Development of a Methodology to Determine the Cost-Effectiveness of Measures and Combinations of Measures for the Water Framework Directive (WFD)

Executive Summary

for

The Collaborative Research Programme on River Basin Management Planning Economics

RPA Consortium

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EXECUTIVE SUMMARY

1. Introduction

The overall objective of the Water Framework Directive (WFD) is to achieve good water status in all waters by 2015. This means that the quality of rivers, lakes, estuaries, coastal waters and groundwaters must be protected and enhanced by 2015. In addition, wetlands depending on groundwater must be safeguarded and water related requirements of other EC legislation taken into account.

Under the WFD, cost-effectiveness analysis (CEA) is to be used for assessing the relative performance of potential measures for achieving the environmental objectives set out in the Directive. In particular, it is to assist in[1]:

- making judgements about the most cost-effective programme of measures which could be implemented in order to bridge a potential gap in water status between the baseline scenario and the Directive's objectives; and

- assessing whether programmes of measures are disproportionately costly or expensive.

At a minimum, the aim of the CEA should be to refine the programme of measures proposed for a given water body by focusing on the largest cost components and the major determinants of the effectiveness of measures[2]. The analysis should enable the development of packages of the most cost-effective measures for achieving alternative water statuses.

However, the level of effort put into the CEA should also be proportionate such that greater effort and more detailed approaches should be concentrated on significant water management issues, areas where there are conflicts between uses and where the integration between environment, economic and social issues is more problematic[1].

Responsibility for implementing the Directive and undertaking the CEA lies with the Environment Agency in England and Wales, SEPA in Scotland and DOENI in Northern Ireland. It is expected that the cost-effective analysis of measures and combinations of measures will be mainly undertaken by non-economists within these Agencies.

The *UK Collaborative Research Programme (CRP) on River Basin Management Planning Economics*, has been set up to develop the methodologies needed to undertake the WFD economic analysis and to provide the guidance on these methodologies in the UK. The Collaborative Research Programme (CRP) involves fourteen parties and is chaired by Defra[3].

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1 WATECO (2003): *Economics and the Environment, The Implementation Challenge of the Water Framework Directive*, Guidance Document.

2 A measure is essentially an action to be taken to improve water status. For example, a measure could be to reduce use of fertiliser. This could have a number of different mechanisms such as a ban on fertilisers, a tax, or a code of practice.

3 Parties to the CRP are: Department of Environment, Food and Rural Affairs (Defra), Scottish Executive, the Environment Agency, Scottish and Northern Ireland Forum for Environmental Research (SNIFFER), Scottish Environment Protection Agency (SEPA), English Nature, Department of Trade

The CRP will run from April 2004 to March 2008. It comprises six sequential projects, with these presented in Table 1, focused on the progressive development of the approaches and data required to assess the costs and benefits of Programmes of Measures (PoMs) proposed under the WFD.

Table 1: Sequential Programme of Work for 'UK Collaborative Research Programme (CRP) on River Management Economics'

- Project 1: developing a better understanding of how economic analysis can best be used to support the decision making processes;
- Project 2: developing a methodology and guidance to assess the cost effectiveness of measures and combinations of measures for the WFD;
- Project 3: guidance on the evidence required to justify disproportionate cost decisions under the Water Framework Directive;
- Project 4: specifying the environmental benefits of concern in the cases identified in Project 3;
- Project 5: developing and trialling guidance on benefits assessment for RBMPs; and
- Project 6: carrying out original studies to provide new valuations of the major environmental benefits of RBMPs.

This report relates to work being undertaken on Project 2, which has four components:

- Project 2a (SNIFFER funded project WFD 54) is focused on developing a methodology for assessing the effectiveness of measures and combinations of measures;
- Project 2b is focused on developing a methodology for an even-handed assessment of the costs and economic impacts of measures and led on combining the methodologies to produce a cost-effectiveness methodology;
- Project 2c requires the development of a benchmark costs database and will produce and test guidance for the application of the cost effectiveness analysis (CEA) methodology; and
- Project 2d requires the development and testing of tailored proformas for obtaining local specific cost information for different sectors.

Projects 2a and 2b build on *Cost Effectiveness Analysis (CEA) and Developing a Methodology for Assessing Disproportionate Costs* (RPA *et al,* 2004)[4], which provides an overarching theoretical framework for undertaking cost-effectiveness analysis under the WFD and for assessing disproportionate costs.

and Industry (DTI), UK Water Industry Research (UKWIR), Royal Society for the Protection of Birds (RSPB), Welsh Assembly Government (WAG), Department of Environment Northern Ireland (DOENI), British Ports/UK Major Ports Group (UKMPG), Countryside Landowners and Business Association (CLBA), National Farmers Union (NFU), and Joint Environment Programme (JEP).

[4] Report available from: www.defra.gov.uk/environment/water/wfd/economics/pdf/ceafrreport.pdf.

This Executive Summary brings together the outputs of Projects 2a and 2b to highlight the combined CEA methodology.

2. The Cost-Effectiveness Methodology

Pre-Requisites for Application of the CEA Methodology

A first pre-requisite for application of the methodology is the identification of the risks of not meeting the WFD standards in the water bodies under consideration, as determined from the WFD River Basin Characterisation (RBC).

A second pre-requisite is knowledge of the standard for the type of water body under consideration expressed in measurable terms. Even once standards for water bodies are known, objectives for the water bodies cannot be confirmed until an initial cost-effectiveness and disproportionate cost analysis has been completed. Alternative objectives and exemptions may be set on the basis of considering the costs and benefits of measures, although exemptions are not always available, for example in protected areas.

