designed to inform stakeholders and provide the opportunity to comment on the scale of ambition for the updated plans.

10.2. Scenario 5 funding assumptions

Assumptions were used to estimate the available funding for the different types of measures in scenario 5. These are summarised in Table 22 with a brief description of the major programmes of measures.

Table 22 Description of sector funding assumptions under scenario 5

Sector	Funding assumption
Government	• Grant in aid funding at current level (including WFD catchment restoration fund) until 2016. For the purposes of this illustration, no assumption has been included on additional grant in aid funding for WFD from 2016 as this is the next government spending review period. • Flood and Coastal Risk Management funding previously announced. Funding for environmental outcomes in draft Medium Term Plan • New Environmental Land Management Scheme and rural development grants and government sponsored advice. Most likely funding level and targeting criteria.
Rural land management	• Current regulatory controls • Current level of voluntary funding
Industry, services and infrastructure	• Current regulatory controls • Current level of voluntary funding
Water industry	• Programme level cost estimates in water company business plans submitted to Ofwat in December 2013 • The final determination of prices will not be made by Ofwat until December 2014. Therefore these cost estimates, while the best available, have some uncertainty associated.

10.3. Scenario 5 predicted funding and water body status outcomes

Table 23 Scenario 5: Illustration of possible 6 year funding profile for scenario 4 by sector (£ million)

River basin district	Government	Rural land management	Industry, services & other	Water industry	Overall Total
Anglian	40	10	10	310	380
Dee	0	0	0	0	0
Humber	40	6	10	250	310
North West	20	3	2	900	920

River basin district	Government	Rural land management	Industry, services & other	Water industry	Overall Total
Northumbria	9	<1	6	40	60
Severn	20	5	6	70	110
Solway Tweed	<1	<1	<1	40	40
South East	9	<1	10	210	240
South West	220	60	40	240	550
Thames	240	10	140	300	690
England total	**600**	**100**	**200**	**2400**	**3300**

Notes

Scenario 5 costs are for 6 years only (2016 to 2021).

Numbers may not add to total due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

Cost of chemicals' measures that affect good ecological status are included

Please note that the table above contains the result from the funding allocation model for the scenario 5 illustration. It is not a prediction of what will happen. For instance, in reality we expect that the rural land management sector will fund measures in all river basin districts.

10.4. Scenario 5 estimated benefits

The main assumptions used to estimate the assumed level of funding and voluntary action in scenario 5 are summarised for each sector in section 10.2. These assumptions were used to estimate the total funding available for different types of measures.

To allocate funds to where they would result in the greatest benefits, the bundles of measures used in the catchment appraisals were ranked by their expected Net Present Value (NPV)[113]. Funding was then allocated from the appropriate funding sources to cover the costs of the measures until each funding source had been fully distributed. Where a bundle of measures was only partially funded, due to funding sources being fully attributed elsewhere, the expected benefits from the partially funded bundle of measure were estimated.

This approach gives a fair estimate of benefits that would result from the assumed funding. However, the number of water bodies improving in status is probably optimistic. The method assumes that actions are targeted to a limited number of catchments when in practice the ability to target action in this way is limited. For instance, many of the measures in this

[113] Total discounted benefits minus total discounted costs over 37 year project time scale. NPV highlights the scale of the benefits being delivered within an operational catchment and is the indicator that Defra advised the Environment Agency to use.

scenario are voluntary, for example the take up of measure under the New Environmental Land Management Scheme and measures implemented by the voluntary sector.

Table 24 Estimated monetised benefits of measures (NPV £ million) and water body outcomes for scenario 5

River basin district	Total present value costs	Total present value benefits	Net Present Value £m	No. of water bodies improved to good or better	Total no. of water body improvements
Anglian	170	230	+60	10	20
Dee	1	2	+1	0	0
Humber	90	240	+140	40	50
North West	310	790	+480	70	90
Northumbria	20	60	+40	20	20
Severn	60	130	+80	50	60
Solway Tweed	30	70	+40	<10	10
South East	60	170	+110	20	40
South West	230	440	+220	20	40
Thames	120	260	+140	20	30
England total	**1,100**	**2,400**	**+1,300**	**260**	**360**

Notes

Estimate of water bodies improved to good assumes a non-linear reduction of scenario 4 using a relationship of the proportion of element improvements to the power of 2.1 to give the proportion of water body improvements to reduce the cost and water body improved values.

Total number of water body improvements calculated by giving every status improvement (e.g. poor-mod or mod-good) in the RBD 1 point, so shows overall level of improvement in the RBD.

Scenario 5 costs are for 6 years only (2016 to 2021); the benefits are the scenario 4 estimates adjusted to show what's achievable in this period, using the proportion of assumed funding to total cost.

The river basin district Net Present Value (NPV) is derived from the aggregated catchment present value costs and present value benefits. Therefore these NPV do not take account of the subsequent adjustments made to the catchment costs in order to present them for the four sector groups. These adjustments were to add in the costs of measures to address chemicals, and a range to the Water Industry costs estimates. The sector totals also do not

include costs of measures not identified to sectors.

