Water Appraisal Guidance; Assessing Costs and Benefits for River Basin Management Planning

Final Draft – May 2013

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

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1. Introduction

1.1. Aim of this guide

This guide has been developed to assist the assessment of benefits for economic appraisal of measures which affect the water environment. This can be used for River Basin Management Planning and other disciplines where relevant.

The main output from using this guide is a summary statement of the level of expected benefits compared to costs of implementing a bundle of measures across a geographical scale.

A number of tools have been developed to standardise the format of an appraisal and can be used alongside this guide. These are the

- Water Appraisal Summary Table;
- Measures, Bundles and Costs sheet;
- Stage 1 Valuation sheet;
- Stage 2 Valuation template;
- Review of Benefits for Value Transfer table.

Where the application of this guidance is used for River Basin Management Planning, please consult the Operational Instruction (OI) to understand the adjacent process.

1.2. How to use this guide

This guide explains context and provides instruction. On first using this guide, it is suggested that you understand the context. Thereafter, we have provided a way to signpost users to instructions.

Instructions have been provided within borders to help users locate them.

Case studies have also been used where possible to illustrate examples.

Appendix A provides a glossary of economics terminology. Appendix B, the assessor's checklist, helps to outline data requirements.

1.3. Who can use it

This guide has been developed with Environment Agency Catchment Co-ordinators, Area Environmental Planning staff and Regional River Basin Management Planning staff in mind, however, every region and area is different and the owner of the assessment may change depending upon local circumstances. The guide can also be used by a non-Environment Agency led group.

Community representatives and external stakeholders can be involved in the development of the assessment. This is in order to obtain the most accurate local evidence on the costs and benefits of measures.

Environment Agency technical specialists you may wish to consider consulting with, where relevant, include those working in;

- Environmental Planning
- Fisheries and Biodiversity
- Groundwater and Contaminated Land
- Hydromorphology specialists
- National Environmental Assessment Service (NEAS)
- Regional River Basin Management Planning
- Regional Water Quality
- Regional Water Resources
- Regional Evidence
- Regional Climate Change
- Regional or national Economists
- National Capital Programme Management Service (NCPMS)

External stakeholders you may wish to consider collaborating with, where relevant, could include;

- River Basin District Liaison Panels
- Rivers Trusts
- Local interest groups e.g. angling clubs, heritage groups, recreational groups.
- Local land managers
- Water company representatives
- National Farmers Union (NFU)
- Organisations within the Defra family NGOs such as RSPB, Wildlife Trusts, National Parks.
- Local Authorities

The group can fairly reflect those who are advantaged and disadvantaged as a result of the project/programme to form a good representation of the impacts.

1.4. Principles

The following principles have been assumed during the development of the AST and user note.

- This assessment will adhere to the appraisal instructions as set out within the Treasury Green Book and associated supplementary guidance.[1]
- The effort required to monetise benefits should be proportional. A 'triage approach' is therefore advised in order to rationalise effort. All monetary assessments should undertake a high level benefits monetisation (known as a stage 1 valuation). A more detailed/local level benefits monetisation (known as a stage 2 valuation) uses a greater amount of resources and should only be undertaken if the results of the former assessment are not clear (leads to benefit cost ratios[2] between 0.5 and 1.5) or a contentious issue requires a more granular assessment.

1 As a result, some of the vocabulary from the Green Book has been used in this guide. If unsure, please use the glossary in Appendix A.

2 Benefit cost ratios can be represented as a ratio such as 1:1.5. In this case, £1 of expenditure (cost) will return £1.50 worth of benefits. Often this is written in short hand such as 1.5. Benefit cost ratio is benefit/cost where projects or programmes with ratios over 1 are said to be 'cost beneficial' and ratios below 1 are said to be 'un-cost beneficial'.

- Environment Agency staff can work collaboratively with stakeholder groups when completing an appraisal.
- Monetary valuation of benefits is not necessary in all cases. It is important to understand what level of information is needed to be fit for purpose.
- We would expect to support bundles of measures[3] with a benefit cost ratio greater than 'unity' (1). However since not all benefits can be monetised, bundles of measures with benefit cost ratios, in a range straddling 'unity'[4], may wish to express the benefits particularly clearly to assist the decision maker. In the reporting stage non-monetised benefits can be expressed with equal importance.
- Uncertainty of inputs can be tested with sensitivity testing.
- The do nothing baseline and do something impacts should consider impacts of climate change. Where uncertainties exist, scenario testing can be undertaken. For more on this, see chapter 7.
- This will not replace existing guidance such as the 'Handbook on Economic Valuation of Environmental Effects' (EVEE) (Eftec, 2010) for flood risk and coastal erosion management projects, policies or programmes and the OFWAT agreed methodology for water company benefits valuation, 'Quantifying the Benefits of Water Quality Catchment Management Initiatives' (OFWAT et al, 2013). This will work alongside the Benefits Assessment Guidance (BAG) (Environment Agency, 2003) which can be used at the 'stage 2 valuation' stage.

1.5. Origin

This appraisal methodology has been developed by drawing on best practice.

Mainly, the Water Appraisal Guide has been 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 AST 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)
- The Strategic Environmental Assessment process.

A full list of references is provided at the end of this document.

3 Measures are local level actions. A bundle is a group of measures which contribute to the improvement or no deterioration of a common water body.

4 We suggest 1.5 to be used as an upper bound which mirrors the bound used in Flood Risk Management. We suggest that 0.5 is to be used as a lower bound. Where there is a concern that the benefits may be overestimates or the costs underestimates, the upper bound could shift upwards. However, a larger range will result in greater amount of resources being spent to apply a stage 2 valuation to 'marginal' projects. Since economics suggest that the greatest resource should be spent on the most cost beneficial projects, it is advised that the resource spent on gathering evidence on 'marginal' projects should be proportional.

A new approach was required for Water Framework Directive relevant measures because the existing Benefits Assessment Guidance did not include all the relevant ecosystem service categories and/or the latest valuation studies. This appraisal guide has been developed in response to this need.

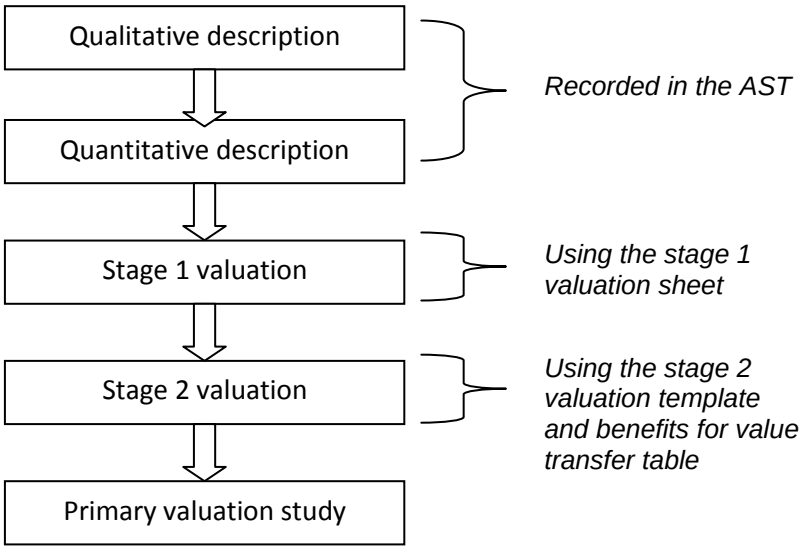
The stage 1 valuation methodology was influenced by the writings of Sen, (2000) who noted that there is a trade off between 'usability and credibility' in appraisal. In other words, a detailed and in depth appraisal can often be undertaken at great expense. With this in mind, a triage approach is recommended. The stage 1 valuation spreadsheet has been designed to be both easy to use and credible for screening out very cost beneficial and very un cost-beneficial bundles of measures. More on this can be found in 4.3.

The stage 2 valuation, which allows more detailed monetisation, can draw information from:

- Valuing environmental impacts: practical guidelines for the use of value transfer in policy and project appraisal (Eftec, 2010)
- UK National Ecosystems Assessment (2011)
- Flood and Coastal Risk Management; Economic Valuation of Environmental Effects (Eftec, 2010)
- Benefits Assessment Guidance (Environment Agency, 2003)
- Environmental Outcomes Mini Programme; Water Body Level Costings Project (Environment Agency and Royal Haskoning, 2013).

1.6. Methodology for benefits assessment

This guide walks the user through the following benefit assessment steps:



It is not necessary to complete all benefits assessment steps.

A **qualitative and/or quantitative description** of the do nothing baseline and the impacts are required before any monetisation of benefits is undertaken. The results of this step can be summarised in the Appraisal Summary Table (AST).

A **stage 1 valuation** uses a simple methodology to monetise benefits and can be useful for undertaking analysis at the national, river basin management or catchment scale, to prioritise a programme or where a high level estimate is fit for purpose at the local level. The results of a stage 1 valuation are used to screen out projects which are clearly cost beneficial or clearly un-cost beneficial.[5] The Stage 1 Valuation sheet should be used to assist calculation.

A **stage 2 valuation** could be used if the recommendations from the former assessment are not clear (benefit cost ratios are reported as being between 0.5 and 1.5) or a contentious issue requires a more granular assessment. The Stage 2 Valuation template and Review of Benefits for Value Transfer documents can help undertake this.

It is unlikely that a **primary valuation study** will be required for any Environment Agency assessment. You should contact the Economics and Social Science (ESS) team before you embark on this stage.

1.7. Process

Benefit cost analysis sits within a decision making process. For River Basin Management Planning, please see the Operational Instruction document and the process maps for WFD options appraisal.

1.8. When to use it

The benefits assessment can help inform catchment appraisals which:

- Will help to inform discussions with partners on objective setting for catchments and water bodies, as part of the disproportionate cost assessment process
- Helps us and our partners to understand the return on investment for expenditure on WFD measures.
- Justifies public expenditure on WFD measures through the business planning process.

This list is non exclusive.

The methodology outlined in this guide can only be used for assessing the benefits of a delivery programme[6]. These are those actions in the delivery stage (red and underlined in the figure below).

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5 "There is a trade-off ...between easier usability (through locked-up formulae) and more general acceptability (through allowing parametric variations)." (Sen, 2000) The stage 1 valuation methodology is aimed at easier usability while the stage 2 valuation methodology is more comprehensive but more time costly. Using a stage 1 valuation to screen projects follows the methodology set out in the Policy Appraisal and the Environment guide by the Department of Transport, Environment and the Regions in 1998 which is summarised on page 91 of Pearce, 1998. Having a two stage approach can help balance the trade off between time and cost and study robustness.

6 If you wish to outline the benefits of pre project work such as scoping, investigating, planning and stakeholder engagement you can describe the benefits qualitatively in terms of the efficiency and quality that good pre project studies can ensure. Essentially the delivery actions may not be optimal unless the pre project stage is undertaken with some care. Still, as an outcome focused organisation we should remember that the pre project stages are a 'transaction cost'. In other words it is the associated administration required before undertaking the valuable delivery work.

A	**Pre project stage**				**Delivery stage**		**Post project stage**		
B	Scoping	Investigations	Strategy	Plan	Actions	Outcomes	Evaluation		
	Stakeholder Engagement								
C	Defining the rationale, objectives and appraisal						Monitoring	Evaluation	Feedback

Table 1.1: Project stages[7]

Actions can be tangible actions (such as fencing, tree cutting) or non tangible actions (such as stakeholder engagement, education and behavioural change actions including campaigns). For both types of actions we can assess benefits through a qualitative and quantitative assessment. Currently we are unaware of strong evidence on how some stakeholder engagement, education and behavioural change actions link to changes in the water environment. Through information on best practice, we know that these changes are positive; we may not have quantified information. This will be updated if more information becomes available, but for now we can only undertake the monetisation stage for tangible actions, or where there is a quantified link between non tangible actions and tangible outcomes.

You need to make sure that this guide is applicable to your project or programme. We support the use of this guide for River Basin Management Planning. Flood Risk Management projects, policies and programmes are encouraged to use 'Flood and Coastal Erosion Risk Management Appraisal Guidance' (FCERM-AG) and the corresponding 'Handbook on Economic Valuation of Environmental Effects' (EVEE). Again, this guide will aim to be consistent with that process by reporting the same values for a number of the ecosystem service categories which can be used in the stage 2 valuation. Other relevant appraisal guides are outlined below.

[7] A; Shortened summary of the Prince 2 stages, B; Environment Agency processes, C; Green Book Policy cycle.

Department/ Agency	Environmental Impact/Policy area	Description and link to guidance
Defra	Air quality	Guidance on the environmental impacts of air quality including recommended damage cost values to apply: http://www.defra.gov.uk/environment/airquality/panels/igcb/index.htm
	Climate change	Greenhouse gas policy evaluation and appraisal guidance: http://www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf Details on the recommended carbon values to apply in policy appraisal: http://www.defra.gov.uk/environment/climatechange/research/carboncost/index.htm
	Flood risk management	Flood risk management project appraisal guidance: http://www.defra.gov.uk/environ/fcd/pubs/pagn/default.htm
	Waste	Review of the environmental and health impacts of waste, including evidence on valuation: http://www.defra.gov.uk/environment/waste/research/health/index.htm
Department for Transport	Appraisal of transport projects	Methodology for taking account of environmental impacts: http://www.webtag.org.uk/webdocuments/3_Expert/3_Environment_Objective/index.htm
Environment Agency	Flood risk management	*Flood and Coastal Erosion Risk Management: Economic Valuation of Environmental Effects*: forthcoming publication
European Commission	Various initiatives to provide guidelines for the assessment of environmental costs and benefits	Guidance on external costs of fuel cycles (energy/transport): http://www.externe.info/ Guidelines in the Water Framework Directive (WFD) context: http://www.aquamoney.ecologic-events.de/ MethodEx: best practice in external cost assessment, extending ExternE analysis to agriculture, industry, waste and other sectors: http://www.methodex.org/

Table 1.2: Guidance on specific environmental impacts in policy appraisal (An introductory guide to valuing ecosystem services, Defra, 2007).