A third pre-requisite of the methodology is to confirm the need to undertake cost-effectiveness analysis. By its very nature, application of the effectiveness methodology demands a rigorous consideration of the problem and of measures to address the problem so as to ensure that comparison of the effectiveness of combinations of measures is robust and auditable. Therefore, it is desirable to screen out those problems that can be easily solved as not warranting full cost-effectiveness analysis through discussions with stakeholders and organisations that are to implement measures.

If, after allowing time for all existing measures to take effect, characterisation has shown that there is still a problem (a gap to close) then by definition new measures will be required to ensure WFD objectives are achieved, and the assessment of any new measures is potentially subject to CEA.

In some circumstances it may be possible to take a simplified approach, which either does not require all of the steps of the methodology to be employed in strict sequence or allows relaxation of the analysis within individual steps. Determination of the criteria under which it is acceptable to adopt a simplified approach to CEA needs further investigation.

Introduction to the Cost-Effectiveness Analysis Methodology

WFD54 (Project 2a) sits alongside Project 2b, which considers the costs of measures. Project 2a is focused on the technical aspects of the identification and selection of Programmes of Measures, but the methodology has been created in such a way as to allow it to be used in conjunction with the outputs of Project 2b to provide an overall appraisal framework for cost-effectiveness analysis. The overall CEA process is set out in Figure 1, which highlights the linkages and iterations between the Project 2a and 2b methodologies. It will be important that there are iterations between Steps 2 to 4 of the effectiveness methodology and Steps 1 to 3 of the cost methodology.

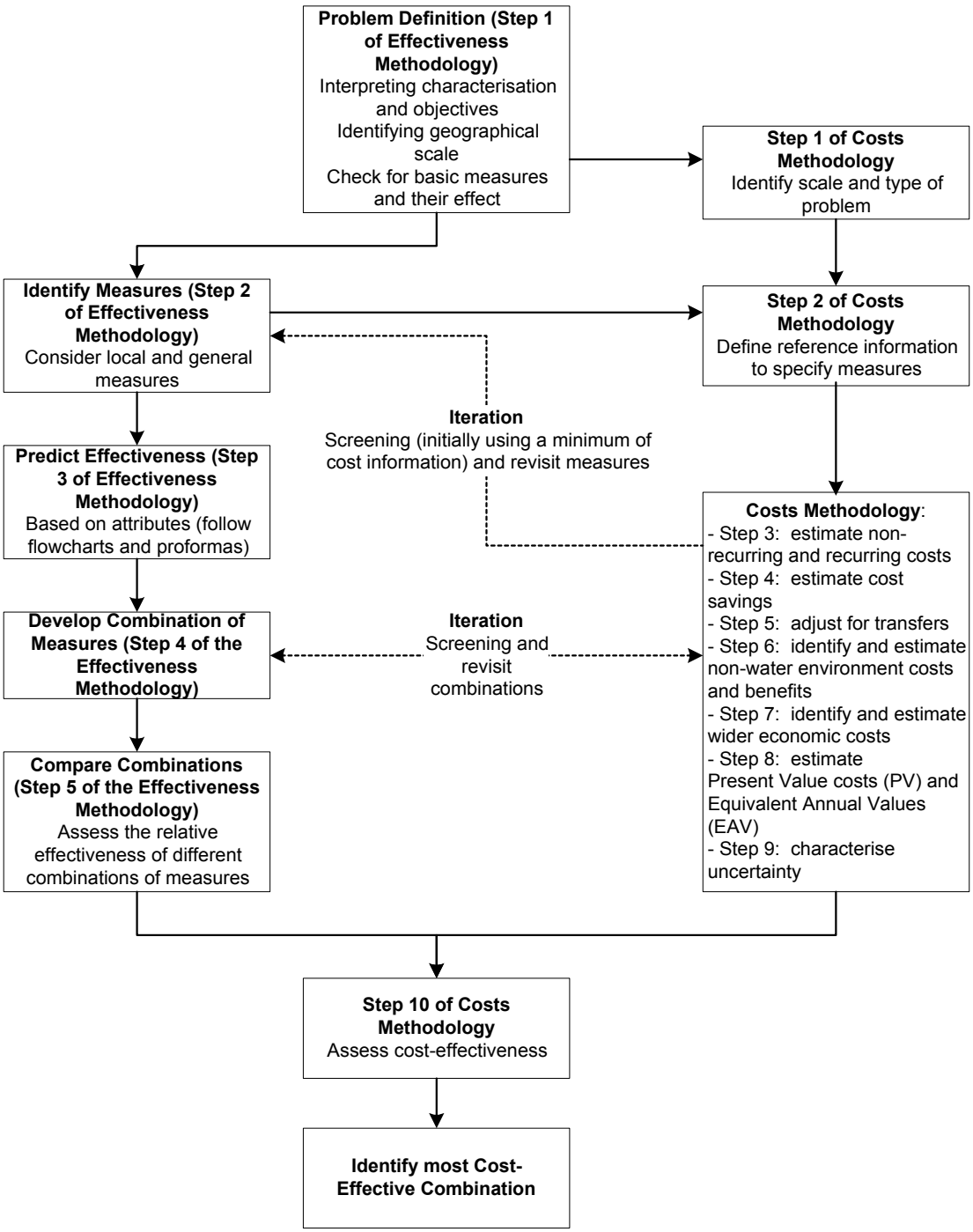

Figure 1: Integrating the Methodologies on Effectiveness and Costs to Assess Cost-Effectiveness

Whilst the steps of the methodology are designed to be applied in succession, the user is encouraged to adapt these steps to suit the particular circumstances of the problem under consideration. Tailoring use of the methodology in this way will help to ensure it is applied proportionately while maintaining a clear audit trail of source data, assumptions made with reasons for them, and decisions made and why. Such an approach will also ensure that the full economic impact of a combination of measures is assessed and not just the impact on the sectors having to implement the measures.