Numbers may not add up to totals due to rounding. RBD totals (>10m) are rounded to the nearest £10m, England totals (>100m) are rounded to the nearest £100m.

10.5. Changes to multiple benefits for scenario 5

The range of benefits attained in this scenario were extrapolated from the total funding for different types of measures, in addition to those noted for Scenario 2, but constrained to the likely level of improvement by 2021. Some of the benefits seen over the medium to long term of scenario 2 would not be evident in the short term (Table 25). These wider benefits should be considered indicative and subject to change if the preliminary funding assumptions and types of measures funded were to differ in cycle 2.

Table 25 Changes to multiple benefits under scenario 5

Significant benefit	^^	Significance of change between baseline and scenario 5
Noticeable benefit	^	
No net change	o	
Noticeable disbenefit	v	
Significant disbenefit	vv	

Benefits and uses	Scale	Benefits to sectors
Provisioning services		
Fresh water	^	Water industry: cleaner water available for abstraction All sectors: more sustainable supplies
Food	o	
Water for non-consumptive use	o	
Regulating services		
Climate regulation & adaptation	o	
Water regulation	^	Government; Rural land management: reduced flood risk
Erosion regulation	^	Rural land management: improved retention of productive agricultural topsoils
Water purification and waste treatment	^	Water industry; Industry, Services and Infrastructure: cleaner water environment; reduced treatment costs
Cultural services		
Cultural heritage	o	
Recreation and tourism	^	Industry, Services and Infrastructure: Bathing waters protected; improvement

Significant benefit	^^		Significance of change between baseline and scenario 5
Noticeable benefit	^		
No net change	o		
Noticeable disbenefit	v		
Significant disbenefit	vv		
Benefits and uses		Scale	Benefits to sectors
			to nature-based recreation such as angling, bird-watching and so on
Aesthetic value		o	
Existence value		o	
Supporting services			
Provision of habitat		^	All sectors: Natura 2000 sites improved; new habitat created, non designated habitat improved, biodiversity supports all other sector benefits

10.6. Government measures for potential progress towards scenario 4 by 2021

A capital investment programme is being developed to maintain and improve flood and coastal erosion defence over the next 6 years to 2021. This will reduce the risks of flooding and erosion to people's homes and the economy. Many projects, while focused on protecting people and business (including farming business) will also protect valuable wildlife sites and contribute towards improving the status of water bodies and create new priority habitat. A smaller number of projects will have the primary purpose of protecting especially important wildlife sites. Where possible, when improving defences, the programme will also reduce any barriers to eel passage.

The new Common Agriculture Policy will benefit the rural economy in England by over £15 billion between 2014 and 2020. Farmers will receive over £11.5 billion in basic farm payments which will include conditions to improve water, through new soil standards to prevent soil erosion and providing wider environmental benefits through 'greening'. For example, buffer strips next to water courses. The Rural Development Programme will invest at least £3.5 billion to support the environment, the farming and forestry sectors and communities in rural areas. Around £2.2 billion is already committed to existing environmental stewardship and forestry agreements. There will be approximately £900 million for new agreements under the new environmental land management scheme (2015 to 2020). This new scheme will support changes to land management and land use to improve biodiversity outcomes with water and flood risk as an important focus. The scheme will also contribute to climate change adaptation and mitigation.

10.7. Rural land management measures for potential progress towards scenario 4 by 2021

The total number of bundles of rural land management sector measures is also reduced according to illustrative funding constraints. Measures would be as per scenario 3, but only including measures that are considered worthwhile with benefits equal to or exceeding costs, for example:

- Voluntary action from land managers to adopt good and if appropriate, best practice (especially for those actions which are considered cost beneficial) are adopted at national scale Sector led approaches (Campaign for the Farmed Environment and voluntary Initiative) to give advice to farmers on good practice and target activity to some catchments. Advice on cross compliance and nutrient management from the Farm Advice Service.
- Forest managers comply with forestry guidelines for soil and water.Farm assurance schemes where consideration is given to water and the wider environment
- Cross compliance against basic measures, good agricultural and environmental condition and “greening”
- Environment Agency regulatory compliance visits in targeted locations where there are issues of greatest risk within catchments
- Government sponsored advice schemes which focus on protected areas but deliver outcomes more widely
- New Environmental Land Management Scheme at landscape scale giving general environmental benefits to water and protecting current levels of water quality
- New Environmental Land Management Scheme at the catchment scale, giving more specific outcomes for catchment management
- Catchment plans or reviews where measures are required at a local scale
- Some targeted land use change (such as woodland creation) can be achieved where opportunities arise

10.8. Industry, services and infrastructure measures for potential progress towards scenario 4 by 2021

Action to protect the environment by the industry, services and infrastructure sector is primarily through environmental regulation. England has a long-established and wide-ranging framework of regulation aimed at protecting both the environment and human health. Many industrial activities are subject to Environmental Permitting Regulations (EPR), Integrated Pollution Prevention and Control Directive (IPPC) permits, discharge consents and/ or water abstraction licences. These regulations control the impact of industrial activities on the environment. In line with the ‘polluter pays principle’, the majority of the cost of complying with regulation is borne by those carrying out potentially polluting activities. The costs of compliance with the regulatory framework to protect water would consist of both capital and operational expenditure, including an element that covers the operational costs of the regulator.