Note that EVEE for flood and coastal erosion risk management is now available at http://www.environment-agency.gov.uk/research/planning/116707.aspx

2. The appraisal context

2.1. Framing the appraisal

Before beginning the qualitative assessment, the assessor must identify:

- Objective/s of the project. In general the key objective will be 'to improve the water bodies within the catchment towards Good Status'. If you are comparing a number of options (bundles of measures) they all must meet the project objective/s collectively.
- Aim of the appraisal. Is this to understand whether a bundle of measures are cost beneficial or not? Is it to compare a number of competing bundles of measure options which meet the objectives to recommend the most economically worthwhile option?
- The baseline condition of the water body under the 'current' condition and 'do nothing' scenario.
- The bundles of measures (packages of catchment actions) which meet your objectives. You may wish to call one a 'do minimum' option if this option reflects general maintenance works for example. In order to provide this, an unconstrained, 'long list' of options should have been cut down to a 'short list' by sifting out options which are not technically feasible or cost effective[8].(Measures and costs can be summarised in the bundles, measures and costs spreadsheet outlined in 2.3).
- The cost of the measures[9]. These can be estimated using the Environment Agency Cost Effectiveness Database (2012), 'Environment Agency CEA tool' for water resources, or evidence from previous projects or contractor quotations.
- The time period that we can assess the benefits for. This will be dependent upon the life time of the benefits of the longest living asset. Where not applicable, we suggest using 40 years to be consistent with the water industry appraisal periods[10].
- The size of study area/length of the study river in km/size of the study water body.

Please note these assertions down and present these when reporting results.

8 Where a number of options provide the same outcomes, the cheapest one should be chosen. For example if a wooden fish pass provided the same outcomes as a gold plated fish pass, the cheaper wooden option should be short listed.

9 To be consistent with the Green Book, this document uses the word 'option'. An option, in this sense, is a package of catchment actions which could help meet good ecological status. We keep the word 'option' to remind us that appraisal can help us decide between doing nothing and a number of do something options. It is good practice to compare a number of options, rather than appraise a single package of catchment actions in one location.

10 FCERM uses 100 years so projects bidding for Flood Defence Grant in Aid monies can be consistent with this. However, Flood Defence projects tend to be asset based with long benefit periods. WFD projects are not the same; they tend to have a shorter life span. There will require good justification for going beyond 40 years.

2.2. Geographical context

Please refer to the Operational Instruction (OI) when deciding at what level to undertake your appraisal for River Basin Management Planning.

Descriptions of the language we use to describe geographical context in this guidance document are as follows:

Actions:

- Measure – an individual action or 'tier three measure' such as 'removal of sediment' or 'river restoration'
- Bundle of measures- groups of measures with benefits which are geographically interdependent e.g. the measures which shall improve a particular 60km stretch of a river to Good Status. This could be at the water body or operational catchment scale, depending on their interdependency.
- Programme – The total bundle of measures in a River Basin District.

Geography:

- Water Body – The most local of geographical classifications. These may be entire lakes, parts of lakes, parts of rivers and streams, estuaries, coastal waters, or groundwater. They are classified with a Unique Identification number.
- Grouped Water Bodies or Operational Catchments – This could be a handful or 40-50 Water Bodies that form a discrete unit, not necessarily source to sea, but a unit that is logically linked and can be considered as one.
- Catchment – This is higher scale geography to the grouped water bodies or operational catchments. These have set boundaries. Also known as 'Defra 104 catchment scale'. Examples include the Hampshire Avon, Colne or Leam catchments.
- River Basin District – These are groups of catchments at the sub regional level. There are around 10 river basin districts in England and Wales. This is the highest level of geography and at which the River Basin Management Plans will be made.[11]

This guide can be used for appraisals at all geographical levels, although there is some principles by which to adhere to.

The costs should be recorded on a measure by measure basis. These should then be aggregated up to the desired geographical scale.

For River Basin Management Planning, all measures which impact on the same geographical stretch (are interdependent) should be grouped together as a bundle of measures. This is to avoid double counting of benefits, which are applied at the per km scale.

The impact of the total bundle of measures should then be assessed qualitatively and quantitatively using the Appraisal Summary Table and assessed in a stage 1 valuation.

Following this principle could result in a bundle of measures which is localised, impacts on a number of water bodies or an entire operational catchment. The principle should guide the geographic level by which the assessment is made. The results of the assessment can then be aggregated up to

[11] More on these can be found at http://www.environment-agency.gov.uk/research/planning/33112.aspx

operational catchment level (or down to waterbody level) in order to present results. Please refer to the Operational Instruction (OI) regarding the geographical level by which final results should be presented.

There is a danger that bundling measures together could 'hide' un cost beneficial individual measures. (For example, if the net present value[12] of measure 1 is £500k and the net present value of measure 2 is -£300k, then the net present value of the bundle would be £200k). The total bundle may look worthwhile, although parts of it might not be.

A way to manage this is to appraise a number of bundle options. As well as appraising the total bundle of measures, you can create alternative bundles. The bundle with the highest net present value should be recommended.

2.3. Bundles, Measures and Costs spreadsheet

To ensure a transparent audit trail, the list of measures which correspond to a bundle of measures, should be outlined. The bundles, measures and costs spreadsheet can help[13].

The spreadsheet is designed to add up costs of individual measures to report a total cost for the bundle. It requires the user to input information on the cost of individual measures from sources external to the spreadsheet[14]. If cost benefit analysis is not required for protected area measures or no deterioration measures then this spreadsheet can be used to remove the cost of these measures from the total. The inputs to the spreadsheet are as follows:

			Which water body/ies will your measure be implemented in? (first insert relevant unique identification numbers/names into column headings below).
Unique measure name	Comments (if applicable)	Will this measure primarily improve a river, lake, coastal area, trac, groundwater?	EXAMPLE GB108048001290
1		River	

[12] Net present value = present value benefit – present value cost

[13] If the measures are for Water Resources, you can use the CEA tool. This looks up costs automatically.

[14] Measures from stage 3 investigations may be already recorded within CPS. If you generate any alternative measures, please enter this information into CPS.

Which water body/ies will your measure impact on? (insert relevant unique identification numbers/names into column headings below)																														Has the measure already been funded **and** is underway?	Is the measure's primary objective to improve a protected area?
EXAMPLE GB108048001290																															
																														Yes	Yes

Will the measure cause:		What are the one-off / capital costs of the project in each of the following years? (For a longer schedule of costs unhide the adjacent columns) (£k)				What are the annual costs (£k/yr)? If none, enter 0	What year do these annual costs start? (year)	Approx. how many years will these annual costs be needed to maintain the envir. improvement or non-deterioration? (number of years up to 40)
A change from current to 'improved'	No deterioration	13/14	14/15	15/16	16/17			
X		*100*	*100*	*100*	*100*	*20*	*2013/14*	*6*

Applicable/ responsible sector?	Assign to bundle: (rename where applicable)				
	1 - Full bundle to Good	2 - [alternative bundle]	3 - [alternative bundle]	4 - [alternative bundle]	5 - [alternative bundle]
Agriculture and rural land management	X				

Table 2.1: Inputs in the bundles, measures and costs spreadsheet

The sheet uses sumif formulas to aggregate cost information which can be pasted into the stage 1 valuation sheet. Those columns marked in dark orange are the inputs required for the 'Bundle of measures cost summary' tab to run correctly.

The sheet is useful in aggregating costs under dfferent scenarios. For example, you may want to calculate costs for rivers, coastal/lakes/trac or groundwater separately as there is a different method for calculating benefits for each type of water body in the stage 1 valuation sheet.

You should choose which costs you would like to be summed using the drop down boxes within the output sheet. The pivot table will then return aggregated costs based on your scenario.

	Data					
Bundle	COUNT	CAPEX 13/14	CAPEX 14/15	CAPEX 15/16	CAPEX 16/17	OPEX (£k per year)
1	3	180	155	155	100	92
2	1	56677	0	0	0	100
3	1	56677	0	0	0	22
4	1	43	0	32	0	15
5	1	0	55	55	0	25
none	1	25	0	0	0	0

Table 2.2: Aggregated cost results in the bundles, measures and costs spreadsheet

There is a possibility to test more than one bundle of measures which affect the same location. For example, a number of bundles of measure options which reach GES or GEP could be tested. As could bundles to test groups of measures to reach alternative objectives. The 'Bundles, Measures and Costs sheet' can help you do this. Each measure can be assigned to up to five options. The costs of these options can be inputted into the stage 1 valuation sheet to estimate the expected benefit cost ratio and expected net present value.

2.4. Stages in a cost benefit analysis

The generalised stages in a cost-benefit analysis are as follows:

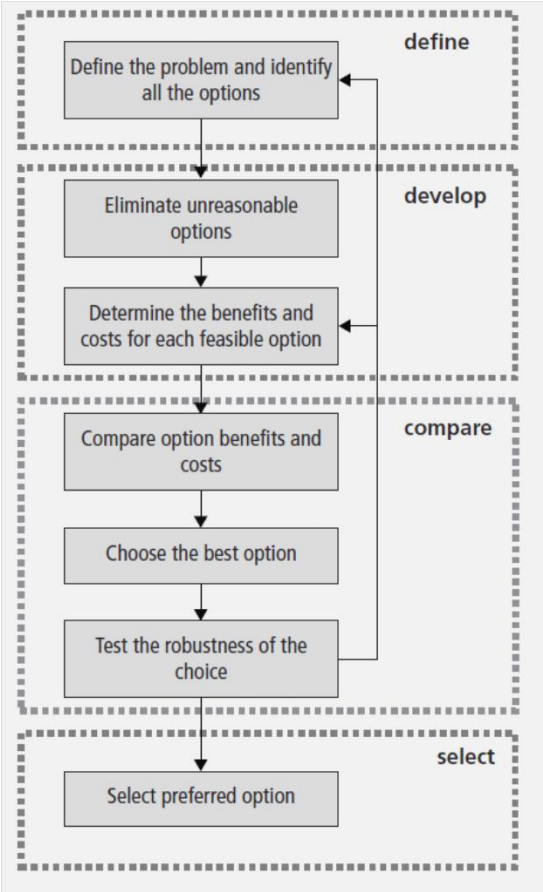

Figure 2.1: Main stages in a cost benefit analysis (FCDPAG3, Ministry of Agriculture, Fisheries and Food, 2000)

Figure 2.1 illustrates the stages within a cost benefit analysis. While this user guide focuses upon the 'Determine the benefits and costs for each feasible option' stage and those that follow, it is important to have followed the previous steps before embarking on the benefits assessment stage. For River Basin Planning, the earlier steps are covered through classification and investigations. This includes identifying the problem, outlining the baseline, identifying a long list of measure options and reducing these to a short list of measure options. For more information on this process please refer to the Green Book (HM Treasury, 2003).

2.5. Estimating cost information

Although this guide focuses on the estimation of benefits, cost information is required to calculate a benefit cost ratio.

A list of measures and costs for River Basin Planning should already be recorded within the Environment Agency CPS system as a result of stage 3 investigations.

Where cost information must be sourced, the Environment Agency Cost Effectiveness Database (2012) can identify average cost data, or more local evidence from previous projects or quotes from contractors and water companies can be used, for example.

Costs should include a small contingency allowance (to take in account optimism bias).

Costs can include green house gas costs (refer to DECC for more information http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx).

Where costs are being funded by the water industry, include the financing costs (interest payments) using the Weighted Average Cost of Capital rate (Ofwat, 2011). The Weighted Average Cost of Capital is the cost of raising capital and includes cost of debt, equity and gearing. You can ask the relevant water company what their WACC is. If in doubt, use a default of 5.5%.[15].

In order to calculate present value costs, costs should be discounted at the social rate of return, 3.5% for years 0-30 and declining thereafter, as recommended in the Treasury Green Book (2003). This will be calculated automatically if you use the stage 1 valuation spreadsheet.

For more information on how to discount costs, if you are not using the stage 1 valuation worksheet, please use the stage 2 valuation template or refer to the Treasury Supplementary Guidance on discounting at http://www.hm-treasury.gov.uk/data_greenbook_supguidance.htm

[15] Including financing costs and discounting at the social rate of return is known as the 'Spackman Approach' (Ofwat, 2011)

Box 2.1: How to inflate past values to current prices

You may be in a situation where you might need to inflate past prices into current prices. For example if you are using costs in your appraisal sourced from a very similar project which was delivered 6 years ago.

In appraisal we must express costs and benefits in current prices (or as close as possible). Therefore, the assessor should not account for inflation in the pricing of future costs and benefits and the assessor should inflate past values to current values. A comprehensive guide on how to do this, plus the latest GDP deflator data, is available on the Treasury website at http://www.hm-treasury.gov.uk/data_gdp_index.htm.

The latest GDP deflator data is listed below. Here, the 2012 index is set at 100. Simplistically, this table tells us that £65.14 in 1992 is worth the same as £100 in 2012.

To inflate past values to current value the assessor should calculate:

Current value = past value x (current year index/past year index)

For example, a study by Brander et al (2008) estimates that a hectare of inland marsh creation could provide benefits to society of approximately £3245 per annum. If we were inflating to 2012 prices then we would calculate the 2012 value as:

Current value = £3245 x (100/92.536) = £3506

This means that £3245 in 2008 is worth the same as about £3506 in 2012.

You should uplift your costs and benefits to the nearest year that data is available, and caveat your results accordingly.

Calendar year	Index	Calendar year	Index
1970	8.850	1992	65.140
1971	9.645	1993	66.515
1972	10.405	1994	67.429
1973	11.169	1995	69.201
1974	12.807	1996	71.322
1975	16.262	1997	72.787
1976	18.769	1998	74.277
1977	21.334	1999	75.810
1978	23.801	2000	76.316
1979	27.213	2001	77.563
1980	32.498	2002	79.341
1981	36.195	2003	81.289
1982	38.824	2004	83.390
1983	40.871	2005	85.388
1984	42.621	2006	87.866
1985	44.979	2007	89.808
1986	46.389	2008	92.536
1987	48.701	2009	93.754
1988	51.587	2010	96.347
1989	55.276	2011	98.605
1990	59.011	2012	100.000
1991	63.149		

Table: 2.3 GDP deflators (Treasury, 2013)

3. Assessing the benefits - qualitative and quantitative assessment

3.1. Why undertake a qualitative and quantitative assessment of benefits for cost benefit analysis?

A qualitative and quantitative description of impacts is required as a starting point for assessing benefits[16]. This is a crucial and important step before monetisation of benefits for cost benefit analysis.

The qualitative information helps economists to understand what benefits could be monetised. The quantitative information can be used as an input into any valuation calculations. Both qualitative and quantitative information helps economists to understand the magnitude of change.