Not all decisions may require the full application of the CEA methodology. For example, problems that would not require CEA include:

- those that will be solved by implementing obligatory measures specified in other Community legislation (e.g. UWWTD);
- problems that are due to a single pressure or set of pressures caused by the activities of one water user and there is a delivery mechanism for ensuring action by that water user[5];
- problems that will be fixed by measures already agreed; and
- other problems that are not considered sufficiently important to warrant the expending of time and resources associated with a full CEA.

Problems that will require application of the CEA methodology include:

- multiple significant water management issues where there are different options for addressing a type of problem that occurs widely within a River Basin District. In such cases increased efficiency in applying the methodology could be achieved by treating the problem as generic and using the methodology to identify combinations of measures at a generic level. The CEA methodology allows for the identification of economies of scale; and
- individual significant water management issues that are of such importance as to warrant detailed case-specific analysis.

In addition to considering these pre-requisites for entering the methodology, there are a number of 'signpost' features embedded in the individual steps. These include:

- highlighting problems where potentially useful measures can be identified but for which there are currently no delivery mechanisms; and
- highlighting problems where there are potentially more cost-effective new delivery mechanisms (e.g. product and process controls, economic instruments, etc.). These are usually likely to be national mechanisms, but not necessarily exclusively so.

Furthermore, the methodology can be applied at a number of different levels of detail:

- **Simple application**: Apply each of the steps once in succession from problem definition to the comparison of combinations. This approach is best suited to the simpler and less contentious problems where the default objective for achieving good status can be met without disproportionate cost. Where the problem is high profile, or particularly complex involving multiple stakeholders, care will be needed to ensure that the approach provides a robust outcome.

[5] In this case, the water user responsible for the pressure can decide how they wish to most cost-effectively solve the problem. It is up to them to consider their options and innovate if appropriate. In doing so, it may be in their interests to follow an approved methodology if they later wish to claim disproportionate expense.

- **Repeated iterations of individual steps**: Use the steps as the foundation but repeat individual steps as necessary, with further refinement and inclusion of more detailed data, as many times as it takes to reach agreement with stakeholders. For instance, if it is easy to agree what measures are required, based on very little detail, then complete the methodology on that basis. Only go into lots of detail with lots of data where there is considerable uncertainty about which measures will work/are acceptable to stakeholders.

- **Selected application**: Apply individual steps to suit the problem under consideration. This may be particularly relevant where multiple problems of a similar type are being considered together. For example, Steps 1, 2 and 3 of the effectiveness methodology may be applied for a selection of cases to build up a generic set of potential measures and combined with the derivation of initial cost estimates following Steps 1 to 9 of the costs methodology using readily available cost data. Steps 4 and 5 of the effectiveness methodology, and the development of more detailed cost estimates would then be applied to the cases where further analysis is required to determine cost-effective combinations.

- **Repeated application of complete methodology**: Although the standard for good status will be known, it may be necessary to determine alternative objectives if it is judged technically infeasible and/or disproportionately expensive to achieve good status. (Alternative objectives may take the form of applying extended deadlines or less stringent objectives). This judgement can only be made after an initial assessment of cost-effectiveness and whether costs would be disproportionate. As a result, more than one application of the methodology will be required in some cases to secure a satisfactory cost-effectiveness outcome. The first application is likely to be most detailed with any subsequent applications limited to updating the combinations of measures to meet an agreed set of objectives.

Assessment of Effectiveness

The core of the effectiveness methodology is a series of steps that describe the assessment process, accompanied by a set of flowcharts. The aim of the steps is to provide a structured framework for the consideration of measures and combinations of measures, and their effectiveness in addressing specific risks (or known impacts).

The methodology is designed to be used to determine the effectiveness of measures or combinations of measures that address risks identified by the WFD characterisation process:

- **Step 1** provides the means for defining the problem in terms of the gap between the target and current conditions of a set of environmental parameters;

- in **Step 2** measures that can potentially contribute to closing the gap are identified, with the potential for screening out of those measures that are less effective and more costly (based on initial cost estimates);

- in **Step 3** predictions of the potential effectiveness of these measures are made, providing the opportunity to discard measures that will not make a useful contribution. Similarly, a preliminary assessment of the costs of identified measures is made, via reference to the costs methodology so that early judgements can be made on screening out measures with low cost-effectiveness; and

- **Steps 4 and 5** are used to develop alternative combinations from the measures retained from Step 3 and the predicted effectiveness of these combinations is compared. Again, potential combinations are referred to the costs methodology to provide an opportunity for those judged to have low effectiveness and high costs to be discarded. This serves to reduce the number of combinations to be compared. It is intended that the relative effectiveness of different combinations is compared by examining the differences between a common set of effectiveness attributes. Some of the attributes can be expressed in numerical terms, others are determined by reference to lookup tables. Judgements of effectiveness need to be based on consideration of the collected set of attributes; no single effectiveness value is determined by application of the methodology.

Whilst the methodology provides a framework for the identification of effective combinations of measures, the successful application of the methodology is dependent upon appropriate engagement with stakeholders. The responsible agency will carry out the initial screening process and will administer the overall process but cost-effectiveness analysis will need to be carried out in conjunction with those causing the problems and other interested stakeholders.