10.9. Water industry measures for potential progress towards scenario 4 by 2021

As per scenarios 2, 3 and 4 potential water industry measures for scenario 5 include traditional hard engineering solutions, such as improving treatment at sewage treatment

works, reduced abstraction and demand management through to more innovative solutions such as catchment measures. Water companies have a key role to play in catchment partnerships. Catchment measures and catchment partnerships can have significant benefits for other sectors such as the rural sector. Phosphorus is the most common cause of water quality failures under WFD, with 45% of river water bodies and 74% of lake water bodies in England exceeding their P standard114. Much of cost of affordable good status measures for the water industry in England is in tackling phosphorus failures of the WFD standard.

Although scenario 5 measures are currently unconfirmed the Environment Agency has been working with Ofwat and water companies to ensure that an allowance is made to fund scenario 5 measures within Periodic Review 2014 (PR14) as far as possible. This approach has been known as 'managing uncertainty'. We asked water companies that when they included 'managing uncertainty' within their business plans, which were submitted to Ofwat in December 2013, that they base this on their knowledge of what is affordable for their customers. We have built scenario 5 based on cost information that water companies have shared with us so far, and applied a cost allocation model to this to help develop the scenario. This does not pre-empt the outcome of the final update river basin management plans or PR14 and is only used in this economic analysis for illustrative purposes.

10.10. Measures and mechanisms to achieve good chemical status

The Environment Agency has identified 13 chemicals that are of national concern with respect to meeting good status in England's water bodies as per Table 1. Of these chemicals, 10 impact on water body good chemical status (GCS) and 3 on good ecological status (GES)[115].

There is currently only adequate data to perform risk assessments for 9 of the 13 chemicals. The actions per sector to address these chemicals under this scenario are listed in Table 26. Overarching measures, such as the Industrial Emissions Directive, is applicable to all Priority Substances and Priority Hazardous Substances not just the ones listed. Estimated costs for improvements to chemical status under this scenario are in Table 27.

Table 26 Measures to achieve good chemical status under scenario 5

Sector[116]	Chemical(s)	Action under scenario 5
Government	Metals (cadmium, copper[†], nickel, lead, zinc[†])	Cost beneficial schemes to reduce pollution from abandoned mines identified through the catchment based appraisals would be included. Spending would be subject to Defra determination of affordability
Industry, services and	Tributyl tin compounds	The Industrial Emissions Directive (IED)[117] and permitting under EPR would support the

[114] 2013 classification data, Environment Agency, 2013

[115] Environment Agency (2014). Draft economic analysis for river basin planning: National chemicals assessment (England). Available on request.

[116] Table not applicable for rural land management sector

[117] http://www.defra.gov.uk/industrial-emissions/eu-international/industrial-emissions-directive/ IED came into force in early 2013 streamlining previous legislation by replacing seven existing directives.

infrastructure	(TBT) Nonylphenol Metals (cadmium, copper, nickel, lead, zinc)	reduction of the emission of specific chemicals into water bodies. In addition to the Industrial Emissions Directive, cost beneficial measures to reduce urban/road run off may be implemented under scenario 5 (although no measures would be progressed for chemicals, subject to Defra consultation).
	Di(2-ethylhexyl)phthalate (DEHP)	REACH regulations[118] is the EU system for controlling chemicals. Compliance should reduce hazardous DEHP entering water courses.
	Triclosan[ŧ]	In addition to the decline in use of triclosan in some products (e.g. domestic[119]) a national campaign for the voluntary reduction of use would accelerate the reduction of triclosan in the environment.
Water industry	Tributyl tin compounds (TBT) Di(2-ethylhexyl)phthalate (DEHP) Metals (cadmium, copper, nickel, lead, zinc)	For all chemicals if there is local evidence of a failure and local investigation giving rise to appropriate measures, these measures must be included. Including the 4 STWs included in PR14 indicative programme. Permitting under EPR would support the reduction of the emission of specific chemicals into water bodies. The potential PR14 programme only would be included under water industry measures to improve good chemical status in water bodies (not the indicative programme), as included in scenario 4.

[ŧ] chemical impacts on ecological status rather than chemical status (copper, zinc, triclosan)

In addition to the risk assessment for chemicals there is a potential[120] PR14 programme for the water industry which is based upon sample data from the recently concluded water

[118] REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) is the system for controlling chemicals in the EU. For more information visit: www.hse.gov.uk/reach/index.htm

[119] http://ec.europa.eu/health/scientific_committees/opinions_layman/triclosan/en/index.htm#3

[120] Where it is shown by sample data from CIP and EA sampling that the site is causing failure of the EQS in the receiving water and therefore treatment should be included in the Periodic Review 2014.

industry chemicals investigation programme[121] (CIP) and Environment Agency sampling. Under scenario 5 treatment options are at 2 sites where sampling suggests that treatment is required.