3.2. Introduction to the Appraisal Summary Table (AST)

The Appraisal Summary Table (AST) is a simple spreadsheet template that can assist in describing the qualitative and quantitative impacts of your project/programme.

If you already have undertaken an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) this may already be fit for purpose to use as the qualitative and quantitative assessment. In some cases you may have to map this evidence across to the ecosystem service categories if this is not already evident. If you have not undertaken an SEA, the Appraisal Summary Table can be used as evidence to support SEA.

The Appraisal Summary Table is the basis for your options appraisal. It is a key step which has a number of important purposes:

a) It shows that we understand and can describe the predicted environmental impacts and outcomes of the actions we're assessing. This information is crucial to back up what the benefit-cost ratio tells us.

b) We consider a wide range of potential benefits and we're taking an Ecosystem Services approach to assessing benefits, as specified in the recently updated Government Guidance on Appraisal (Treasury Green Book).

c) It provides the evidence base to help us determine when the NWEBS values used in the stage 1 valuation are likely to be significant under or over estimates.

d) We can use the information in the AST to identify additional monetary values that we can add into the Stage 1 valuation, to make our assessment more robust.

The AST is structured as follows:

[16] Benefits are a generalist term. We also assess negative impacts which reduce net benefits.

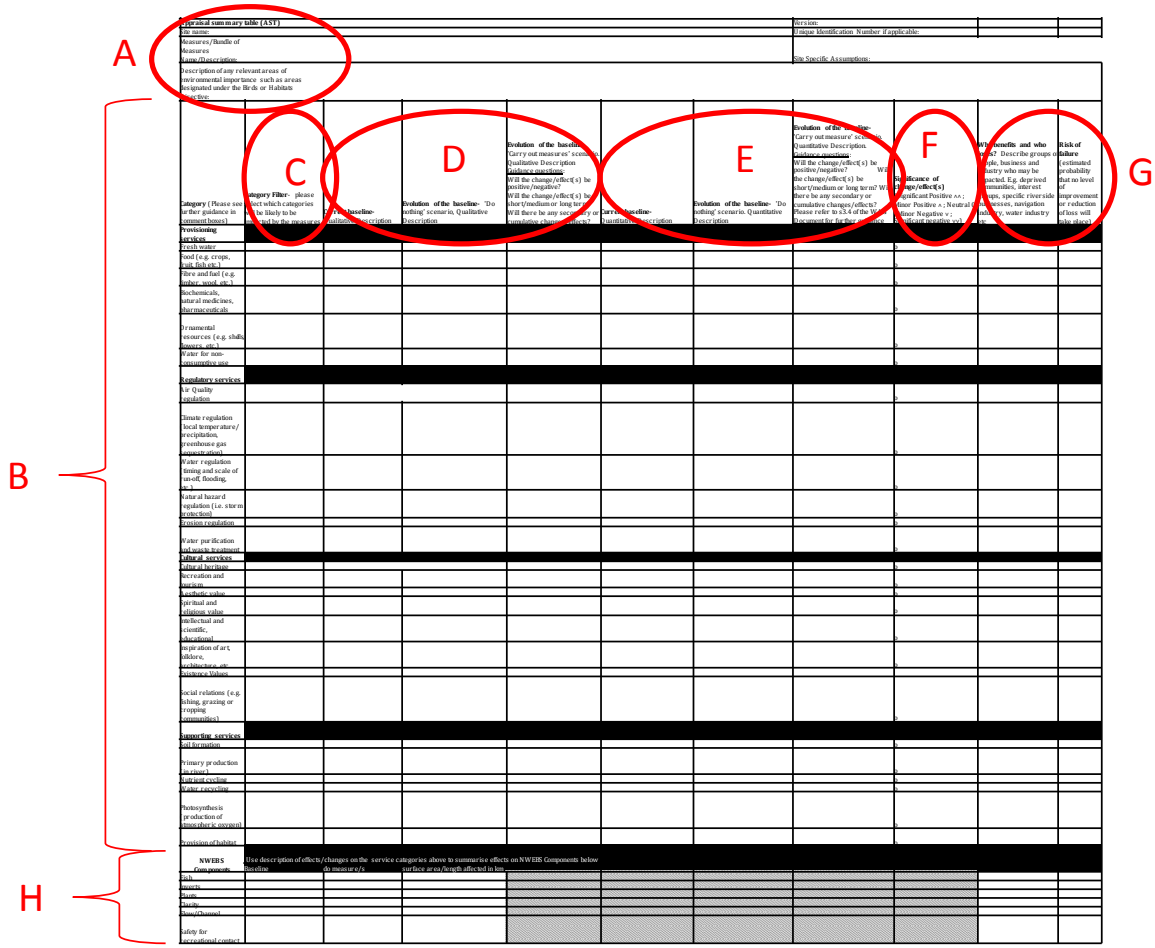

Figure 3.1: Structure of the Appraisal Summary Table (AST)

A	Background information.	Asks for site name, bundle of measures name/description, description of any relevant areas of environmental importance such as areas designated under the Birds or Habitats Directive, Unique ID number if relevant, AST version number and site specific assumptions.
B	Benefit categories.	Ecosystem services categories. This acts as a comprehensive list of impacts. See section 3.3.
C	Category filter.	Helps to prioritise effort, since not all ecosystem services will be impacted upon. See section 3.4.
D	Qualitative description.	Columns for the qualitative description of 'current baseline' 'evolution of baseline – do nothing' and 'evolution of the baseline – implement measures'. See section 3.5.
E	Quantitative description.	Columns for the quantitative description of 'current baseline' 'evolution of baseline – do nothing' and 'evolution of the baseline – implement measures'. See section 3.6.

F	Significance of change / effect(s).	This column allows the use of arrow icons to summarise the impact from significant positive to significant negative. See section 3.9.
G	Beneficiaries and effectiveness.	Column to describe who benefits and who loses. Column to describe risk of failure. See sections 3.10 and 3.11.
H	National Water Environment Benefits Survey (NWEBS) components.	Rows to describe NWEBS step change impacts. This is required for applying the NWEBS willingness to pay survey results in the stage 1 valuation. See sections 3.7 and 3.8.

The following sections act as a guide to filling in the AST.

3.3. The benefit categories

The principle categories within the AST are based on ecosystem services because they represent a comprehensive list of impacts from recreation to water regulation. This list acts as a reminder of what impacts to consider during the assessment and some will be more relevant than others. This is consistent with benefit assessment methodologies by other Defra family members as 'taking forward and encouraging [ecosystem services] use is a priority for Defra and one which presents important opportunities for improved decision making' (Incorporating Valuation Ecosystem Services into Policy and Project Appraisal, Defra, 2010).

The ecosystem service categories (relevant to changes in the water environment) are:

Ecosystem Services Categories	Description
Provisioning services	
Fresh water	The storage and retention of water for domestic, industrial and agricultural use by current and future generations. This water will help meet economic and societal needs of communities.
Food	Floodplains are naturally fertilised and therefore are amenable to seasonal grazing by livestock and arable production. Waterbodies also support commercially significant fisheries (salmon, trout, crayfish, etc). Other harvested crops may include: fruit, berries, fungi and nuts.
Fibre and fuel	Fibre may include skins, reeds, leather, cotton and straw. Fuel sources may include timber (willow, popular, etc), firewood, turf and biomass.
Biochemicals, natural medicines, pharmaceuticals	Includes natural medicines and pharmaceuticals. These may be from known valuable agents such as salicylic acid (willow bark), fungal extracts, and local herbal remedies.
Ornamental resources	The provision of pebbles, gravel, cobbles and sand. Also Includes

	insectivorous (carnivorous) plants, bulrushes and other plants of decorative interest.
Water for non-consumptive use	The provision of water that is used for energy generation (hydroelectric, cooling for thermoelectric such as fossil fuel and nuclear plants), Navigation and Transport which may help sustain economic and population growth.
Regulatory services	
Air Quality regulation	Waterbodies may assist in the settlement of aerial particulates (including dirt, dust and soot) and the metabolism of pollutants (such as SOX, NOX and Ozone). Climatic improvements (suppressed wind speeds) may occur on some sites depending on the nature of the site.
Climate regulation	Carbon accumulates where production of plant litter exceeds decomposition and generally under waterlogged, predominantly anaerobic conditions. The deposition of organic sediments within lakes, ponds and reservoirs is an important component of the carbon budget. Waterbodies may also regulate the microclimate. This includes temperature and precipitation. This is because temperature and humidity may be different within the habitat and without. The degree will depend on size of the habitat. Waterbodies also can develop Important moist microclimates.
Water regulation	This may be defined as the influence the ecosystem has on the timing and magnitude of water runoff, flooding, and aquifer recharge, particularly in terms of the water storage potential of the ecosystem or landscape.
Natural hazard regulation	Aspects of the waterbody may protect or mitigate against the adverse effects caused by storms, floods, landslides, etc.
Erosion regulation	The regulation or prevention of negative effects of erosion (such as impoverishing of soil and increased sedimentation of water bodies) by promoting sediment stabilisation and soil retention. Vegetative cover plays an important role in soil retention and the prevention of landslides.
Water purification and waste treatment	Freshwater systems can dilute, store and detoxify waste products and pollutants. Water purification and waste treatment includes the decomposition/capture of nutrients and contaminants and the prevention of eutrophication of water bodies.
Cultural Services	

Cultural heritage	Includes sites of historical significance such as Scheduled Ancient Monuments, Listed Buildings, Heritage Coasts, World Heritage Sites, Battlefields and territorial boundaries. Data can be found on Easimap (EA Staff) or English Heritage's Online Mapping (Public): http://list.english-heritage.org.uk/
Recreation and tourism	Includes recreational fisheries, landscape appeal, iconic species (rare birds, flowers or amphibians), swimming, boating, kayaking, etc.
Aesthetic value	Includes designated landscapes such as National Parks and Areas of Outstanding Natural Beauty (AONB) Also covers waterscapes, landscapes and other areas valued for their beauty or local distinctiveness.
Spiritual and religious value	Freshwaters may be sites of historical baptisms or religious festivals.
Intellectual and scientific, educational	Lake, floodplain and mire sediment sequences contain palaeo-environmental archives and human (pre)history, artefacts that may be lost if disturbed or desiccated. Freshwater ecosystems are also important outdoor laboratories.
Inspiration of art, folklore, architecture, etc	
Existence Values	This is the value that individuals place on knowing that a resource exists, even if they never use that resource.
Social relations (e.g. fishing, grazing or cropping communities)	Ecosystems influence the types of social relations that are established in particular cultures. Fishing societies, for example, differ in many respects in their social relations from urban or agricultural societies.
Supporting Services	
Soil formation	
Primary production (in river)	The assimilation or accumulation of energy and nutrients by organisms.
Nutrient cycling	Flow of nutrients (e.g., nitrogen, sulphur, phosphorus, carbon) through ecosystems.
Water recycling	Flow of water through ecosystems in its solid, liquid, or gaseous forms.
Photosynthesis (production of atmospheric oxygen)	Process by which carbon dioxide, water, and sunlight combine to form sugar and oxygen.
Provision of habitat	Includes designated habitats such as National Nature Reserves

	(NNR), Sites of Specific Scientific Interest (SSSI), and Local Nature Reserves (LNR). These designation can be viewed on mapping at Easimap (internal EA) or www.magic.gov.uk (Public) Also BAP Priority Habitats (see http://jncc.defra.gov.uk/page-5706) Includes habitat connectivity and green infrastructure.

Table 3.1: Ecosystem service categories and brief descriptions

Reminders of these ecosystem service descriptions can be found by hovering over the relevant box in the AST. Comment boxes have been included to explain the category in more detail.

There are further categories to consider for the purpose of benefits monetisation in the stage 1 valuation. The six National Water Environment Benefits Survey (NWEBS) components are outlined in the AST; fish, other animals such as invertebrates, plant communities, the clarity of water, the condition of the river channel and flow of water and the safety of the water for recreational contact. These are not additional ecosystem services, but relate to the recreational and aesthetic services.

These have corresponding drop down boxes for selecting 'NWEBS good', 'NWEBS moderate', 'NWEBS poor' or 'NWEBS bad'. More on NWEBS can be found in sections 3.7 and 4.3.

If you are undertaking a qualitative and quantitative assessment, you do not need to fill in the entire AST. The table is flexible depending upon local circumstances and need. Evidently, you do not need to fill in rows where there are no or negligible impact. Impact categories can be added if the existing categories do not cover all relevant impacts. If this is done, however, please be aware of double counting impacts during the benefits assessment.

3.4. Using the category filter

It is not mandatory to appraise every ecosystem service in the Appraisal Summary Table. In order to prioritise effort, we suggest that the assessor considers the 'category filter' column first.
The assessor should have in mind the baseline scenario and consider how the bundle of measures might affect the ecosystem service category.

You should choose from the following options from the drop down box:

Impact expected

No impact expected

It is important to remember that the aim of this section is to understand which ecosystem service categories could be focused upon during the assessment to encourage the best use of time.

If there is a small but insignificant impact, then select 'no impact expected'.

For example, an Area Environmental Planner, Brett, is keen to understand the impacts of a bundle of measures in the Par and St Austell waterbodies, in the South West, which aim to improve the river to good status under the Water Framework Directive. The bundle of measures will alleviate Zinc, the pressure which is causing the waterbodies to fail.

Category (Please see further guidance in comment boxes)	**Category Filter**- please select which categories will be likely to be impacted by the measures
Provisioning services	
Fresh water	Impact expected
Food (e.g. crops, fruit, fish etc.)	No impact expected
Fibre and fuel (e.g. timber, wool, etc.)	No impact expected
Biochemicals, natural medicines, pharmaceuticals	No impact expected
Ornamental resources (e.g. shells, flowers, etc.)	No impact expected
Water for non-consumptive use	Impact expected
Regulatory services	
Air Quality regulation	No impact expected
sequestration)	No impact expected
Water regulation (timing and scale of run-off, flooding, etc.)	No impact expected
Natural hazard regulation (i.e. storm protection)	No impact expected
Erosion regulation	No impact expected
Water purification and waste treatment	Impact expected
Cultural services	
Cultural heritage	No impact expected
Recreation and tourism	Impact expected
Aesthetic value	Impact expected
Spiritual and religious value	No impact expected
Intellectual and scientific, educational	No impact expected
Inspiration of art, folklore, architecture, etc	No impact expected
Existence Values	No impact expected
Social relations (e.g. fishing, grazing or cropping communities)	Impact expected
Supporting services	
Soil formation	No impact expected
Primary production (in river)	Impact expected
Nutrient cycling	No impact expected
Water recycling	No impact expected
Photosynthesis (production of atmospheric oxygen)	Impact expected
Provision of habitat	Impact expected

Table 3.2: Category Prioritisation

3.5. Qualitative description of the ecosystem service category impacts

A qualitative description of the current status, 'do nothing' scenario and 'carry out measures' scenario is required to understand the direction of change and qualitative magnitude. There are many benefits for doing this. For cost benefit analysis, it helps economists understand what impacts can be monetised. If the impacts have not been monetised but they have been described, the descriptions help to build a case for recommending taking forward or not taking forward marginally scoring projects. Furthermore, the description helps us understand the limitations of the cost benefit analysis.