Once the potential measures and implementation mechanisms have been identified (Steps 1 and 2), their effectiveness may be predicted (Step 3). The assessment of effectiveness is conducted with reference to a set of effectiveness attributes. A common set of attributes is required to enable the relative effectiveness of measures (and combinations of measures) to be assessed. A base set of 23 effectiveness attributes has been identified, grouped under the following headings:

1. **magnitude of effect**: informs understanding of the potential contribution each measure could make to the achievement of the target improvement, depending on the level of effort applied (i.e. identifies the scope for trade-off between measures) and helps choose a combination of measures that delivers the target improvement (rather than overshooting or undershooting). These attributes are to be determined for all measures since this will provide vital information on a measure's performance in reducing the gap in the environmental parameter;

2. **characteristics of effect**: to identify combinations that will deliver the improvements by 2015 and/or identify the earliest date after 2015 by which combinations could deliver the target improvements, to differentiate between combinations with varying requirements for intervention to maintain effectiveness over time and to identify combinations that are adaptable in response to the results of monitoring, which may be important where the environmental response is uncertain;

3. **practicability**: to identify the combination that is most practicable to implement in terms of local acceptability, motivation for implementation, presence/absence of a responsible organisation, planning process or delivery mechanism; and

4. **side effects**: to help discriminate between different options that can each achieve the target improvement, where, for example, a combination with significantly greater beneficial side-effects than others would be preferred.

To reduce the complexity of analysis, it is recommended that inclusion of other attributes in the assessment is dependent upon the need to provide information to allow differentiation between measures or to provide other information that needs to be highlighted (such as other side effects). Each of the attributes under characteristics of effect and practicability should be assigned a numerical value, which can be selected from a series of lookup tables.

The next step (Step 4) is to develop combinations of measures to address the pressure(s). A valid combination is one that contains sufficient measures to address each of the risks identified in Step 1, as characterised by the gaps in environmental parameters. It may not be necessary to include measures to reduce every pressure as long as the gaps in the environmental parameters are addressed. Where a measure can be implemented by more than one mechanism and/or applied with differing degrees of effort, each combination must include no more than one mechanism and one degree of effort for each measure included in that combination. Where it is important to compare the effectiveness of the same measure for different mechanisms or degrees of effort, then a separate combination will need to be developed for each different mechanism or degree of effort.

The final part of the methodology is the comparison of combinations (Step 5), where a table of combinations against attributes of effectiveness is constructed and examined. Recording the attributes in this way maintains a full audit trail of combinations, which can then feed into the decision-making process. After compiling the table of combinations and attributes, there is an opportunity to screen out combinations that do not meet a minimum threshold of effectiveness or otherwise are considered to have a low effectiveness.

Assessment of Costs

The costs methodology has been developed to enable an assessment of the costs of measures from the local to the national level. It provides an approach to estimating the costs of combinations of measures, starting with the estimation of direct financial and economic costs, with only qualitative descriptions of non-water (indirect) costs and wider economic costs, and moving to the full monetary valuation of all costs and benefits (to the degree possible). The combinations to be costed are those identified in Step 5 of the effectiveness methodology, although initial costings of individual measures are also required to feed into earlier steps of the effectiveness methodology. This allows early screening of those measures that are more expensive and less effective, and ensures on-going iteration between the assessment of costs and effectiveness.

The costs methodology includes ten steps, nine of which relate to estimating the costs of measures, with the final step (Step 10) involving identification of the most cost-effective combination(s) of measures (see Figure 1). The methodology can be applied at different levels:

- each step within the assessment process can be applied at three different levels, with the level of analysis and detail required increasing from a ‘broad level’ to a ‘detailed level’ to an ‘in-depth level’. Simple sensitivity based decision rules are set out to help determine when more detail may be required; and

- the methodology has also been separated into a local/sub-regional component and a regional/national component. This reflects the fact that some types of impacts will not

become significant until they occur at a larger geographic or economic scale than implied by a measure adopted only at a very local level. However, it is also recognised that it may be appropriate to group waterbodies for assessment purposes, thereby ensuring that any impacts that may arise across a large area or a large number of businesses/operators are identified as such and are addressed at the regional/national level as appropriate.

The cost types that need to be brought together to estimate the total costs of a measure within the cost-effectiveness analysis are:

- non-recurring costs: these relate mainly to capital costs, but more generally are the additional one-off costs generated by a new measure/change in policy;

- recurring costs: these include changes in fixed costs (costs that do not vary across levels of production), in variable costs (costs that vary across levels of production or levels of activity) and in semi-variable costs (costs that have both a fixed and a variable component);

- non-recurring and recurring costs for regulators: regulator costs are associated with the set-up, administration, enforcement and monitoring of a new measure or a change in policy;

- cost savings: these may arise from the adoption or implementation of a measure and include savings in materials (inputs), reduced energy requirements, the recovery or sale of by-products, reduced maintenance costs, reduced manpower requirements, etc.;

- transfers: these are associated with the existence of taxes and subsidies and may result in estimates of the financial costs to businesses varying significantly from traditional measures of economic costs;

- non-water environment costs/benefits resulting from implementing the measure: they include changes in habitat, landscape, emissions to air, noise, etc. that may result from changes in land use (e.g. due to changes in agricultural practices or forestry), the construction of new treatment plants and pumping stations, and other types of works; and

- wider economic effects: any knock-on effects that are passed on or through to other sectors, organisations, etc. This includes the effects on producers and consumers in related markets that are not captured by the estimation of direct non-recurring and recurring costs.