Table 27 Scenario 5: Estimated costs to improve chemical status (£million). Illustration of possible initial 6 year funding profile for scenario 4

	Government	Industry(2), services, and infrastructure(3)	Rural land management(4)	Water industry	Total PV Costs(5)
£million	20	Not quantified	n/a	60	80

Notes

These are primarily Present Value costs from the Chemicals Investigation Programme (CIP). The PVs were calculated for a 20 year appraisal period using a discount rate of 3.5%.

(1) Government includes investment in metal mine remediation

(2) Investment by industry has not been quantified at this stage as this is largely driven by Industrial Emissions legislation, which is being implemented separately.

(3) There is no specific allocation of investment on infrastructure to tackle urban diffuse pollution to chemicals as this is part of an ongoing Defra consultation on diffuse urban pollution

(4) There is no estimate for rural land management. EQS compliance is generally not an issue for agricultural chemicals. The main driver relating to pesticides is protection of drinking water protected areas, this does not relate to priority chemicals. Risks to drinking water protected areas for other pesticides are covered in scenario 2 and consider measures currently available.

(5) Numbers may not sum to totals due to rounding.

11. General conclusions

The scenarios are illustrative and not recommendations. The analysis has drawn on a large and diverse evidence base. By its very nature, the sort of complex analysis summarised here requires the use of assumptions and brings with it a degree of uncertainty. However, the results are of sufficient quality to inform this consultation. The analysis will be revised to inform the impact assessment that will be needed to justify the preferred option for the updated river basin management plans that the Environment Agency will submit to the Secretary of State next autumn.

The following general conclusions are intended to inform the debate and consultation responses.

[121] UKWIR CIP (Chemicals Investigations Programme): Volume 1 – Main Report (Ref. No. 13/EQ/01/6) https://www.ukwir.org/site/web/content/reports/reports 1st phase options appraisal for the Water Industry.

- Scenario 1 would result in significant deterioration in the quality of the water environment and associated loss of benefits. It illustrates what could happen if the WFD requirement to prevent deterioration was not met. This is the only scenario expected to have an overall negative impact on society.
- Scenario 2 demonstrates that there are still significant additional costs to prevent future deterioration of current status and to achieve the objectives of the most important, protected areas of water. There are also significant benefits leading to an overall NPV of around £6 billion if this scenario was implemented. To achieve protected area objectives (part of scenario 2), the cost of measures to resolve pressures arising from rural land management is higher than the cost of measures to resolve water industry issues. This difference reflects the fact that over the last 20 years the water industry has greatly reduced the impact of its activities on protected areas. As the water industry impacts have been reduced, the impacts of rural land management activities on protected areas have become more apparent and represent a greater proportion of the remaining problems.
- The best outcomes for the water environment would be achieved under scenario 3, but not necessarily the best overall wellbeing for society, estimated by the NPV. The additional cost to achieve outcomes over and above those under scenario 2 (improvements in water body status) would be greater than the additional benefits. The WFD does not require the achievement of water body objectives at disproportionate cost. This scenario may therefore go beyond the requirements of the WFD. Total costs of scenario 3 may also be underestimated. Some potentially large costs were excluded from the catchment scale appraisals because the actions would clearly have resulted in little additional benefit.
- Scenario 4 represents the economic analysis behind the draft objectives outlined in Part 1 of each river basin district's draft river basin management plan. The estimated benefit of achieving the proposed environmental objectives in these proposals is about £21 billion (PV). It would cost about £12 billion (PV). Under this scenario, around 75% of waters would reach good status or potential by 2027 (or later where natural recovery times are an issue). Around 95% of the individual elements measured across all water bodies would reach good.
- Scenario 5 is based on an illustrative level of funding and shows a possible initial 6 year funding profiles for scenario 4. It would result in significant benefits that outweigh the costs. It could result in modest (7%) increases in the numbers of water bodies at good status or potential by 2021. However, even this rate of progress could be optimistic, given the historical experience for ecological recovery.
- A comparison of scenarios 3 and 4 shows that up to £4 billion (PV) of measures are not justified on the basis of the benefits being outweighed by costs. Many of these measures are those to reduce the impact of water industry activities, including further reductions in the amount of phosphorus and ammonia discharged from some sewage treatment works, and changes in the way water is abstracted for public water supply.
- Under scenario 5, the water industry (funded by their customers) would continue to make the largest investment and the fastest progress towards mitigating the damage their activities have on the water environment. Based on initial draft determinations published by Ofwat as part of its Price Review, it is likely that this level of water industry contribution could be absorbed within their overall investment programmes without increasing customer bills.
- The reported costs of measures to improve chemical status are relatively low. However, they might rise significantly as further evidence becomes available over the course of the consultation and next few years.