A qualitative description of the baseline and predicted change could be described for those categories chosen using the process above.

An explanation of the current relevant impacts should be outlined in the 'current baseline' column.

In the 'evolution of the baseline – do nothing' column, the assessor should describe an estimate of the water quality, flow and equivalent ecosystem services that would occur in the absence of any environmental improvement work. You should consider a 40 year horizon, where possible.

Finally, the 'evolution of the baseline – 'carry out measures' scenario' should be described. This should outline the best estimate of the impact of measure implementation on the ecosystem service provision.

The descriptions may be sourced from local experts or subject specialists, or in consultation with stakeholders. For more in depth understanding of ecosystem services please see 'Realising the value of nature- Framework guidance for the Environment Agency on ecosystem services assessment' (Environment Agency, 2013).

The purpose of this section is to tell a story about the expected impacts of a bundle of measures. The type of information which may be relevant to discuss can include:

- Visible impacts to ecosystem services
- Magnitude of change (in both positive and negative directions)
- Relevant geographical characteristics[17]
- Description of users
- Degree of user accessibility
- Local importance and extent of use
- Availability of alternative sites or substitutes
- Any other relevant information for example species types (especially fish species), names of local recreation clubs etc.

For example, a bundle of measures in the Leam in Warwickshire aims to improve the river to good status under the Water Framework Directive. The catchment coordinator, Rachel, has worked with partners and understands that they must improve fish passage to do this. Her partners are also keen to improve the overall river environment. One of the bundles of measures to be assessed, Bundle Option A, is to develop a fish pass with a bypass channel and wetland around Stoneythorpe weir.

Rachel has filled in the qualitative impacts of the most significant categories in her AST. In this example the non significant ecosystem service categories have been hidden.

Category	**Current baseline-** Qualitative Description	**Evolution of the baseline-** 'Do nothing' scenario, Qualitative Description	**Evolution of the baseline-** 'Carry out measures' scenario. Qualitative Description Guidance questions: Will the change/effect(s) be positive/negative? Will the change/effect(s) be short/medium or long term? Will there be any secondary or cumulative changes/effects?
Provisioning services			
Fresh water	High levels of phosphate and pesticide within the watercourse has to be removed when abstracted for water supply use.	Phosphate levels are likely to rise causing more treatment to be required.	Sediment capture and wetland filtering should reduce the levels of pesticide and phosphate within the raw water, thereby reducing the level of treatment and improving quality of treated water.

[17] For example biological, chemical and hydromorph characteristics which are relevant to the impact category

Regulatory services			
Climate regulation (local temperature/ precipitation, greenhouse gas sequestration)	Some natural greenhouse gas sequestration occurs in catchment.	Levels are unlikely to significantly change.	Wetland creation will improve carbon sequestration and potentially lower local temperatures. Potential tree planting will also add benefits.
Water regulation (timing and scale of run-off, flooding, etc.)	Current flood peak flows travel directly down river.	There are no plans to develop this rural area, so any increase in flood risk would be due to climate change impacts. Modelling would be needed to explore the extent.	Wetland will provide flood storage and reduce speed of flood peak and volume downstream. This would likely affect farmland and a Sewage Treatment Works, but modelling is needed to explore the extent.
Erosion regulation	Flood peaks result in erosion	Modelling would be needed to explore any change.	Wetland will provide flood storage and reduce speed of flood waters, thereby reducing erosion risk downstream.
Water purification and waste treatment	High levels of phosphate and pesticide within the watercourse has to be removed when abstracted for water supply use.	See above (freshwater)	Sediment capture and wetland filtering should reduce the levels of pesticide and phosphate within the raw water, thereby reducing the level of treatment and improving quality of treated water.
Cultural services			
Recreation and tourism	Land currently not accessible (private)		
Aesthetic value	Open ground	Unknown change	Wetland habitat
Social relations (e.g. fishing, grazing or cropping communities)	Angling limited by barrier to fish passage.	Angling limitations unlikely to improve.	Improved fish stocks due to bypass channel around weir.
Supporting services			
Primary production (in river)	Algal blooms from high phosphate levels, low biodiversity due to poor water quality, low flows and barrier to fish passage.	Increased phosphate levels over time will cause the problem to be more widespread.	Reduced phosphate levels downstream of wetland, higher flows in Stowe to increase dissolved oxygen levels and removal of barrier to fish passage. All should improved habitat and thereby general health and production in watercourse.
Nutrient cycling	Limited.	Limited	Development of wetland will increase nutrient cycling.
Photosynthesis (production of atmospheric oxygen)	No wetland	No wetland	Improved biodiversity, including development of wetland plants to increase photosynthesis in area.
Provision of habitat	No wetland habitat, barrier to fish passage, low dissolved oxygen levels.	Will continue as current.	Wetland habitat, increased fish passage, improved dissolved oxygen levels for invertebrates.

Table 3.3: Qualitative description example 1: Bundle Option A on the Leam

Furthermore, Brett and his colleagues have completed the following qualitative description of the impacts of the Par and St Austell bundle in the South West, as described in 3.4. This aims to alleviate Zinc pressures, predominately in the Par. Again, the non significant columns have been hidden.

Category (Please see further guidance in comment boxes)	**Current baseline-** Qualitative Description	**Evolution of the baseline-** 'Do nothing' scenario, Qualitative Description	**Evolution of the baseline-** 'Carry out measures' scenario. Qualitative Description Guidance questions: Will the change/effect(s) be positive/negative? Will the change/effect(s) be short/medium or long term? Will there be any secondary or cumulative changes/effects?
Provisioning services			
Water for non-consumptive use	The Lower Par discharges into the Par Harbour and it is expected that there are elevated zinc levels in the Harbour as a result.	Zinc levels in the Lower Par will continue to be elevated but this will not have adverse effects on operational activities in Par Harbour	Zinc levels will be reduced but there would not be any discernible effects on Par Harbour.
Regulatory services			
Water purification and waste treatment	Zinc is currently removed from the water abstracted from the Lower Par at the Par Water Treatment Works	Zinc will continue to be removed from the water abstracted from the Lower Par at Water Treatment Works.	There would be a reduction in the level of treatment needed for drinking water
Cultural services			
Recreation and tourism	The Lower Par is popular with anglers and walkers.	Recreational activities on the river (angling, etc) would continue to be detrimentally affected by the effects caused by elevated zinc levels	There would be positive effects on recreational activities carried out on the Par.
Aesthetic value	The Lower Par is popular with anglers and walkers.	The river would continue to have elevated zinc levels which would have a detrimental effect on biodiversity in the river. This would have localised effects on waterscapes.	Biodiversity would be improved in the River and there would be positive effects on aesthetic value.
Supporting services			
Primary production (in river)	Unknown	There would be no increase in primary production in the river.	Primary production would increase as pollution is reduced resulting in more ecological diversity
Photosynthesis (production of atmospheric oxygen)	Unknown	No increase in photosynthesis	Photosynthesis in river increases as a result of increased biodiversity
Provision of habitat	Unknown	No improvement in habitats	Improved habitat in river

Table 3.4: Qualitative description example 2: Bundle 1in the Par and St Austell.

The total impact of the scheme should be the difference between the 'do nothing' and 'carry out measures' scenarios, unless otherwise stated in Operational Instructions[18].

[18] The Operational Instruction for 'second cycle' River Basin Management Planning states that 'no deterioration' measures are assumed to be a requirement and do not undergo cost benefit analysis. Therefore for cost benefit analysis, it is assumed that the 'no deterioration measures' have been undertaken. Therefore, in this case, the impacts monetised in the valuation stages will be the costs and benefits from 'current' status to 'carry out measures' scenarios.

3.6. Quantitative description of the ecosystem service category impacts

Where appropriate, a description of the baseline and predicted change can be described quantitatively. The content will be similar to the qualitative assessment except that it could be provided with number estimates. Where this is not possible an indication of 'High', 'Medium' or 'Low' status could be identified. The type of information which may be relevant to discuss can include:

- Number of waterbodies at what states
- Number of users[19]
- Frequency of use[20]
- Number, respective quality and distance of alternative sites or substitutes
- Quantitative magnitude of change (in both positive and negative directions)
- Time horizon of impact
- Any other relevant information such as local membership rates for recreation clubs such as angling clubs or canoe clubs if available.

A quantitative description will assist the monetary valuation stage in Part 2 as well as telling a more comprehensive story about the expected impacts of a bundle of measures.

The columns are ordered in a similar way to the qualitative description; assessors are asked to provide a quantitative description of the current baseline, 'do nothing' evolution of the baseline and 'carry out measures scenario' evolution of the baseline (i.e. the 'do something'; impact).

For example, Brett was considering the impacts of a bundle of measures which reduce Zinc levels in the Par and St Austell, in the South West. Brett and colleagues have supplied some quantitative evidence related to the Recreation and Tourism ecosystem service, below.

Category (Please see further guidance in comment boxes)	**Current baseline-** Quantitative Description	**Evolution of the baseline-** 'Do nothing' scenario. Quantitative Description	**Evolution of the baseline-** 'Carry out measure' scenario. Quantitative Description. Guidance questions: Will the change/effect(s) be positive/negative? Will the change/effect(s) be short/medium or long term? Will there be any secondary or cumulative changes/effects? Please refer to s3.4 of the WAG Document for further guidance
Cultural services			
Recreation and tourism	There are 800 rod licences for the Lower Par.	It is not expected that there would be an increase in the amount of licences for the Lower Par	It is expected that there would be a 10-20% increase in the amount of licences for the Lower Par as a result of the improvements in water quality.

Table 3.5: Quantitative description example: Bundle Zinc in the Par and St Austell.

3.7. Recording NWEBS step changes

[19] Split by distance from water body if applicable. For example, users within 0-0.5km, 0.5-3km, 3-12km and 12-60km.

[20] Take into account seasonal differences.

If the assessor wishes to undertake a stage 1 valuation (which monetises the value of improvements to surface waters) they should outline any step changes in the National Water Environment Benefits Survey (NWEBS) components and an estimate of the number of km (river water bodies) or km² which are most likely to experience that change.

For example, Brett has inputted the following information into the AST for the bundle of measures which would alleviate the zinc pressure in the Par and St Austell in the South West. This shows an estimate of 12km would be improved from NWEBS moderate to NWEBS good for fish, inverts and plants.

NWEBS Components	Use description of effects/changes on the service categories above to summarise effects on NWEBS Components below			
	Baseline	do measure/s	surface area/length affected in km	
Fish	NWEBS Moderate	NWEBS Good	12.0	
Inverts	NWEBS Moderate	NWEBS Good	12.0	
Plants	NWEBS Moderate	NWEBS Good	12.0	
Clarity	NWEBS Moderate	No change	0.0	
Flow/Channel	NWEBS Moderate	No change	0.0	
Safety for recreational contact	NWEBS Moderate	No change	0.0	

Table 3.6: Example of NWEBS step changes recorded on the Leam

Where there is more than one step change for each component, please note this detail within the shaded box.

3.8. Description of the NWEBS step changes

The NWEBS study estimates willingness to pay for improvements in the water environment. In order to illicit this value, a survey of over 1500 people in the UK was undertaken.

The survey described water quality from a socio-economic viewpoint. The descriptions of the NWEBS components and step changes, based on the original survey are simplistic in environmental science terms[21]. For example, NWEBS used two river typologies within the willingness to pay survey. Under the WFD, there are around 18. Furthermore, flow and channel in NWEBS uses descriptions of meanders, speed of running water and obstructions. A scientific description may include the dynamics and quantity of flow; connection to groundwater; wide/depth profile; longitudinal and lateral connectivity; riparian zone condition; and structure of the river bed and substrate.
A mapping exercise has been undertaken to link pressures to NWEBS, (please see section 4.4) in order to bridge the gap between environmental science and socio-economics. However, we advise that technical specialists map the results of their stage 2 and 3 investigations to the study descriptions below as best they can in order to decide which NWEBS status is applicable for their study. For Artificial/ Heavily Modified Water Bodies, the closest natural river typology should be

[21] The values from the survey were originally calculated for Low to Medium and Medium to High quality, corresponding to Bad to Poor/Moderate and Poor/Moderate to Good/High. The EA has applied an assumption that the value of an improvement from Bad to Poor is worth two thirds of the Low to Medium value, that the value of an improvement from Poor to Moderate is worth one third of the Low to Medium value plus one third of the Medium to High value, and that the value of an improvement from Moderate to Good is worth two thirds of the Medium to High value. The descriptions below reflect the descriptions from the survey, adjusted for the above assumptions.

referred to and the step changes described in the cost benefit analysis should follow the descriptions below, rather than the WFD moderate and good 'potential' classifications.