Sixteen generic types of measure have been defined, with these reflecting the main drivers for action:

- treatment/transformation of emissions, such as discharges, dredged material, minewater, etc.;
- relocation of activities, for example, removing abstraction points or moving discharge points;
- recycling or re-use through take-back schemes, or within process recycling;
- substitution of a polluting substance with a less polluting alternative;

- process changes or re-design to remove the source of the pressure;
- reduced levels of input use, to include inputs such as fertilisers, pesticides, chemicals, etc.;
- product-related restrictions, such as restrictions on content or final use;
- improved management covering modifications to equipment, timing of actions, planning controls, etc.;
- changes in consumer/producer behaviour, for example, labelling of products or education and information campaigns;
- changes in prices including taxes and subsidies;
- conditions/controls on activities through tightening of controls, permits, operating conditions, etc.;
- natural processes and monitoring, where this relates to a measure that would incur costs (otherwise reliance on natural processes would form part of the baseline);
- modifying/removing/building physical structures, particularly in terms of channel or drainage modifications, flood defence structures, etc.;
- waste minimisation;
- restoration/remediation/re-creation including measures such as gravel cleaning through to channel restoration and creation of new habitats; and
- research to better understand processes, applicability, feasibility of measures and/or to better assess the costs and effectiveness of measures.

Each of these types of measure may be implemented through a range of different delivery mechanisms or policy instruments (e.g. regulatory standards, economic instruments or voluntary measures). The relevant cost types (non-recurring, recurring, etc.) have then been identified for each measure type. The aim is to help ensure that all relevant costs are taken into account and that there is consistency across sectors as to what types of costs are considered when developing total cost estimates for different types of measure.

The cost assessment involves developing estimates for individual measures and then aggregating these for a proposed combination of measures. In the methodology, there are a series of steps to follow in assessing the cost of measures. The work required under each step is described, together with the key issues that may arise in each step. Flowcharts set out the process to be followed in each step and illustrate the linkages between the effectiveness and costs methodologies:

- **Steps 1 and 2** essentially involve pulling together key reference information such as the waterbody (or waterbodies) being assessed, geographic scale, measures being assessed and baseline assumptions from the effectiveness methodology;

- **Steps 3 and 4** set out the process to develop financial cost estimates (non-recurring, recurring costs and cost savings, to the organisation(s) implementing the measure and to regulators); low, medium and high estimates are to be developed and probabilities associated to the likelihood of these estimates being realised;

- in **Step 5**, financial costs are adjusted to reflect economic costs as required by removing the effect of transfers; again low, medium and high estimates are to be carried forward;

- **Step 6** involves the assessment of non-water environment costs and benefits, with these described in qualitative and quantitative terms first and then monetised where they may

have an influence on the choice of measures. This is to ensure that the full costs (or benefits) of a measure are taken into account to reflect that impacts on the environment are not always accounted for in the costs to organisation(s) implementing the measure and/or to regulators; where quantitative estimates are developed, these should be in terms of low, medium and high figures, with their associated probabilities of occurrence;

- **Step 7** is used to determine whether wider economic impacts may be significant (where for example, the costs of the measure are large or where an activity would be forced to stop); if so, users are referred to the in-depth assessment and the assistance of regional or national economists;

- Once all of the cost elements making up each measure/combination of measures being considered have been estimated, it is necessary to estimate the discounted costs of individual measures. This is done in **Step 8**, which brings the cost estimates together to allow the Present Value (PV) and Equivalent Annual Value (EAV) costs to be estimated based on the low, medium and high assumptions; and

- **Step 9** is aimed at further characterising the level of uncertainty surrounding the cost estimates. The aim of this step is to guide the user on whether further data should be collected to reduce uncertainty.

Throughout Steps 3 to 6 (and 7 where wider economic effects are considered significant), users are to specify both the timing and duration of impacts. They are also to account for uncertainties in cost assumptions through the use of low, medium and high cost estimates. Probabilities should be assigned to the low, medium and high estimates to reflect uncertainty (where known this should be based on specified probabilities (e.g. the 10%, 50% and 90%iles); where probabilities are not known, then equal probabilities should be assigned to the low, medium and high estimates). All quantitative estimates are then converted to estimates of (net) present value costs and equivalent annual costs (in Step 9). Qualitative information is retained for non-valued impacts.

Combining the Assessments of Effectiveness and Costs

The final step of the cost-effectiveness methodology (Step 10) is to bring together the results of the effectiveness assessment and the cost assessment to provide an overall indication of cost-effectiveness in a way that will inform decision-making.

A simple tabular summary is used to summarise the required information on costs, effectiveness, uncertainty and non-quantified attributes. This is because presentation of the results as a single numeric indicator of cost-effectiveness (i.e. costs ÷ effectiveness) would result in a loss of too much information and would oversimplify the actual trade-offs involved in choosing between combinations of measures. There are also issues regarding the fact that this type of approach can hide or obscure key information, for example, on the uncertainty surrounding costs, the percentage of gap addressed and/or the area over which the pressure has been reduced. Given the importance of ensuring that the decision making process is open to stakeholders, the information underlying the choice of the most cost-effective combination should be transparent. The use of a summary table also allows non-monetised impacts such as those related to sustainability and synergies/conflicts between policies to be brought

forward to the decision-making stage. It is proposed that this summary table records details on:

- each combination of measures being assessed;
- the pressure(s) being addressed by that combination;
- effectiveness of the combination in terms of:
  - percentage of the gap in the target for the affected environmental parameter(s) met; and
  - proportion of the area over which the improvement in the environmental parameter(s) would occur.
- time for the measure to be effective;
- certainty of effect;
- costs of the combination of measures (as a range);
- non-monetised costs (e.g. descriptions of the non-water environment costs and benefits or wider economic effects, where applicable and not monetised); and
- other key factors that have arisen during the assessment of costs and effectiveness that should be taken into account during decision-making. This would, for example, include key assumptions on which the assessment is based and include any issues affecting sustainability, synergies, antagonisms, or policy conflicts.