12. Risks and assumptions

The following assumptions have informed the catchment based appraisals and development of results for options 3, 4 & 5. They discussed in the following sections:

- Appraisal period
- Use of benefit cost ratio
- Benefit cost ratio range for additional monetised benefits to be used (a stage 1+ valuation)
- Risk of failure % applied to bundles of measures to account for uncertainty
- Separation of no deterioration measures from improvement measures
- Disaggregation of National Water Environment Benefits Survey (NWEBS) willingness to pay values into six components
- Sourcing of cost data
- Optimism bias
- Ecological uncertainty
- Sustainability risks – population growth and climate change
- Risk assessments for assessing chemical status

12.1. Assumptions for Option 3, 4 and 5 data in detail

Appraisal period

Assumption: The default of 37 years (2016-2052) from the first year that works have been completed has been used as the appraisal period.

The Treasury Green Book advises that the life of the longest living asset should set the appraisal time period. However, in some cases, either the lifetime of the longest living asset is unknown or there is no clear cut lifetime when an asset is removed.

Following a precautionary approach, the default appraisal period used in the appraisals is 43 years (from 2009 at the start of cycle 1, ending 2052). The rationale for using 43 years was that it comprises 18 years (the first 3 cycles of RBMP) plus an average asset life of 25 years average asset life. The exact appraisal period used depends on the date that the works in the bundle of measures that you're appraising are estimated to start.

The appraisals used a discount rate of 3.5% for the first 30 years and then 3% thereafter, as per Treasury Green Book guidance.

Use of benefit cost ratio to determine if a bundle of improvement measures is cost beneficial

Assumption: Cost benefit analysis is to answer the policy question ‘is the bundle of measures cost beneficial (economically or socially worthwhile) or not?’ Cost benefit ratio and net present value are both useful in answering this question for river basin management planning. Where in the catchment scale assessment of costs and benefits, a stage 1 valuation reports a benefit cost ratio of 0.5-1.0, a stage 1+ assessment was used to monetise further benefits and inform a decision.

In the stage 1 valuation, a number of the most significant ecosystem services are monetised; recreation, aesthetic and non-use values, using the National Water Environment Benefit Survey (NWEBS) values[122]. Benefits resulting from wetland creation are also monetised. Where there are other significant benefits that can be monetised such as additional output from commercial fisheries or from tourism these have also been monetised.

If the benefit cost ratio is already above one/net present value is greater than zero, without monetising other positive benefits, then we do not need to spend further resources monetising other benefits as it will only reinforce the recommendation to take the programme forward[123]. The stage 1 valuation results, alongside the qualitative and quantitative assessment within AST can confirm if this is the case. Once calculated, the Benefit Cost Ratio (BCR) is used to determine whether the bundle is worthwhile in economic terms (BCR>1).

Net present value of the options should be used to guide decisions on affordability (different competing solutions for independent proposals), as advised by the Treasury Green Book). Any prioritisation of actions for an area should not use the results of the appraisal alone as it will need to take in account additional impacts, plus other factors such as forthcoming external contributions.

Use of risk of failure

Assumption: Environment Planners should use expert judgement to estimate the risk of a bundle of measures failing to meet their intended environmental improvement outcome. National guidance on thresholds for high, medium and low risk of failure provide a benchmark. For example, well tested hard engineering solutions such as an upgrade to sewage treatment works are likely to have a low risk of failure, whereas measures based on providing advice and guidance to land managers may have a higher risk of failure as it is optional to take up the advice provided. Sensitivity testing is used in the analysis to understand the impact of using different risk of failure rates.

There is a risk that a measure could fail to meet objectives. For example, if we invest in one hundred wetlands, one in one hundred might fail because severe weather conditions prevented the plants from growing. This is particularly prevalent with regards to voluntary initiatives such as those promoted by catchment sensitive farming schemes. Not every landowner targeted would take up recommended measures. The estimate of benefits values should reflect this risk.

The risk of measures within a bundle failing to meet their expected outcome is context specific. Nationally thresholds for high, medium and low risk of failure have been set to be used in conjunction with local expert judgment.

In the absence of any information on the probability distribution of the effectiveness of measures in terms of kilometres of river affected for fish, plants etc, a simplistic approach of reducing the benefits by the likelihood of failure has been applied. For example, if we expect

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[122] The main method of monetising benefits used is the values supplied by the National Water Environment Benefits Survey (NWEBS) which cover aesthetic, recreational and existence values: P.Metcalfe (2012). Non-market valuation using stated preferences: Applications in the water sector, Thesis submitted to the Dept.of Geography and Environment, the London School of Economics & Political Science.

[123]Where there are disbenefits, the tradeoff should be understood in order to understand the direction of travel of monetised benefits, if other ecosystem service impacts are monetised.

that a wetland will fail to produce the expected environmental outcomes 10% of the time, then we reduce the benefits by 10%.

To control for subjectivity, automatic sensitivity tests have been included within the stage 1 valuation sheet to test the benefit-cost ratio when the risk of failure is 0%, 25% and 50%. When these are flagged to be a sensitive issue, more consideration to the risk of failure shall be made.