The descriptions of the NWEBS status, based upon the original willingness to pay survey, are as follows:

Applied NWEBS Status	Survey description		Clarity	Fish	Inverts & other animals	Plants	Flow and Channel	Safety for recreational contact	(Other)	Main types of uses and benefits associated with this status
Good	Good	Rural rivers	Generally clear but may be murky after periods of rain/high flow	A good and varied fish population including salmon/trout and coarse fish	Insects such as caddis and mayflies will be common during spring/summer	Wide range of plants and mosses on bank and in the water.	Mixture of deeper pools and shallow lengths of faster flowing water. Meanders and backwaters in lowland.	Water safe for contact	Edges and banks well covered by plants. No bare areas of banks trodden down by animals. Semi-natural channel with only infrequent reinforcements.	Drinking water abstractions with some treatment required. High amenity value. Good for angling. Suitable for contact activities.
		Urban rivers	Generally clear but may be murky after periods of rain/high flow	A good and varied fish population of coarse fish	Insects such as caddis and mayflies will be common during spring/summer	Flowering plants, shrubs and trees on banks and plants in water.	Periodic and large increases of water due to storms but no resulting deaths of fish etc	Water safe for all contact except bathing	No sewage derived litter in banks. Physical modifications include environmental enhancements.	Drinking water abstractions with some treatment required. High amenity value. Good for angling. Suitable for contact activities except bathing.
		Lakes	Clear water. Bed visible in shallows.	Varied fish population, mainly coarse but possibly trout in uplands	Insects such as caddis and mayflies will be common during spring/summer. No non-native species	Beds of underwater plants. Reeds etc round edges	No description	Water safe for contact	Clean shorelines, with exposed areas clean of fine muds and silt.	Drinking water abstractions with some treatment required. High amenity value. Good for angling. Suitable for contact activities.
		Estuaries and coastal	Some waters naturally murky, but other waters clear. Only occasional foams from natural algal blooms	Abundant and diverse fish population; good spawning and nursery areas. No barriers to fish migration.	Abundant shellfish and worm in muds and sediments. May be diverse bird population	Naturally diverse plantlife. Few occurrences of excessive algal growth. Brown seaweeds common in rocky waters	No description	Water safe for contact, industrial or agricultural use, mariculture, shellfisheries .	Natural physical shape and characteristics.; Mitigation of physical modifications on ecology present	Contact sports; recreational angling including salmon and sea trout; industrial and agricultural uses; mariculture and shellfisheries.

Applied NWEBS Status	Survey description		Clarity	Fish	Inverts & other animals	Plants	Flow and Channel	Safety for recreational contact	(Other)	Main types of uses and benefits associated with this status
Moderate	Adjusted for less than good	Rural rivers	Less clear than good, murkier after rainfall/high flow	Possible salmon/ trout and abundant coarse fish	Dependent mammals and birds such as voles and kingfishers occasionally spotted	Some luxuriant plant growth.	Mainly unmodified banks	Water safe for some contact (e.g. boating)	Banks intermittently covered by flowering plants shrubs and trees with rare occurrences of reeds and rushes	Drinking water abstractions with advanced treatment required. Moderate amenity and recreational values Suitable for some contact activities like angling, boating.
		Urban rivers	Less clear than good, murkier after rainfall/high flow	Coarse fish	No description	Some plant growth in and alongside river. Some invasive species	No description	Water safe for some contact activities where there is access	Possible sewage-derived litter after storms. Few measures to enhance physical habitat	Some amenity and recreational value. Suitable for some low-grade abstraction for industry.
		Lakes	Less clear than good. Possible spring/summer algal growth	Some coarse fish present, but no trout	Some mayflies/ caddis flies	Reduced areas of reed beds and limited growth of underwater plants. Non-native species may be present	No description	Water safe for some contact (e.g. boating)	Natural shoreline may be partially lost	Moderate amenity and recreational value. Low-grade abstraction possible (e.g. irrigation).
		Estuaries and coastal	Occasional periods of murkiness and/or visible surface slicks. Some algal blooms.	Some barriers to fish migration. Reduced diversity of fish and fish nurseries.	Abundance of snails and mud shrimps but reduced diversity of other animal and bird.	Seagrasses uncommon. Fewer brown seaweeds and increased green seaweeds. Increased frequency of algal blooms and resulting foam, slime and odour.	No description	Water safe for some contact (e.g. boating)		Moderate amenity and recreational value. General angling but not salmon/sea trout); boating, walking, bird watching. Some low grade abstractions. Occasional closure of shellfisheries due to algal toxins

Applied NWEBS Status	Survey description		Clarity	Fish	Inverts & other animals	Plants	Flow and Channel	Safety for recreational contact	(Other)	Main types of uses and benefits associated with this status
Poor	Adjusted for less than good	Rural rivers	Low clarity, but some good clarity if flow levels allow	No salmon/ trout, limited coarse. Periodic fish kills	Dependent mammals and birds such as voles and kingfishers not supported	Either poor plant growth or over-luxuriant growth which blocks the channel. invasive species	Some modifications such fords or reinforcements.	Water safe for limited contact	Some banks trodden down by animals. Low amounts of bankside vegetation.	Drinking water abstractions with advanced treatment required. Low amenity and recreational values Suitable for occasional contact activities
		Urban rivers	Low clarity, but some good clarity if flow levels allow	Some coarse fish, particularly pollution tolerant, but fish kills after storm flows	No description	Either poor plant growth or over-luxuriant growth which blocks the channel. invasive species	No description	Water safe for limited contact where there is access	Sewage derived litter after storms. No measures to enhance habitat	Limited amenity and recreational value. Suitable for some low-grade abstraction for industry.
		Lakes	Low clarity particularly in spring/ summer due to algal growth	Some coarse fish. Occasional fish kills	Rarely seen caddis/ mayflies	Reduced areas of reedbeds and very limited growth of underwater plants. Non-native species present	No description	Water safe for limited contact	Natural shoreline partially lost	Poor amenity and recreational value. Low-grade abstraction may be possible (e.g. irrigation). Occasional amenity loss due to algal growth
		Estuaries and coastal	Increased periods of murkiness and/or visible surface slicks. Increased occurrence of algal blooms.	Probable barriers to fish migration. Decrease in diversity of fish and fish nurseries.	High abundance of snails and mud shrimps; increased reduction in diversity of bird/ animal populations. Possible "gender-bending" in dogwhelk populations	Seagrasses rare. Much fewer brown seaweeds and increased green seaweeds. Greatly increased frequency of algal blooms and resulting foam, slime and odour.	No description	Water generally safe for some contact (e.g. some boating)	No description	Moderate to low amenity and recreational value. General angling but not salmon/sea trout); boating, walking, bird watching. Few low grade abstractions. Some closure of shellfisheries due to algal toxins

Applied NWEBS Status	Survey description		Clarity	Fish	Inverts & other animals	Plants	Flow and Channel	Safety for recreational contact	(Other)	Main types of uses and benefits associated with this status
Bad	Far from Good	Rural rivers	Cloudy – green or brown coloured. Slimy or sludgy bed	Mostly no fish present	Only pollution-tolerant species (e.g. sludge worms). No caddis/mayflies	Localised occurrence of in-stream plants and little tree/shrub cover on banks	Obviously modified river channel	Grossly polluted waters with no safe contact		Unsuitable for all uses, with no amenity or recreational value. Offensive and odorous.
		Urban Rivers	Cloudy – green or brown coloured. Slimy or sludgy bed. Odour	Possible pollution-tolerate coarse fish but mainly no fish at all	Only pollution-tolerant species (e.g. sludge worms).	Localised occurrence of in-stream plants and little tree/shrub cover on banks	Hard engineered channel. Few natural features	Grossly polluted waters with no safe contact	Visible sewage-derived pollution.	Unsuitable for all uses, with no amenity or recreational value. Offensive and odorous.
		Lakes	Very murky for most of the year. Blanket weed may cover the surface	Usually no fish present.	Only pollution-tolerant species (e.g. sludge worms). Periodic mass kills of small water animals and any fish present	No submerged water plants and sparse shore-lining plants e.g. reeds	No description	Grossly polluted waters with no safe contact. May be unsafe for animals to drink	No description	Unsuitable for all uses, with no amenity or recreational value. Offensive and odorous.
		Estuaries and coastal	Greatly reduced visibility; discoloured water. Sewage slicks; spots on sediment surface; common algal blooms; visible faecal matter	Very low diversity of fish. No sustainable fish breeding. Periodic and extensive fish kills. No fish migration through estuary.	Low diversity of small animals in sediment. Periodic and extensive shellfish kills. Pollution-tolerate species (e.g. red sludge worms) may be present in very large numbers.	Absence of rooted or attached plants.	No description	Serious odour problems near inputs and pipes into waters. Unsuitable for all uses.	No description	Unsuitable for all uses. Serious public nuisance from odour and visual problems. No recreation or amenity value. Frequent closure of shellfisheries due to algal toxins.

Table 3.7: NWEBS step change descriptions

3.9. Significance of change

In the AST, this column can be used in order to help compare the impacts of the bundle of measures by glance. An assessor can use this column without the need for a qualitative or quantitative assessment; however a better result may be achieved with them. Please note that this column should be used to assess the significance of change from the current baseline.

Please use the information derived in the qualitative and quantitative assessment in the AST to fill out this column. If you have any data which can quantify the change then this could be used to help inform this section.

The significance levels are as follows:

Improvement	significant	^^
	noticeable	^
	no noticeable change	o
	noticeable	v
Disimprovement	significant	vv

Again, please remember that the significance levels are used to compare the options of the project against one another and not to make a statement of the project's significance on UK Plc.

Alongside the AST, an 'Options Summary' table has been provided which can be used to summarise these results for bundle of measures comparison. For example, the summary for option bundles A, B and C on the Leam can be seen below:

	Significance of change		
	Do something option		
Category	A	B	C
Provisioning services			
Fresh water	^	^	0
Food (e.g. crops, fruit, fish etc.)	0	0	0
Fibre and fuel (e.g. timber, wool, etc.)	0	0	0
Genetic resources (used for crop/stock breeding and biotechnology)	0	0	0
Biochemicals, natural medicines, pharmaceuticals	0	0	0
Ornamental resources (e.g. shells, flowers, etc.)	0	0	0
Energy Harvesting (non MA)	0	0	0
Regulatory services			
Air Quality regulation	0	0	0
Climate regulation (local temperature/ precipitation, greenhouse gas sequestration)	^	^	0
Water regulation (timing and scale of run-off, flooding, etc.)	^	^^	^
Natural hazard regulation (i.e. storm protection)	0	0	0
Pest regulation	0	0	0
Disease regulation	0	0	0
Erosion regulation	^	^	0
Water purification and waste treatment	^	^	0
Pollination	0	0	0
Noise and Light regulation	0	0	0
Cultural services			
Cultural heritage	0	0	0
Recreation and tourism	0	^^	0
Aesthetic value	^	^^	0
Spiritual and religious value	0	0	0
Intellectual and scientific, educational	^	^	0
Inspiration of art, folklore, architecture, etc	0	0	0
Social relations (e.g. fishing, grazing or cropping communities)	^^	^^	^^
Supporting services			
Soil formation	0	0	0
Primary production (in river)	^	^	0
Nutrient cycling	^	^	0
Water recycling	0	0	0
Photosynthesis (production of atmospheric oxygen)	^	^	0
Provision of habitat	^^	^^	^^

Table 3.8: Example of the significance of change for Options A, B and C on the Leam

3.10. Who benefits and who loses?

We are interested in the groups of people, business, and industry who may be impacted. These include deprived communities, interest groups, specific riverside businesses, navigation industry, water industry etc. This helps us to understand who our partners are.

For example, in the Par and St Austell case study (as described in 3.4) in the South West, the following has been noted:

Category (Please see further guidance in comment boxes)	**Who benefits and who loses?** Describe groups of people, business, and industry who may be impacted. E.g., deprived communities, interest groups, specific riverside businesses, navigation industry, water industry etc
Regulatory services	
Water purification and waste treatment	Water Industry will benefit from reduced treatment costs.

Table 3.9: Example of 'who benefits' on the Par and St Austell

3.11. Risk of failure

There may be a chance that the impacts described do not take place and objectives are not met. For example, wetland planting may fail due to bad weather causing little or no positive impacts on freshwater, climate, water and erosion regulation and so on. Please indicate an estimate of the risk of failure related to each ecosystem service category.

The following choices are given:

Low (0-20%)
Med (21%-40%)
High (41%-65%)
Very High (66%-100%)

3.12. Presenting the results

When outlining the results of your qualitative and quantitative assessment in an appraisal report, please remember to:

1. Outline the project objective/s
2. Frame the appraisal (as described in part 2.1)
3. Outline the bundle of measures being assessed
4. Present the appraisal summary table
5. List the most significant ecosystem service impacts as a result of 'doing something' and provide narrative where necessary (as described in part 3.9).
6. If an options appraisal is being performed, list the options in order of estimated benefits using the AST, if possible (greatest first).
7. If an options appraisal is being performed, also list the options in order of cost (cheapest first).
8. If there is a clear preferred option, explain. Otherwise monetary valuation may be necessary.

An example of points 6 and 7, above, can be seen here. Here the results from the qualitative and quantitative assessment for the options appraisal on the Leam have been summarised in order of benefits and costs (highest, first). This is only applicable for an options appraisal.

Benefits	Costs
Option B; Fish passage with bypass channel and wetland at confluence of Rivers Itchen and Stowe	**Option C;** Fish passage with bypass channel only (either location)
Option A; Fish passage with bypass channel and wetland around Stoneythorpe weir only	**Option B;** Fish passage with bypass channel and wetland at confluence of Rivers Itchen and Stowe
Option C; Fish passage with bypass channel only (either location)	**Option A;** Fish passage with bypass channel and wetland around Stoneythorpe weir only

Table 3.10: Example of ranking competing options by benefit and cost on the Leam.

This could be accompanied by a statement such as 'we cannot see an obvious solution (preferred option) from this qualitative evidence. Nor do we know if any of the bundles of measures are disproportionately costly. We therefore require stage 1 valuation to help answer these questions.'

4. Assessing the benefits – stage 1 monetary valuation

4.1. Limitations of monetary valuation

The approach below outlines a method to value benefits. However we cannot always capture the benefits in monetary terms due to a limitation of evidence. Meanwhile, it is not always appropriate to capture benefits in monetary terms, e.g. spiritual or inspirational values.

There are limitations to monetary valuation. However, by converting impacts (albeit imperfectly) into a common unit, the £, it does help us to summarise complex problems and help inform decision making.[22]

In partial mathematics terminology, net benefits are (x + y), where x is the net monetised benefits and y is the net non-monetised benefits. So when presenting these results we must say, for example, 'the benefits of this project are £1,000,000 plus the net benefits we haven't been able to monetise'.

Economic appraisal is a very useful tool which helps us to make decisions, but where there are issues of equity or morality, other reasoning may be needed. The methodology outlined in this document can help us understand what investments the Environment Agency are likely to support, but locally favoured projects which do not pass economic appraisal tests could be taken forward if, for example, a local contribution is forthcoming and there are other non economic drivers.

4.2. Choosing between a stage 1, stage 2 or primary valuation

There is an understanding among environmental economists that there is a trade off between the depth and detail of monetary valuation and the time and resources taken to undertake it. In a perfect world, where there are no costs of sourcing information, we might be keen to survey the willingness to pay of local residents and visitors for every improvement or no deterioration action.