The preferred approach for reflecting uncertainty on the estimates is through the use of ranges, with these applying to both effectiveness and costs; however, an explanation should also be provided as to the key reasons for the uncertainty (reliability or accuracy and whether this is due to uncertainty over adaptability, technological progress, etc.). In general, it is proposed that the following approaches are adopted to deal with uncertainty and to incorporate it into the final assessment of cost-effectiveness:

- **Broad Level Assessment**: for this level of assessment, pair-wise comparison and/or hedging and flexing techniques can be used to provide an indication of what combination of measures would be adopted from different risk taking perspectives. The use of these would be accompanied by data on the expected value, lower, mid and upper bound estimates to allow a simple form of sensitivity analysis and calculation of switching points.

- **Detailed Assessment**: as the assessment becomes more detailed, assessors may still want to consider the implications of hedging and flexing criteria, but the assessment should be accompanied by the use of expected values. At this stage, it may be important to consider the use of more probabilistic analysis to aid in a formal analysis of the impacts of uncertainty. Value of information or decision analysis may be of particular value here in determining what types of research/further data collection may be of most value as part of a more in-depth assessment.

- **In-Depth Assessment**: decision making as part of the in-depth assessment would rely on the use of expected values, with further analysis of the associated probability distributions. For example, this may rely on the use of stakeholder and expert opinions and encoding techniques to refine assumptions concerning the likelihood of low, medium and high estimates, or the use of Monte Carlo analysis where the probability distributions across the range of key uncertain variables are known.

3. Pilot Testing

The objectives of the pilot testing have been to:

- test the methodologies to ensure that they provide an even-handed assessment across sectors;
- test the methodologies to ensure that they produce realistic, sensible results that will help determine cost-effective packages of measures;
- test the accessibility of the methodologies to ensure they can be used by non-economists. Following on from the lessons learnt during testing, determine whether there is the potential to streamline the methodologies; and
- test the ability of others to replicate the assessments.

The three pilot test areas examined for this project are:

- Hampshire Avon (River Wylye and Upper Avon);
- River Ribble (River Darwen); and
- River Leven and Loch Leven, Scotland.

The pressures assessed within each pilot test are summarised in Table 2.

Table 2: Summary of Pressures Addressed within each Pilot Test

Pressure	Hampshire Avon (River Wylye/Upper Avon)	River Ribble (River Darwen)	River/Loch Leven
Point phosphorus	✓	✓	✓
Diffuse phosphorus	✓	✓	✓
Point nitrate	(✓)		
Diffuse nitrate	(✓)		
Abstraction	(✓)		✓
Morphology	✓	✓	✓
Urban pollution (BOD, NH_3)		✓	

Note: (✓) means the pressure was identified but was not assessed fully due to time and data constraints

For all three pilots there was a start-up meeting with Agency staff (Environment Agency or SEPA) to identify the area and pressures to be considered in the testing. Otherwise, Environment Agency and SEPA involvement in the pilot trials varied between the three areas, from full application of the methodologies in the River Ribble, to application of the effectiveness methodology only in the River/Loch Leven, to provision of data for the Hampshire Avon but no application of the methodologies. There was no direct stakeholder involvement due to time constraints, although the Ribble trial had previously asked stakeholders to identify which pressures they wished to see assessed during the trial. The testing period was seven weeks. Where possible, use was made of readily available information and data supplied by the Environment Agency/SEPA.

Table 3 summarises the key findings of pilot testing.

Table 3: Comparison of the Pilot Trials with the Objectives	
Objective	**Implications of Testing**
Provide an even-handed assessment across sectors	A general lack of data for specifying the measures in detail means that some measures were identified as requiring further research before a decision could be made as to their effectiveness and costs. In the pilots, this resulted in the measures being screened out, with the implication that the remaining measures that are identified as cost-effective reflect those for which more data are available. Adopting this type of approach could result in some sectors having to implement more measures than others due to better data rather than more cost-effective solutions.
Provide accurate results at both national and regional/local levels	Two national measures were identified to deal with phosphorus pressures. It was assumed that they would have been identified, assessed and implemented separately from the local measures and have been applied to all three pilot trial areas (although the costs of implementing the national measures at the local level could not be estimated with the data available). There are concerns over the accuracy of the cost estimates due to the amount of data that were available on which to base the costs.
Can be applied by non-economists and makes sense to Environment Agency/SEPA staff and potential to streamline/add short-cuts	Key areas of difficulty in the Ribble trial were in relation to transfers, the timescale to be used and on non-water environment costs and benefits. The assessment of transfers is likely to need assistance from economists. Guidance is also needed on the time horizons that should be used and the implications of different timescales for different measures. There was concern, particularly by SEPA staff, that the methodology could be applied inconsistently if undertaken by non-economists. Input was likely to be required from economists to undertake all costing of measures. Standard cost data were highlighted as useful but that the assessment must not become a 'push-button' exercise to avoid alienating stakeholders. The need for training on the methodology was raised if SEPA staff are going to be able to use it. Two further opportunities to screen the methodology have been identified: screening for technical feasibility during Step 2 of the effectiveness methodology (when measures are being defined) and screening for measures that are more costly/less effective before developing combinations of measures (Step 4 of the effectiveness methodology). Streamlining was undertaken in terms of the approach to assessing uncertainty. One other potential for streamlining would be to consider the significance of other cost elements when compared with the largest cost (e.g. operating costs compared with capital costs). If the capital costs are by far the largest cost element, then less effort could be placed on obtaining precise estimates of operating costs.
Potential for replicability	The main issue in terms of replicability is the amount of detail that is available to specify the measures. The testing highlighted that there is a general lack of data to allow detailed specification of measures, particularly for morphological pressures. There was also a general lack of readily available cost data. This means that a lot of simplifying assumptions had to be made, particularly in the River/Loch Leven case study. Another assessor may have made different assumptions such that the costs of measures may have varied considerably.