Separation of no deterioration measures from improvement measures

Assumption: A 'current status' (2013) baseline is used to appraise measures to get to good.

Only measures to support water bodies in reaching good status (for non-protected areas) are subject to catchment based economic appraisal and the assessment looks at the additional costs and benefit of moving from the current status to good status. Measures to prevent deterioration and meet Protected Area compliance (scenario 2) have been appraised in a separate process (see methodology sections 'scenario 2').

To deal with this issue practically within appraisal, a rule of thumb is required to assess measures when a measure provides recovery of deterioration and also achievement of "good".

Disaggregation of total National Water Environment Benefits Survey (NWEBS) willingness to pay into six components

Assumption: The total NWEBS willingness to pay per step change in water body status is divided equally into six and allocated to the following components: fish, inverts and other animals, plants, flow and channel, clarity and safety for recreational contact.

The reason for disaggregating the full willingness to pay value is to:

Apply benefits to marginal changes in quality (e.g. where a bundle of measures cause a large improvement to fish (from NWEBS bad to NWEBS good) but a small improvement to flow (from NWEBS moderate to NWEBS good))

Apply benefits to some components when others are already at good (e.g. where clarity, suitability for recreational contact and flow/channel may already be at NWEBS good, and the bundle of measures are therefore addressing fish, plant and invert improvements).

Apply benefits where the km/km² impacted is not uniform for all components (e.g. where an improvement to fish passage in a river would benefit the distance upstream until the nearest barrier (e.g. 20km) and flow is improved locally down and up stream of the structure removal (e.g. 2km)).

Assumptions have been used to disagregate the total NWEBS willingness to pay value for use within the appraisal. The original NERA (2007) survey, which produced the NWEBS values, asked survey respondents how much they were willing to pay for certain step changes in water body status[124]. In practice, the water body may not experience such a clear step change in quality; some areas may improve and others not.

In order to reflect this, the value needed to be disaggregated to represent changes to different components of the water body. Since the original study described the changes in

[124] The step changes which were used in the willingness to pay study have been translated into bad-good step changes to align more closely with WFD terminology. However, since splitting out the total value into non WFD type components, based upon the survey description, the step changes should be termed NWEBS bad – NWEBS good to represent marginal differences from the WFD framework.

terms of fish, inverts and other animals, plants, flow and channel, clarity and safety for recreational contact, it was sensible to attribute the value to these components. The challenge, then, was how the total willingness to pay value can be split between the components. A brief review was undertaken to see if there was any literature which described societal preference between the components. No such preference studies were found. Anecdotal evidence from discussions with business leads has told us that the preferences are likely to change at local levels. For example, an area with a national canoeing centre may value the safety for recreational contact higher than elsewhere.

In the absence of information, the assumption that all components are valued equally has been made. Local differences are managed by allowing flexibility, when justified, to choose the high, central or lower willingness to pay bounds within the appraisal. Sensitivity tests show whether an appraisal is sensitive to any change in benefits.

Sourcing of cost data

Assumption: Local costs were preferentially selected and if costs were not available locally then national values from the cost effectiveness database (Environment Agency, 2013) were used. National calculators e.g. 'Cost of agricultural measures' tool were used to aggregate costs of measures to address specific pressures across a catchment

Most costs (and benefits) in this economic analysis are presented to three significant figures for consistency and to avoid displaying spurious accuracy. Where cost information is sourced, users have used local evidence from previous projects or quotes from contractors and water companies can be used. Where this information is not available, the Environment Agency Cost Effectiveness Database (Environment Agency, 2013) provides average cost data.

Optimism bias

Assumption: Optimism bias has not been applied in developing these figures.

It is a recommendation within economic appraisal to make an explicit adjustment for optimism bias. Evidence on optimism bias for the types of costs outlined in this economic analysis suggests that costs are as likely to be underestimated as overestimated. We therefore made the decision not to apply Optimism Bias, but account for and test the sensitivities of the cost estimates in other ways, as per the Treasury's Green Book guidance.

Ecological uncertainty

Assumption: Best available current evidence from a variety of sources including scientific literature, grey literature and expert judgement in context specific cases will be used to select the measures for local environmental improvements and judge the environmental outcomes and benefits associated with those measures

Key areas of uncertainty are:

- Uncertainty about the relationship between the environmental indicators that we monitor and report on and the objectives and standards that we aim to meet, e.g. increases in fish or decreases in nutrients and kilometers of water moving from moderate to good status.
- Uncertainty about the extent and source of the problem and the direction of underlying trends, for example in transitional coastal waters.

- Uncertainty about the effectiveness of measures to address the problem where innovative measures are being used, or where a tried and tested measure is used to try to meet a very low environmental quality standard.
- Uncertainty about the interaction between pressures, particularly the relationship between flow, morphology and chemical standards.
- Time lags which may occur due to the nature of biological and chemical processes, creating a delayed reaction between the period in which measures are taken and the period in which the benefits are seen. Such delays may amount to 50 years or more. In this economic analysis, measures are considered to be sufficient if they would meet WFD objectives given the delay caused by natural processes.