However, since we are unable to commit resources to surveying the entire population of the country, we rely on 'benefits transfer' instead. This is where we use information about societal values from existing academic studies and surveys and transfer them to our study, with or without adjustment to take into account local factors (including population levels, quality of change, socioeconomic factors and so on).

We can further simplify the practice of monetising the benefits of measures which improve the water environment, by creating a screening stage[23] known as a stage 1 valuation. In this,

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[22] Pearce (1998), Sen (2000) and Heinzerling and Ackerman (2002) are useful journals which outline further issues of cost benefit analysis. Some suggest lower discount rates should be used for long term and catastrophic environmental damages, as Stern had done in the economics of climate change (2006) (0.1%) and as has been suggested in the supplementary green book guidance on intergenerational wealth transfers on social discounting (2003) (3% for years 0-30 and 2.57% for years 31-75 in a sensitivity test). The journals also suggest that economic appraisal is not effective in flagging up the winners and losers of a project

[23] The largest proportion of monetised benefits of measures which improve the water environment, tend to come from a small number of categories; recreational, aesthetic, non-use, carbon and water

recreational, aesthetic and non use values are monetised by applying the values from the National Water Environment Benefits Survey. This is likely to provide a lower bound estimate of monetised benefits[24]. If the benefit cost ratio is greater than one, despite only monetising some of the full impacts, then we do not need to spend more resources in monetising any further positive ecosystem service impacts if that will only reinforce the decision to go ahead with the project.

We recommend that all assessments for River Basin Management Planning undertake a stage 1 valuation to recognise clearly cost beneficial bundles of measures.

Benefit cost ratios can be represented as a ratio such as 1:1.5. In this case, £1 of expenditure (cost) will return £1.50 worth of benefits. Often this is written in short hand such as 1.5. Value for money is represented by a benefit cost ratio greater than 1.

Bundles of measures with benefit cost ratios greater than 1 are worthwhile in economic terms. However, since the cost and benefits inputs in this stage is at a high level, we suggest that bundles of measures with benefit cost ratios between 0.5 and 1.5 may need more investigation[25]. In this case, it may be worthwhile to undertake a stage 2 valuation, whereby there would be a greater attempt to monetise a larger number of ecosystem services. This stage would take require a greater amount of time and resource to complete.

Furthermore, if the results of the stage 1 valuation are met with contention, then a stage 2 valuation may be appropriate. It may only be worthwhile to do this if sensitivity testing showed that feasible changes in the costs and /or benefits would make a difference to the final recommendation. Sensitivity testing can help understand whether a feasible change might have an impact on the final recommendation and thus show robust the decision choice is. For example, if there is some argument that the benefits we have estimated are too high, then the 'low' willingness to pay estimates can be selected in the stage 1 valuation sheet to see what impact that has on results. More on this can be found in chapter 7.

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company treatment cost savings. Thus if we monetise a number of these categories we can get a ball park lower estimate of monetised benefits. *Almost all* of the projects/programmes/policies which we tend to assess will have implications on recreational, aesthetic and non use value. *Some* have further impacts on carbon (as benefits through sequestration and/or costs through energy use) and freshwater.

[24] There is also space in the stage 1 valuation to include water company treatment cost savings, where estimated. Many economists argue that carbon values bias the benefits upwards, due to their large unit values. And since the evidence on the carbon sequestration benefits is sometimes light, we do not include this in the stage 1 screening process.

[25] Uncertainty in the cost and benefits estimation means that we should still consider projects with cost benefit ratios which range closely above or below unity (CBR=1). The range chosen will have an impact on the time and cost of appraisal and the amount of projects pushed forward for implementation. For example if the range was 0.9-1.1, a minority of projects/programmes/policies would need to undertake a stage 2 valuation but there is greater risk of not correctly identifying projects that are worthwhile or not. While if the range was 0.2-1.8 then many more projects would be required to go through a stage 2 valuation for a greater cost, causing resources to be spent on projects with a higher likelihood of being un-cost beneficial. In this round of river basin planning we have chosen the range 0.5-1.5 for further investigation. Projects which have cost benefit ratios less than 0.5 from the stage 1 valuation may be considered in later planning rounds.

4.3. Introduction to the stage 1 valuation

Stage 1 has the advantages of being relatively quick and simple to apply using a standard spreadsheet with inbuilt pick lists and calculations.

Unfortunately, at the moment, Stage 1 only covers surface waters and not groundwaters. This is because the NWEBS did not include ground waters. For ground waters please see the supplementary guide; 'Tool for estimating the costs and benefits of groundwater measures' (Eftec, 2013). This work gives guidance on using the AST for groundwater and recommends valuation evidence which can be applied for benefits valuation.

A stage 1 valuation will use values transferred from the 2012 National Water Environment Benefits Survey (NWEBS). This work, as described in 'NWEBS briefing note' (Metcalfe, 2013) and 'An assessment of the non-market benefits of the Water Framework Directive for households in England and Wales' (Metcalfe et al, 2012) is based on a national study funded by the Defra led Collaborative Research Programme in 2007 which elicited willingness to pay for improvements in the water environment (with respect to WFD).

Respondents of the 2007 questionnaire used in NWEBS considered six equally weighted[26] ecosystem components when making their assessment. These ecosystem components were;

1. Fish
2. Other animals such as invertebrates
3. Plant communities
4. The clarity of water
5. The condition of the river channel and flow of water
6. The safety of the water for recreational contact

The NWEBS values (2012) consider a number of ecosystem services, in particular, recreational services, aesthetic services and non-use values.

[26] There has been some discussion as to whether the components are equally weighted in the eyes of society. However, anecdotal evidence appears to show that for some areas, where angling is important fish are more highly weighted, in other areas where water based activities are popular safety for contact is valued more highly and so on. The weights are locally specific and without a study into local weighted preferences, we are unable to weight the components in an alternative way. We can, however, capture differences in local preferences through an alternative route. Higher or lower willingness to pay values can be selected within the stage 1 valuation tool to represent higher or lower than average value in any component.

Potential water quality benefits	Current user benefits	Direct use	**In-stream** • **Recreation:** fishing boating, rafting, etc… • Commercial: fishing, navigation
			Withdraw • Municipal: drinking water, waste disposal • Agriculture: irrigation • Industrial/Commercial: cooling, processes, steam etc.
		Indirect use	**Near-stream** • **Recreation:** hiking, picnicking, bird watching, boating, photography, etc… • **Relaxation:** viewing • **Aesthetic:** enhancement of adjoining amenities
	Intrinsic benefits	Potential use	**Option** • **Near-term potential use** • **Long-term potential use**
		No use	**Existence** • **Stewardship:** maintaining a good environment for everyone to enjoy (including future family use bequest) • **Vicarious consumption:** enjoyment from the knowledge that others are using the resource

Table 4.1: A typology of potential Water Framework Directive benefits with those considered in the NWEBS study

The table above was featured in the Environment Agency WTP Benefits Study, Environment Agency (2012). (Original source: Desvouges, Smith and McGivney (1983)). The services in red indicate the services monetised by NWEBS. The table above is not a full list of the ecosystem service categories.

When applying the NWEBS values in a stage 1 valuation the assessor should be mindful that there are some ecosystem services which are not valued in NWEBS. The diagram (not to scale) below illustrates this. NWEBS values a proportion of benefits (green circle) including recreation, amenity and non use values. Outside of this we can monetise other water related benefits (blue outer area). But there are other benefits we cannot currently value (red outer area).

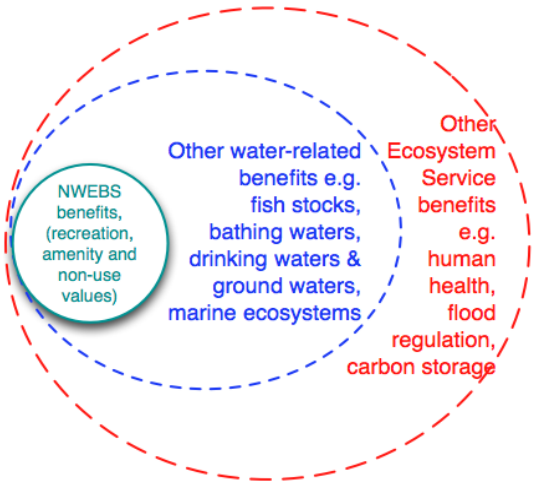

Figure 4.1: Ecosystem service benefits monetised in the NWEBS study

Please note that if your AST illustrates that there are other ecosystem services which are significant and not covered by NWEBS then this can be valued separately, whilst avoiding double counting. One example might be the avoided cost of water treatment to water companies (fresh water services). If these other ecosystem services cannot be valued then the results using NWEBS could be considered as an underestimate of the benefits, if the non monetised benefits are positive.

4.4. Selecting the NWEBS components

In order to value impacts using NWEBS you must understand how many components that your actions will impact upon (fish, other animals such as invertebrates, plant communities, the clarity of water, the condition of the river channel and flow of water, the safety of the water for recreational contact). In order to do this you can consider primary *and* secondary effects. For example, an abstraction change may predominantly affect flow, but this may also have a secondary effect on fish. You could include both in your assessment of effects. A description of the NWEBS step changes can be found in section 3.8.

If you are working from the pressure angle, the following look up table may assist you in your assessment. This was developed for the 'Benefits by Pressure' study (Environment Agency, Capita Symonds and Tamar Consulting, 2013). The numbers within the look up table were drawn from from a literature search and through consultation with experts in academia and the Environment Agency.

Table 4.2 helps connect various pressures to the 6 NWEBS components. 1 means that the pressure does affect the NWEBS component, 0 means that the pressure does not affect the NWEBS component. 0.5 (or any number between 0-1) means that the NWEBS component is affected to a lesser extent.

The numbers between 0-1 provided can give a scale to help estimate lengths of benefits. For example, it is likely that acidification affects fish, inverts and plants (to a lower extent). A bundle of measures which includes a measure which tackles acidification could improve fish for 10km, inverts for 10km and plants for 5km. This look up table should only act as a guide. Local knowledge should inform the final assessment of km affected for each component.

	FISH	INVERTS	PLANTS	CLARITY	FLOW /CHANNEL	SAFETY
Pressure List						
2,4-dichlorophenoxyacetic acid	1	1	1	0	0	0
24d	1	1	1	0	0	0
Acid Neutralising Capacity	0	1	1	0	0	0
Acidification	1	1	0.5	0	0	0
Aldrin, Dieldrin, Endrin & Isodrin	1	1	1	0	0	0
Alien species-Chinese mitten crab	0	0	0	0	0	0
Alien species-fish stocking	1	0	0	0	0	0
Alien species-Floating pennywort	1	1	1	0	1	0
Alien species-North American Signal crayfish	0	1	0	0	0	0
Alien species-other crayfish	0	1	0	0	0	0
Alien species-other invertebrates	0	1	0	0	0	0
Alien species-other plants	0	0	1	0	0	0
Alien species-Topmouth gudgeon	1	0	0	0	0	0
Ammonia	1	1	0	0.5	0	0.5

	FISH	INVERTS	PLANTS	CLARITY	FLOW /CHANNEL	SAFETY
Ammonia (Annex 8)	1	1	0	0.5	0	0.5
Ammonia (Phys-Chem)	1	1	0	0.5	0	0.5
Benzo (a) and (k) fluoranthene	1	1	0	0	0	0.5
Benzo (ghi) perelyene and indeno (123-cd) pyrene	1	1	0	0	0	0.5
BOD	1	1	0	0.5	0	0.5
Cadmium And Its Compounds	1	1	1	0	0	0.5
copper	1	1	1	0	0	0
Cyanide	1	1	0	0	0	0.5
cypermethrin	1	1	0.5	0	0	0
diazinon	1	1	0.5	0	0	0.5
Dissolved Oxygen	1	1	0	0.5	0	0.5
Diuron	0.5	0.5	1	0	0	0
Fish Stocking	1	0	0	0	0	0
Fluoranthene	1	1	0	0	0	0.5
General Chemical Test	0.167	0.167	0.167	0.167	0.167	0.167
Hexachlorocyclohexane	1	1	0.5	0	0	0
Hydrology	0.5	0.5	0	0	1	0
iron	1	1	1	0.5	0	0
Isoproturon	0.5	0.5	1	0	0	0
Lead And Its Compounds	1	1	1	0	0	0
linuron	0.5	0.5	1	0	0	0
mecoprop	0.5	0.5	1	0	0	0
Mercury And Its Compounds	1	1	1	0	0	0
Mitigation Measures Assessment	0.5	0.5	0.5	0	1	0
Morphology	0.5	0.5	0.5	0	1	0
Napthalene	1	1	0	0	0	0
Nickel And Its Compounds	1	1	0	0	0	0
permethrin	1	1	0.5	0	0	0
pH	1	1	0.5	0	0	0
phenol	1	1	0.5	0	0	0.5
Phosphate	0	0	1	0	0	0
Priority Substance	0	0	0	0	0	0.5
Sediment	1	1	1	1	0	0.5
Temperature	1	0.5	0	0	0	0
Total Phosphorus	0	0	1	0	0	0
Trichloroethylene	1	1	1	0	0	0
zinc	1	1	1	0	0	0

Table 4.2: Pressure to NWEBS component look up table

Once you know which components your bundle of measures will affect, you can report the current state (NWEBS Bad, Poor, Moderate or Good[27]) and the estimated state under the bundle of measures (NWEBS Bad, Poor, Moderate or Good) to estimate the step change. Please note this step

[27] We assume high to be classed as good just for the purposes of valuation.

change is not the WFD status (also there is close correlation). This is the NWEBS step change as outlined in section 3.7.

Please note that the NWEBS components are not separate to ecosystem services. They are categories which move through ecosystem classes.

4.5. Selecting the willingness to pay value

Within questions 8 to 13 b of the Stage 1 spreadsheet, the central willingness to pay value should be selected as the default in the stage 1 valuation. However there are cases when the low or high values can be selected. This depends upon:

- Public access to the site. If there is no public access, then the lower willingness to pay value can be used.
- Comparative value of the component improved. For example, Salmonoids are highly valued and so an improvement could justify a higher willingness to pay value. Chalk streams are also nationally valued and could invoke higher willingness to pay value. Lower willingness to pay values could be used for lower value fish, species or habitat.

Any change from the default should be justified using the Appraisal Summary Table to maintain the audit trail.