One of the key conclusions from the testing is that costing of measures requires a significant amount of technical and scientific data, much of which is not readily available and/or will require the involvement of either knowledgeable individuals or a considerable amount of research. The testing simplified the data collection exercise by using assumptions where data

were not readily available. This was the only practical approach within the time available, but may under-estimate the resource implications of data collection for the real CEAs.

For morphological measures, there is a key issue in terms of the current level of understanding of the impacts of pressures, the potential benefits of measures and the implications for intervention at one location in terms of unintended consequences elsewhere. There are other issues relevant to morphological pressures, however, including the use of terminology and descriptions that do not immediately appear to apply to morphological measures. Although some morphological pressures have been considered in the pilot trials, pressures such as ports, harbours, boating, etc. in transitional and coastal waters have not been covered. Given the concerns over the need for significant data collection exercises to be able to assess measures, a pilot trial to cover these issues is likely to be necessary. This could be used to provide an indication of the extent to which data are available to provide a reasonable indication of effectiveness and costs, where further data would be required and the way that these data could be obtained.

4. Where to Find More Information

Outputs of Project 2a

Table 4 summarises the outputs of Project 2a by task.

Table 4: Project Tasks and Outputs of Project 2a

Task	Description	Outputs
1	Project scoping: to further define the project's work packages and resource allocation for each phase, and identify links with Project 2b	Scoping Report
2	Measures analysis: identification of the main measures and identification of how their success can be measured through two facilitated regulator workshops	Workshop Output Report: Lists of measures, attributes and gap analysis
3	Design of appraisal framework and methodology: development of a first draft of the Effectiveness Method Report	1st Draft Methodology
4	Integration of effectiveness with costs: formally bringing together the work of this Technical Effectiveness Project (Project 2a) and the Cost Project (Project 2b)	Report under Task 6 of Project 2b and presented as a combined methodology report (Part A: introduction, Part B: effectiveness, Part C: costs, Part D: cost-effectiveness)
5	Pilot testing: joint testing of the Project 2a and 2b methodologies on three catchments	2nd Draft Methodology (Individual pilot test reports submitted as Annexes 1 to 3 of the Project 2b Final Report: Part 1 (Progress Report))
6	Refinement taking into account the findings of pilot testing and comments from the Steering Group	Final Report Also Part C of the combined 2a/2b methodology report

Outputs of Project 2b

Table 5 summarises how each of the tasks of Project 2b have been reported. To reduce duplication, the outputs of Tasks 1, 2, 3 and 6 are included in the Interim Report (dated April

2005). The results of Task 4 are presented in a separate Task 4 report, which also includes the results of Task 9.

Table 5: Project Tasks and Outputs of Project 2b

Task	Description	Outputs
1	Characterise measures distinguished and described by their key features that affect how to assess their costs	Reported in the Interim Report Part 1
2	Liaise closely with the Agencies' technical teams and other consultants to ensure that the outputs of the cost assessment work are in a form that can be used when carrying out their cost-effectiveness analysis	Reported in the Interim Report Part 1
3	Consult stakeholders (industry representatives) on the specification of the costs and economic impacts of the main measures about which they are most concerned	Reported in the Interim Report Part 1
4	Review the available data on costs of these measures to identify the major gaps	Reported in the Task 4 report
5	Develop a peer reviewed practical methodology for deriving cost functions for estimating the financial and economic costs for each of the main types of measures across the main sectors	Presented as a combined methodology report, with the costs methodology presented in Part C
6	Organise and participate in a workshop to develop a cost-effectiveness methodology	Reported in the Interim Report Part 1
7	Organise the testing of the cost-effectiveness methodology using virtual analyses and pilots in the Ribble catchment, in the Leven and the Hampshire Avon	Aims and objectives set out in the Interim Report Part 1 Reported in the Final Report: Part 1 (Progress Report) Individual pilot test reports submitted as Annexes 1 to 3 of the Final Report: Part 1 (Progress Report)
8	Scope the requirements of a database to collate and store the cost data	Reported in the Final Report: Part 1 (Progress Report)
9	Scope out the potential role of approximate/nationally derived cost information	Included in the Task 4 report as Summary and Conclusions Section
10	Organise a workshop to peer review the methodology and method for collating the cost estimates for their practical use for PoMs	Held on 13 September 2005 at the RSA, London. Workshop report is included as an Annex 5 to the Part 1 Final Report

A combined Project 2a and 2b report is also available that sets out the full CEA methodology.

5. Next Steps

The methodology is to be operationalised through the development and testing of guidance, which will build upon the methodology described above. This is to be undertaken as part of Project 2c, with the aim of enabling application of the CEA methodology by staff of the agencies.