Sustainability risks

Assumption: The quantitative aspect of the catchment based appraisal does not factor in population change to future conditions.

The UK's population is predicted to grow by nearly 10 million in the next 20 years, and its demands and expectations continue to evolve[125].

Although the quantitative aspect of the catchment based appraisal does not factor in population change to future conditions the work we have done looking at potential broad brush costs for point source investment to reduce P loads works on a baseline assumption that the sewage treatment works (STW) is discharging at its consented limit. This has the effect in practice (since many STW discharges have headroom in their consents) of building-in a population expansion 'time-buffer' to our estimates.

The majority of permits have a design horizon built into them to allow for some future growth and development. If future development requires a permit variation to increase discharge flows we will apply the 'no deterioration' approach to other permit conditions to ensure no deterioration in downstream quality.

Our catchment based appraisals will help to inform the judgements we have to make about how river water quality might change in the future and what actions will best ensure either no deterioration or improvement to an acceptable standard. The impact of population growth on individual STWs would need to be considered in this wider context.

13. Impacts on greenhouse gas emissions, climate regulation and adaptation

The 2008 Climate Change Act established a target to reduce the UK's greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. The National Adaptation

[125] UK National Ecosystems Assessment, 2011: http://uknea.unep-wcmc.org/

Programme outlines the actions needed to adapt to a changing climate, including the 2nd cycle river basin management plans. The draft updates to the river basin management plans support a contribution both to reducing greenhouse gas emissions and adapting to the effects of a changing climate. Each plan sets out the measures that are likely to improve climate resilience.

A positive improvement in climate regulation and adaptation benefits under scenario 4 is predicted in 30% of catchments; 7% are considered to have no significant net change (i.e. the positive impacts were predicted to be similar to the negative impacts) and less than 1% are predicted to have a negative impact. In the remaining 62% of catchments the impacts on climate regulation were not considered to be significant.

13.1. Government sector

Broadly, the government sector is taking action across the public sector to make procurement sustainable and reduce greenhouse gas emissions, waste and water usage.

The Environment Agency's corporate strategy makes a commitment to reducing our total carbon footprint by 33% by 2015. Operational electricity represents one third of this and represents emissions from 'non-office' field assets such as pumping stations. In 2010 we introduced carbon saving plans for targeted investment for energy saving. Areas have been working to find more cost effective energy savings and to take a longer term view to prepare for making further savings in 2015-2020.

The Environment Agency Flood and Coastal Risk Management (FCRM) National Asset Performance and Engineering is working to share best practice and develop more cost effective investments for funding in 2014/15 and beyond to further reduce energy use. The process of annual challenge and revision of the carbon plans and the impetus to seek more savings will continue.

By April 2014 we have made an estimated 28% saving on operational energy; however our actual carbon reduction was measured at 19% due to exceptional flood events between December 2013 and March 2014. To achieve further carbon savings we will have to do things in a different way and adopt new technology and innovation. Carbon savings will also come from changes to operations associated with flood risk strategies and plans. This will come partly through reviewing whether assets and operations are economic but also altering service levels (and water levels) to save energy. Lead local flood authorities will need to make similar changes to their flood risk operations.

Habitat creation and restoration works by the government sector have the potential to create or improve carbon sinks through wetlands, peatlands and woodland planting.

13.2. Rural land management sector

Agriculture causes 9% of the UK's greenhouse gas (GHG) emissions[126]. For England this is comprised of nitrous oxide (61%), methane (32%) and carbon dioxide (7%). Greenhouse gas (GHG) emissions (incl. CO2; CH4; N2O) from the agriculture sector are a consequence of growing crops and keeping livestock.

[126] Department of Energy & Climate Change, Gov.uk Reducing greenhouse gas emissions from agriculture, 2014

Total GHG emissions from UK agriculture have fallen by 19% since 1990, due to the reduced use of nitrogen fertilisers and a decline in overall livestock numbers, partly as a result of reforms to the Common Agricultural Policy. In England advisory schemes such as Catchment Sensitive Farming, incentives through agri-environment payments and NVZ regulation combined are estimated to have reduced emissions by over 1 million tonnes CO2-equivalent (Mt CO2e)[127].

In 2011 the industry committed to a reduction in annual emissions in England of 3 Mt CO2e by the third carbon budget period (2018 – 2022) compared to a 2007 baseline. The primary mechanism for this voluntary initiative is the Greenhouse Gas Action Plan developed by representatives of the agriculture industry.

Future changes to the UK climate, potentially resulting in lower river flows and more extreme rain fall events, will increase the environmental risk to the water environment from diffuse pollution from agriculture, as well as exposing the sector to vulnerabilities from water resource shortages or flooding.

The most effective agricultural measures in respect of mitigation, adaptation and increasing resilience are likely to be:

Improved nutrient management: Nitrogen from manures and fertiliser spread on crops and grassland increases the nitrogen in the system and leads to emissions of nitrous oxide. Excessive nutrients also cause water pollution. Measures which improve nutrient management include changing from a slurry to a solid manure handling system, installing covers on slurry stores, using slurry band spreading application techniques, using slurry injection application techniques and more targeted application of nitrogen.