4.6. Stage 1 valuation spreadsheet

The 'stage 1 valuation spreadsheet' helps us to calculate the benefits and elicit a benefit cost ratio.[28]

Where relevant, the information from the AST should be used to answer questions in the stage 1 valuation spreadsheet.

The format of the input cells is as follows (see below). Those fields marked green affect the final results. Those fields marked orange are for information.

1a. Unique Identification (UID) number	1b. Unique Identification name	2. Short description of the measure/ bundle of measures	3a. Catchment	3b. River Basin District	4. Type of activity from the five WFD broad categories	5a. Primary Significant Water Management Issue tackled	5b. Secondary Significant Water Management Issue tackled (if applicable)	5c. Tertiary Significant Water Management Issue tackled (if applicable)
1234567	*River Itchen and Stow Option A;*	*Fish passage with bypass channel and/or wetland around Stoneythorpe weir only*	*Warwickshire Avon*	*Severn*	*Habitat improvement (includes Fish Passage)*	*Physical Modification*		

6. Should the measure/bundle of measures improve the condition of the waterbody or are they for no deterioration?	7. How many indicators of water quality are improved/have not deteriorated due to the measure/bundle of measures? (see Guidance sheet for list of indicators)	8a. The number of km improved or not deteriorated with respect to **fish**						8b. Willingness to pay value to be used for **fish** (default should be 'central') **only one box must be crossed**			9a. The number of km improved or not deteriorated with respect to **other animals such as invertibrates**					
	1-6	*Bad-Poor*	*Poor-Mod*	*Bad-Mod*	*Mod-Good*	*Poor-Good*	*Bad-Good*	*low*	*central*	*high*	*Bad-Poor*	*Poor-Mod*	*Bad-Mod*	*Mod-Good*	*Poor-Good*	*Bad-Good*
improvement	*6*				*10*				*X*					*10*		

9b. Willingness to pay value to be used for **other animals such as invertibrates** (default should be 'central') **only one box must be crossed**			10a. The number of km improved or not deteriorated with respect to **plant communities**						10b. Willingness to pay value to be used for **plant communities** (default should be 'central') **only one box must be crossed**			11a. The number of km improved or not deteriorated with respect to **the clarity of water**						11b. Willingness to pay value to be used for **the clarity of water** (default should be 'central') **only one box must be crossed**		
low	*central*	*high*	*Bad-Poor*	*Poor-Mod*	*Bad-Mod*	*Mod-Good*	*Poor-Good*	*Bad-Good*	*low*	*central*	*high*	*Bad-Poor*	*Poor-Mod*	*Bad-Mod*	*Mod-Good*	*Poor-Good*	*Bad-Good*	*low*	*central*	*high*
	X					*10*				*X*					*10*				*X*	

12a. The number of km improved or not deteriorated with respect to **the condition of the river channel and flow of water**						12b. Willingness to pay value to be used for **the condition of the river channel and flow of water** (default should be 'central') **only one box must be crossed**			13a. The number of km improved or not deteriorated with respect to **the safety of the water for recreational contact**						13b. Willingness to pay value to be used for **the safety of the water for recreational contact** (default should be 'central') **only one box must be crossed**		
Bad-Poor	*Poor-Mod*	*Bad-Mod*	*Mod-Good*	*Poor-Good*	*Bad-Good*	*low*	*central*	*high*	*Bad-Poor*	*Poor-Mod*	*Bad-Mod*	*Mod-Good*	*Poor-Good*	*Bad-Good*	*low*	*central*	*high*
			1				*X*					*10*				*X*	

14. What are the one-off / capital costs of the measure/bundle of measures in each of the following years? (For a longer schedule of costs unhide the adjacent columns)				15.Are there any annual costs?	16. What year do these annual costs start?	17. Approx. how many years will these annual costs be needed to maintain the envir. improvement or non-deterioration?	18. What year will the environmental improvements / non-det start?	19. And approx. how long will the resulting improvements/non-det last in years? (Use 40 as default)	20. Are there any one off cost savings in first year as a result of the measure/bundle of measures? (£s)
£k				*£k/year*	*year*	*Number of years*	*year*	*No. of years*	*£*
13/14	14/15	15/16	16/17						
	320				*2013/14*		*2014/15*	*40*	

21. Are there any annual cost savings as a result of the measure/bundle of measures? (£s)	22. This spreadsheet monetises recreational, aesthetic and non-use benefits. Are any of the following benefits also significant?				23. Input any one off market benefits (such as water company treatment cost savings or market value of additional fish sold commercially)?	24. Input any annual market benefits (such as water company treatment cost savings or market value of additional fish sold commercially)?	25. What is the risk of failure (the measure/bundle of measures will not meet objectives)? Low (0-20%), Med (21%-40%) High (41%-65%) or Very High (65%-100%).
£/year	Freshwater	Climate regulation	Flood and coastal risk management	Commercial fisheries	£	£/year	
	X	X	X				5

Ball-park expected net present value benefits (£)	Ball-park expected benefit cost ratio (£1 cost : £x benefits)	26. Decision point; take option forward?
£		
4,426,347	15.32	Yes

Table 4.3: Stage 1 valuation GES tab inputs for option A on the Leam.

The input tabs are the same for the GES – Coastal, Lakes and Transitional Waters as for GES- Rivers, except that the km improved are km².

The guidance tab of the stage 1 valuation spreadsheet contains more information on the input cells. This is also summarised in the checklist in Appendix B of this document.

The 'Calc-GES' tab summarises the results. The spreadsheet has automatically looked up the catchment specific values to transfer and applied these per component and per km. The spreadsheet aggregates this annual data up for the total life of the bundle of measures and discounts it at the 3.5% (and declining) social discount rate. This information is presented as 'PV of benefits over life of project'. If you have inputted in capital and maintenance costs[29], the spreadsheet discounts these at the 3.5% (and declining) social discount rate. More on this can be found in 6.1.

4.7. Results of the stage 1 valuation

Please see chapter 6 on comparing costs and benefits for an explanation of the results calculated in the stage 1 valuation sheet. The sheet calculates the expected net present value, (see section 6.3) and expected cost benefit ratio (see section 6.4). These can be used to understand whether the bundles of measures are economically worthwhile.

[29] You should not include inflation within your estimates. All costs and benefits should be in today's prices. If you are using cost or benefits information from previous years, where possible you should use CPI information to bring the prices up to today's values.

The expected ballpark benefit cost ratio and expected net present value benefits are recorded in the results summary tabs. See below for an example. More detail can be found in the Calc-GES tabs.

Bundle to be taken forward?	**Unique Identification (UID) number**	**Unique Identification name for the bundle of measures**	**Catchment**	**River Basin District**	**Whole life cost (£)**
Yes	1234567	River Itchen and Stow Option A;	Warwickshire Avon	Severn	280,000

		This spreadsheet monetises recreational, aesthetic and non-use benefits. Are any of the following benefits also significant?			
Ball-park expected net present value benefits (£)	**Ball-park expected benefit cost ratio (£1 cost : £x benefits)**	**Freshwater for abstraction**	**Climate regulation**	**Flood and coastal risk management**	**Commercial fisheries**
4,187,878	16.48	X	X	X	0

Table 4.4: Stage 1 valuation results summary tab example: bundle of measure options A on the Leam

Please note that whole life costs are not discounted and therefore there cannot be a meaningful direct comparison between these and the expected net present benefits. More information on the discounted costs can be found in the Calc – GES tabs.

4.8. Stage 1 sensitivity testing

There is likely to be uncertainty concerning the inputs to the stage 1 valuation. Sensitivity analysis can help understand how important those concerns are to the final recommendations of the appraisal.

There are a number of automated sensitivity tests built into the stage 1 valuation sheet in the 'sensitivity tests' tab. If you require further sensitivity testing, you can alter the inputs of your spreadsheet. You could use higher or lower feasible value to see what happens to the final result.

Please see more information in chapter 7.

5. Assessing the benefits – stage 2 monetary valuation

Whilst it is likely that the stage 1 valuation will be fit for purpose in most cases, there are times when more local detail may be required. For example, this could be where the benefit cost ratio (of the base case or under a feasible scenario flagged by sensitivity testing) derived from the stage 1 process is between 0.5 and 1.5 or in contentious cases where a benefits assessment is used as evidence in court.

A stage 2 valuation involves a detailed look at the individual ecosystem service impacts to monetise them. To do this, research of economic valuation evidence is required so that values can be 'transferred' from other studies to be used in your assessment.

You will need to have completed the qualitative and quantitative descriptions in the Appraisal Summary Table as described in chapter 3 to undertake the stage 2 valuation.

You can use a spreadsheet to record your workings. We have provided a 'stage 2 valuation template' as an initial outline. This already includes tabs to help you uplift prices into current prices, as described in the box in 2.5, and to discount.

5.1. Understanding how a stage 2 valuation can improve your appraisal

You should use the results of the sensitivity tests in the stage 1 valuation to understand where you require more information to make a more robust recommendation. For example, if a feasible change in the cost causes the benefit cost ratio to dip into the 0.5-1.5 range (or a change in preferred option under an options appraisal), then it would be worthwhile to investigate the costs of the measure bundle in more detail.

The rest of this chapter focuses on the case whereby a feasible change in the monetised benefits could change the appraisal recommendation. In this case, there may be justification to spend more time monetising local benefits.

It is useful to develop an understanding of the NWEBS benefits in the stage 1 valuation. The study values recreational, aesthetic and non use values. You may still be able to use the NWEBS values in the stage 2 assessment if the numbers seem robust. In this case you could consider the other impacts outlined in the AST from the qualitative and quantitative assessment.

If the NWEBS values do not do the bundle of measures/programme justice (where the site has vastly below/above average recreational use values, for example if the area is a location of national significance), you may wish to no longer use the NWEBS values and value the recreational, aesthetic and non use values separately. The assessor should avoid double counting.

5.2. The Review of Benefits for Value Transfer table

The 'Review of Benefits for Value Transfer' table exists alongside this guide. This summarises valuation evidence which have been derived through willingness to pay studies, travel cost method

studies and many more. This includes the values recorded in the Benefits Assessment Guidance (BAG), and Economic Valuation of Environmental Effects (EVEE) used in Flood Risk Management. To use this you should understand what ecosystem service categories you need to value. Then you could use the drop down boxes to filter the studies so that you are able to browse a more manageable amount of information.

The physical characteristics of the goods: e.g. the impact, pollutant, habitat, species, resources, etc	Unit Value (£s)	Parameter (e.g. per household per annum	Value year	Source
Inland Marsh	~£1300, with range £200-£4300	per ha per annum	2008	EVEE guidance table 2.2.
Salt Marsh	~£1400 with range £200-£4500	per ha per annum	2008	EVEE guidance table 2.2.
Intertidal Mudflat	~£1300, with range £200-£4300	per ha per annum	2008	EVEE guidance table 2.2.
Peat Bog	~ £300 with range £0-£1000	per ha per annum	2008	EVEE guidance table 2.2.
Commercial fisheries; trout fingerlings	£170	per tonne restocking rate.	2002	Nix (2002) as summarised in table 4.3 in BAG part 2
Commercial fisheries; trout fry	£210	per tonne restocking rate.	2001	ABC (2001) as summarised in table 4.3 in BAG part 2
Commercial fisheries; Grisle (young) salmon	£2,200	per tonne restocking rate.	2001	ABC (2001) as summarised in table 4.3 in BAG part 2
Commercial fisheries; pre-salmon	£2,300	per tonne restocking rate.	2001	ABC (2001) as summarised in table 4.3 in BAG part 2
Commercial fisheries; salmon	£2,400	per tonne restocking rate.	2001	ABC (2001) as summarised in table 4.3 in BAG part 2
Commercial fisheries; Carp (fry, 2 to 3 inches long, 700 to 800 per acre)	25p	per fish restocking rate	2001	ABC (2001) as summarised in table 4.3 in BAG part 2

Table 5.1: An extract from the Review of Benefits for Value Transfer table

Where the study information fairly closely matches your case, you can transfer this value (with or without adjustment) to your study. We suggest that you use the Review of Benefits for Value Transfer table as a reference point, and use the source to help guide you on how best to apply to value.

5.3. Using Benefits Assessment Guidance (BAG)

Some of the benefits outlined in the 'review of benefits for value transfer' table are derived from the Benefits Assessment Guidance at http://www.environment-agency.gov.uk/business/sectors/37305.aspx. You could refer to this to guide your stage 2 valuation.

This guide was developed in 2003 and has had several updates including the addition of a worked example in 2012. The guide is comprehensive and has been developed for the use by non-economists. It has guidance on valuation for rivers and groundwaters, reservoirs lakes and broads, coastal waters including bathing waters and estuaries and works related impacts.

There are issues you should bear in mind when using BAG. Some of the studies are relatively old and there could be a more relevant study. If in doubt, check the review of benefits transfer table (see 5.2). Not all of the ecosystem service impacts are covered by BAG so ensure that you are considering

all significant impacts when monetising benefits. And finally, avoid using values published by BAG without considering whether they are right for your study area. For more on this see 0.

5.4. Using the Defra Value Transfer Guidelines

There are principles which should be followed when transferring a value from a study site to your policy site. These principles are outlined in the Defra Value Transfer Guidelines at http://archive.defra.gov.uk/environment/policy/natural-environ/using/value.htm. In particular please refer to Valuing environmental impacts: practical guidelines for the use of value transfer in policy and project appraisal

The Defra 'Practical Steps for Benefits Transfer'[30] gives more information on how to:

Step 1: Establish the policy good decision-context

Step 2: Define the policy good and affected population

Step 3: Define and quantify the change in the provision of the policy good

Step 4: Identify and select monetary valuation evidence

Step 5: Transfer evidence and estimate monetary value of policy good

Step 6: Aggregate value of change in policy good

Step 7: Conduct sensitivity analysis

Step 8: Report results

There are likely to be differences between the study site and your policy site. The guidelines help you to understand what the differences are. This is useful if you wanted to adjust the study value upwards or downwards before transferring it for use in your appraisal.

5.5. Using Flood and Coastal Risk Management Water Body Level Cost Benefit Analysis model and the Economic Valuation of Environmental Effects guidance (EVEE)

In 2013, Royal Haskoning and RPA developed a Water Body Level Cost Benefit Analysis model to assist the cost benefit analysis of habitat improvement measures. This principally uses the benefits listed in the Economic Valuation of Environmental Effects guidance (EVEE) (Eftec, 2010). The model tests investment scenarios for FCERM investment into WFD and Habitats Directive work.