6. Glossary and Acronyms

Term	Definition
Attribute	A characteristic of a measure. Some attributes can be assigned quantitative values; others require descriptive entries.
Broad level assessment	The initial level of assessment undertaken when following the costs methodology, focused mainly on estimating the financial costs of measures.
Cost-Effectiveness Analysis (CEA)	A technique which seeks to identify the least cost option for meeting a particular objective. It enables prioritisation between options, but ultimately cannot assess whether an option is economically worthwhile.
Combination of measures	A group of measures selected to reduce the gap.
Detailed level assessment	The second level of assessment which requires collection of more detailed cost data than for the broad level assessment.
Discounting	The technique of applying a discount rate to convert future monetary amounts to their equivalent value in today's terms, (based on the premise that people prefer to receive benefits in the present rather than in the future).
Disproportionate costs	Refers to 'beneficial objectives being achieved by other means' in the context of designations, derogations and new modifications. Designation of heavily modified water bodies, new modifications and (again) less stringent objectives can be justified when the current needs and socio-economic benefits accruing from an activity cannot be achieved by other means not entailing disproportionate costs. Whether an improvement is found to be disproportionately expensive or 'other means' disproportionately costly will be decided by individual Member States on a case-by-case basis. Ultimately, disproportionality is a political judgement informed by economic information.
Disproportionately expensive	Refers to measures for improving water quality. Time derogations or less stringent objectives can be justified on the grounds that measures are disproportionately expensive measures (Articles 4.4 and 4.5)
Economic cost	The monetary measure of the change in social welfare associated with the change in the provision of some good. It is not to be confused with monetary value, unless the latter is explicitly designed to measure the change in welfare, nor with financial value, which reflects an impact on cash flows.
Effectiveness	A judgement of the success in achieving the desirable effects of a measure. Effectiveness is a composite attribute which is expressed in terms of other attributes that describe different aspects of the effects a measure.
Effort	The application of resources to achieve a desired effect. It may be possible to apply some measures with different degrees of effort to achieve corresponding different degrees of effect.
Equivalent Annual Value (EAV)	The discounted value of a stream of future costs or benefits presented as annualised values.
Even-handed	A consistent approach to identifying measures, assessing effectiveness and assessing costs across the relevant sectors.
Expected value	The sum of individual outcomes multiplied by their probability of occurrence.
Financial cost	The impacts of changes in expenditure on the cash flow of a company.
Gap	The difference between the target and current conditions of a set of environmental parameters.
Good status	The status achieved by a water body when both its ecological status and its chemical status are at least 'good'. For groundwater, good status relates to quantitative status and chemical status.
Hedging and flexing	Decision rules that assume that either the worst, or the best, outcome will occur for each measure and then choose the measure which gives the least bad outcome, or the best possible outcome; these criteria essentially capture 'regret' based approaches using minimax and maximin criteria. These type of criteria are most appropriately used together with a scenario based analysis, which defines upper and lower bounds.
In-depth level assessment	The third level of assessment within the costs methodology and the most detailed. It involves collection of considerable amounts of site specific cost data and monetary estimation of most (if not all) of the cost variables.

Term	Definition
Less stringent objectives	Paragraph 4.5 'Member States may aim to achieve less stringent environmental objectives than those required under Paragraph 1 for specific bodies of water when they are so affected by human activity, as determined in accordance with Art. 5.1, or their natural condition is such that the achievement of these objectives would be infeasible or disproportionately expensive and all of the following conditions are met: (a) the environmental and socio-economic needs served by such human activity cannot be achieved by other means, which are a significantly better environmental option not entailing disproportionate costs; (b) Member States ensure, - for surface water, the highest ecological and chemical status possible is achieved, given impacts that could not reasonably have been avoided due to the nature of the human activity or pollution; - for groundwater, the least possible changes to good groundwater status, given impacts that could not reasonably have been avoided due to the nature of the human activity or pollution; [...] (d) the establishment of less stringent environmental objectives, and the reasons for it, are specifically mentioned in the RBMP required under Art. 13 and those objectives are reviewed every six years.'
Measure	An action that may be applied to prevent, reduce or remove an impact.
Mechanism	The delivery or planning process for implementing a measure.
Monte Carlo analysis	A numerical technique for assessing the probability of different outcomes from two or more variables.
Non-recurring cost	Costs that only occur once and do not re-occur.
Non-water environment costs and benefits	Costs and benefits arising as a result of implementation of a measure that are not directly related to the water environment. They could include: creation/loss of habitat, impacts on landscape, noise, odour, global warming, air quality, congestion, accident risks, changes in risk of flooding or erosion, disruption, inconvenience, soil quality, use of non-renewable resources, etc.
Programme of Measures (PoM)	Applicable by the end of 2009, the programme of measures defines, for each district, the measures to be implemented to achieve the objectives defined for 2015 by the Management Plan. The programme of measures is actually a part of the management plan.
Present Value (PV) cost	The discounted value of a stream of future costs or benefits.
RBD	River Basin District.
RBMP	River Basin Management Plan.
Recurring cost	The additional on-going costs that may occur on an annual basis or be more periodic in nature (e.g. arising every five years). These will take the form of variable or semi-variable costs.
Transfers	Payments from one sector to another. Failure to account for transfers in economic estimates of costs will result in over or underestimation of the real economic costs of a measure and may affect the end-ranking in terms of cost-effectiveness.
Uncertainty	Stems from a lack of information, scientific knowledge or ignorance and is characteristic of all predictive assessments.
Value of Information (VOI)	Value-of-information techniques provide an analytic framework for deciding whether it is better to make a decision now based on an inherently uncertain risk or to collect additional information first and then decide.
Water body	Distinct and significant volume of water. For example, for surface water: a lake, a reservoir, a river or part of a river, a stream or part of a stream. For groundwater: a distinct volume of water within one or more aquifers.
Water Framework Directive (WFD)	Directive 2000/60/EC establishing a framework for Community action in the field of water policy.
Wider economic effects	Any knock-on effects that are passed on or through to other sectors, organisations, etc.