Water companies use energy to treat this water, producing GHGs as a consequence. Therefore any measures that reduce agricultural water demand, such as constructing winter storage reservoirs, are likely to have some impact on Water Industry GHG emissions. Likewise any diffuse water pollution reduction measures will reduce water treatment GHG consequences.

13.3. Industry, services and infrastructure sector

The electricity generation sector is by far the largest licensed abstractor of water (from all sources) of all sectors, including Public Water Supply. It is licensed to abstract over half of all freshwater licensed. In practice however, it takes around a third of this, with the majority of the water abstracted from tidal sources. The results of demand modelling[128] show a very uncertain future for water demand but demonstrate an overall trend of increasing total demand. Projections for future freshwater demand are more variable and could increase or decrease depending on the future electricity generation mix (including the uptake of water intensive Carbon Capture and Storage), future location and the cooling technology used.

In 2009, emissions from waste management represented a little over 3% of the UK total[129]. The Government estimates that emissions of methane from landfill (responsible for around

[127] Review of Progress in Reducing Greenhouse Gas Emissions from English Agriculture, Defra, 2012.

[128] Forecasting future water demand by the electricity generation sector, Environment Agency, 2014 (unpublished report)

[129] The Carbon Plan: delivering our low carbon future, HM Government, 2011

90% of the sector's emissions) will be substantially below current levels. The Government is working with businesses on a range of measures to drive waste reduction and re-use.

Habitat creation and restoration works by environmental NGO's have the potential to create or improve carbon sinks through wetlands, peatlands and woodland planting.

13.4. Water industry sector

The water industry contributes 1% of the UK's greenhouse gas emissions, reported as 4 million tonnes CO2e in 2012-13. A further 4-5% of UK emissions result from domestic water heating but this is mostly outside the control of the industry.

The main sources of carbon emissions are the electricity required to pump and treat potable water and wastewater and the embedded carbon in assets such as treatment facilities. Broadly two thirds of emissions derive from pumping and treatment and one third is embedded carbon from asset construction and maintenance such as wastewater treatment works[130].

Overall the industry is aiming to achieve an 80% reduction in emissions by 2050 despite facing a significant challenge in needing to provide improved treatment standards for a wider range of substances in order to meet WFD objectives. Measures that the industry is utilising to achieve this include:

- research into and development of low energy treatment technologies, such as new base materials for reed beds that improve effluent treatment performance.
- measures such as catchment management that minimise contamination of water supplies at source. The economic regulator for the industry, Ofwat's, totex approach is likely to encourage measures such as these and reduce the emphasis on building new effluent treatment facilities, which were favoured under previous capital based approaches
- demand management measures such as metering to reduce the amount of potable water needed to be treated and pumped and the associated reduction in energy needed for the pumping and treatment of wastewaters
- process optimisation, for example advanced process control at wastewater treatment works which have shown the potential for reducing energy use whilst still achieving water quality treatment standards

[130] CIWEM: A Blueprint for Carbon emissions Reduction in the Water Industry, 2014

14. Annex A: Water Industry Funding Allocation Assumptions

Water industry allocations for scenario 2 and scenario 5 are based on the estimated costs for NEP4 and 'managing uncertainty' in their December 2013 business plan submissions. These assumptions were used in the scenario 5 model.

Water industry funding allocation assumptions £m				
RBD	**NEP4 Allocation**[(1)(3)]	**'Managing uncertainty' amount available**[(2)(3)]	**'Managing uncertainty' allocation from model**[(4)]	**Scenario 5 modelled allocation**[(5)(6)]
Anglian	230	100	80	310
Dee	0	0	0	0
Humber	60	200	190	250
North West	640	260	260	900
Northumbria	30	10	10	40
Severn	20	90	50	70
Solway Tweed	30	5	5	40
South East	110	100	100	210
South West	150	90	90	240
Thames	70	220	230	300
TOTAL[(6)]	**1400**	**1100**	**1000**	**2400**

Note

(1) The water industry allocation for Scenario 2 has been based on the money allowance estimates included by water companies for NEP4 in their December 2013 business plan submissions.

(2)The water industry 'managing uncertainty' figures (rounded) are from water companies' December 2013 business plan submissions for 'managing uncertainty' (but not the detail of the measures they have included).

(3) These are mid-point costs estimates. They have at least +/- 30% range reflecting the uncertainty of the estimates which should be considered when reading this information

(4) These are the modelled output of the 'managing uncertainty' figures (part of Scenario 5 assumptions)

(5) The total water industry allocation for Scenario 5 is based on the NEP4 allocation plus the modelled allocation based on the 'managing uncertainty' estimates

(6) Scenario 5 outputs are 6 year funded amounts (£m)

(7) Figures rounded to nearest £10m unless under £10m. Totals rounded to £100m

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