Since, it uses national level cost and benefit information, uses broad assumptions and does not account for technical infeasibility, the model will not provide a better cost benefit analysis result than a local assessment. Although the model is not fit for purpose for a stage 2 valuation, data within it can be used on an ad hoc basis. To support this, we fed the cost data from the model into the cost effectiveness database and benefit data from EVEE into the benefits for value transfer spreadsheet.

[30] document found at www.defra.gov.uk/environment/natural/ecosystems-services/valuing-ecosystem-services/

Conversely, we encourage valuation evidence from the Economic Valuation of Environmental Effects guidance (EVEE) (Eftec, 2010) to be used at the stage 2 valuation stage. This guide is very useful for estimating the benefits of increasing environmental assets such as 'hectares of habitat'.

5.6. Avoiding bad practice

When you transfer values from an academic study to your local assessment, please be armed with some common sense. The two main things to consider are double counting and misleading direct application of benefits transfer.

As described in the beginning of this chapter, the assessor should avoid double counting. This is usually the case where different studies, which value the same thing, have been used in benefits transfer. For example, NWEBS includes recreational use value. If an assessor also values benefits to angling, using an alternative study, then adds the two benefit totals together, you would have counted the benefits of improved angling twice. This is double counting.

Applying some values from one study to your case can be misleading. For example, part 2 of the Benefits Assessment Guidance (2003) suggests that if you use the Jacobs Gibb (2002) study on the Mimram to estimate non-use benefits, then you should assume 98% of individuals living 12.01-60km of a river are non-users and that they have a non-use value of £0.29. But applying these non use values to a population in a 60km radius for a river improvement in Hertfordshire, for example, will capture the population volume of large parts of North London. This large population usually creates large benefit numbers and can skew the results. Some would argue that the results were an overestimate. In this case some anecdotal evidence on who might value the improvements might be useful to ground truth this calculation. In this case the assessor might follow a precautionary approach and decide to apply the values to those living within a 12km radius instead of within 60km. If the bundle of measures is still cost beneficial after using the precautionary approach, then we can have greater confidence in recommending the programme.

5.7. Filling in the AST for the stage 2 valuation.

A number of columns (J-N) in the AST have been hidden to avoid unnecessary use of them at a stage 1 valuation. You can now un-hide these.

Relevant value transfer numbers	Reasons for taking value transfer	Monetary Valuation (total undiscounted)	Monetary Valuation (annual benefits, undiscounted)	Results of sensitivity

Table 5.2: Unhidden columns in the AST to be used for stage 2 valuation

In the 'relevant value transfer numbers' and 'reasons for taking value transfer' columns please note down the value chosen from the 'review of benefits for value transfer' table (£s per unit e.g. £3.03 per visitor), the study source (author, year) and the reasons for any adjustments you have made to the number. Please explain your reasons for choosing this value (e.g. 'this study estimated the flood risk benefits of creating a hectare of peat bog. Since this project is about creating peat bog, this seemed appropriate. I have updated this value to 2012 prices').

In the monetary valuation column you can note down the undiscounted annual average (net) benefits associated with the ecosystem service impact (and where appropriate, the years in which the benefits occur).

To understand the context surrounding the inputs into the AST you should record any assumptions. Please include these within the 'category specific assumptions' column.

Where possible, you should also note down an estimate of the probability that level of improvement or reduction of loss will take place. If there is a large range, either note this down or state 'uncertain'.

5.8. Using the Stage 2 valuation template

You can use the stage 2 valuation template to help aggregate and discount the benefits and apply the expected benefits calculation.

You will need to add new sheets to record the monetisation of each ecosystem service benefit/disbenefit. For example if you were calculating the annual benefits to a commercial fishery, your data inputs may be 'commercial value per fish, (£)' x 'increase in fish stock due as a result of undertaking measures, (number of fish per annum)'. You should then reference your source data. If data is sourced through expert judgement, please name the person (and their job title).

Then add these benefits and input this into the 'present value benefits' tab.

The template allows for the appraisal of up to four option bundles.

5.9. Primary valuation

Only in exceptional circumstances where a stage 1 and 2 valuation has not been fit for purpose you may consider initiating a primary study. Primary studies take a considerable amount of time and cost and we would suggest you contact an Environment Agency Economist before moving ahead with this. In normal circumstances, a primary valuation is not required, since value transfer (stage 2 valuation) is fit for purpose for decision making.

5.10. Stage 2 Sensitivity Testing

As explained in the stage 1 sensitivity testing section, it will be likely that there is uncertainty concerning the inputs to the valuation study. Sensitivity analysis can help understand how important those concerns are to the final recommendations of the appraisal.

Under sensitivity testing, you can alter the inputs of your spreadsheet where there exists uncertainty. You could use higher or lower feasible value to see what happens to the final result.

Please see more information in chapter 7.

You can report the results of your sensitivity tests so that they can be considered at any decision making stage.

6. Comparing costs and benefits

If you have followed the cost estimation stage in 2.5 and the stage 1 and/or 2 valuation stage described in chapters 4 and 5 you will be able to compare costs and benefits. You can report the net present value benefits and the benefit cost ratio.

6.1. Calculating the present value costs and benefits

The stage 1 valuation spreadsheet automatically calculates present value and the 'Present value' tabs within the stage 2 valuation template are also set up to discount. The following is, therefore, for information as you will not need to derive discount factors.

Discounting adjusts future values to reflect our preference to receive benefits now rather than later and to pay later rather than now. A 3.5% social preference rate suggests that society is indifferent to receiving a payment of around £100 in ten years time to around £70 now. Similarly, it suggests that society is indifferent between paying a cost of £70 now or £100 in ten years. In this example, the £70 is referred to as the 'present value'.

Note that appraisals undertaken by the Environment Agency for river basin management planning should use the 'social preference rate' as outlined in the Green Book. Water companies use a higher 'rate of return'; mainly to reflect the cost of financing capital works. More on how to account for this can be found in section 2.5.

Period of years	0–30	31–75	76–125	126–200	201–300	301+
Standard rate as published in the Green Book	3.50%	3.00%	2.50%	2.00%	1.50%	1.00%

Figure 6.1: Green Book Discount Rates (Treasury, 2008)

To calculate present value, benefits or costs for each year should be multiplied by the corresponding discount factor.

A list of discount factors can be found in the Treasury Green Book supplementary guidance on discounting, 'Intergenerational wealth transfers and social discounting' (2008)[31]. You can also calculate the discount factor by using the following equation:

$$\textbf{Discount factor} = 1/(1 + r)^{(year)}$$

Where 'r' is the discount rate and 'year' is the number in the sequence where the first year is year 0.

For example the discount factor for year 4 using the 3.5% social discount rate is as follows[32]:

$$\textbf{Discount factor} = 1 / (1 + 0.035)^4 = 0.871$$

31 Found at http://www.hm-treasury.gov.uk/green_book_guidance_discounting.htm
32 The formula becomes more difficult at year 30 when the rate changes from 3.5% to 3%. In excel, the easiest way to manage this is to formulate the discount factor by: 1 / ((discount factor of previous year) x (1 + discount rate)). You should check your results with page 6 of the 'Intergenerational wealth transfers and social discounting' supplementary guidance.

You can either apply the discount factors per annum if your costs and benefits change annually over the time period, as shown below.

Year	*0*	*1*	*2*	*3*	*4*	*5*
Undiscounted Value	£5,000,000	£5,000,000	£100,000	£100,000	£5,000	£5,000
Discount Factor	1.0000	0.9662	0.9335	0.9019	0.8714	0.8420
Discounted Value	£5,000,000	£4,830,918	£93,351	£90,194	£4,357	£4,210

Table 6.1: Example of applying discount factors annually

Or if your costs or benefits are consistent each year, you can calculate the cumulative discount factor[33] and apply the following equation:

Present Value = Total undiscounted benefits or costs x ((cumulative discount factor at final year – cumulative discount factor at first year) + discount factor at first year)

For example, if we wanted to know the total present value of an annual benefit of £100,000 which was realised between years 2 and 5, we would calculate the following:

Present Value = total undiscounted benefits or costs x (((D1+D2+D3+D4+D5) – (D1+D2)) +D2)
= Total benefits or costs X (D2+D3+D4+D5)

Where Dn is the discount factor for year n.

Present Value = Total undiscounted benefits or costs x ((cumulative discount factor at final year – cumulative discount factor at first year) + discount factor at first year)

Present value = £100,000 x ((5.5151-2.8997)+0.9335) = £354,889

You can look up your discount factors and cumulative discount factors using the table below.

33 For example cumulative discount factor at year 5 would be
1+0.966+0.934+0.902+0.871+0.842=5.515

Year	Year no.	Stream of values	Discount factors	Cumulative Discount factors
2012/13	0	3.5%	1.0000	1
2013/14	1	3.5%	0.9662	1.9662
2014/15	2	3.5%	0.9335	2.8997
2015/16	3	3.5%	0.9019	3.8016
2016/17	4	3.5%	0.8714	4.6731
2017/18	5	3.5%	0.8420	5.5151
2018/19	6	3.5%	0.8135	6.3286
2019/20	7	3.5%	0.7860	7.1145
2020/21	8	3.5%	0.7594	7.8740
2021/22	9	3.5%	0.7337	8.6077
2022/23	10	3.5%	0.7089	9.3166
2023/24	11	3.5%	0.6849	10.0016
2024/25	12	3.5%	0.6618	10.6633
2025/26	13	3.5%	0.6394	11.3027
2026/27	14	3.5%	0.6178	11.9205
2027/28	15	3.5%	0.5969	12.5174
2028/29	16	3.5%	0.5767	13.0941
2029/30	17	3.5%	0.5572	13.6513
2030/31	18	3.5%	0.5384	14.1897
2031/32	19	3.5%	0.5202	14.7098
2032/33	20	3.5%	0.5026	15.2124
2033/34	21	3.5%	0.4856	15.6980
2034/35	22	3.5%	0.4692	16.1671
2035/36	23	3.5%	0.4533	16.6204
2036/37	24	3.5%	0.4380	17.0584
2037/38	25	3.5%	0.4231	17.4815
2038/39	26	3.5%	0.4088	17.8904
2039/40	27	3.5%	0.3950	18.2854
2040/41	28	3.5%	0.3817	18.6670
2041/42	29	3.5%	0.3687	19.0358
2042/43	30	3.5%	0.3563	19.3920
2043/44	31	3.0%	0.3459	19.7379
2044/45	32	3.0%	0.3358	20.0738
2045/46	33	3.0%	0.3260	20.3998
2046/47	34	3.0%	0.3165	20.7164
2047/48	35	3.0%	0.3073	21.0237
2048/49	36	3.0%	0.2984	21.3221
2049/50	37	3.0%	0.2897	21.6118
2050/51	38	3.0%	0.2812	21.8930
2051/52	39	3.0%	0.2731	22.1661
2052/53	40	3.0%	0.2651	22.4312

Table 6.2 Discount factors and cumulative discount factors

6.2. Managing risk by using expected values

There is a risk that an action could fail to meet objectives. For example, if we invest in one hundred wetlands, one in one hundred might fail because, say, severe weather conditions prevented the plants to grow.

This is particularly prevalent with regards to campaigns and advisory actions. Not every landowner targeted will take up recommended actions.

It is therefore not realistic for us to assume that all of the benefits that we have reported in the AST and valuation stages will be accrued all of the time. We can adjust the benefits values to take into account of the risk. We use expected values to do this.

Expected value = sum of (outcome x probability)

Simplistic Model:

Expected value = (zero benefits x probability of failure) + (modal average benefits x (1- probability of failure)

For example, we could say that our measure/bundle of measures have an estimated 1% probability of failure. In this case, if the benefits of the base scenario were £100k then:

Expected benefits = (£0x0.01) + (£100k x 0.99) = £99k

Please ensure you apply the expected value calculation (above) to your benefits, where applicable. This has already been embedded within the stage 1 valuation sheet.

6.3. Calculating the net present value (NPV)

This is calculated by:

Net Present Benefits (£) = Present Value Benefits (£) – Present Value Costs (£)

Net present benefits should be greater than £0 for a project or programme to be deemed worthwhile in economic terms. This means that benefits are greater than costs.

Where you have used the expected value calculation to account for risk, the calculation is as follows:

Expected Net Present Benefits (£) = Expected Present Value Benefits (£) – Expected Present Value Costs (£)

The stage 1 valuation sheet does this automatically and the stage 2 valuation template helps you to do this in the 'Summary' tab.

Where you are comparing a number of options, you should choose the option with the highest Net Present Value.

6.4. Calculating the benefit cost ratio (CBR)

This is calculated by

Benefit cost Ratio = Present Value Benefits (£)/ Present Value Costs (£)

This tells us the amount of benefits returned for every £1 invested. For example if total present value benefits over 40 years was £150,000 and total present value costs over 40 years were £100,000 then:

Benefit cost Ratio = £150,000/£100,000 =1.5

The stage 1 valuation sheet does this automatically and the stage 2 valuation template helps you to do this in the 'Summary' tab.

Similarly, if you use expected values then the calculation will be as follows:

Expected Benefit cost Ratio = Expected Present Value Benefits (£)/ Expected Present Value Costs (£)

6.5. Reporting results

You may wish to use the templates below to summarise your results.

For a stage 1 valuation you can report the results from the 'results summary' tab. For example the results of the options appraisal on the Leam has been summarised below.

Bundle to be taken forward?	**Unique Identification (UID) number**	**Unique Identification name for the bundle of measures**	**Catchment**	**River Basin District**	**Whole life cost (£)**
Yes	1234567	River Itchen and Stow Option A;	Warwickshire Avon	Severn	280,000

		This spreadsheet monetises recreational, aesthetic and non-use benefits. Are any of the following benefits also significant?			
Ball-park expected net present value benefits (£)	**Ball-park expected benefit cost ratio (£1 cost : £x benefits)**	**Freshwater for abstraction**	**Climate regulation**	**Flood and coastal risk management**	**Commercial fisheries**
4,187,878	16.48	X	X	X	0

Table 6.3: Summarising results for an appraisal using the stage 1 valuation; example from the Leam

If you require more detail than that provided within the results summary tab, you can report on some of the more detailed information from the Calc – GES tabs.

Unique Identification name	Total benefits per annum, £	Whole life cost, £	Present Value (PV) of benefits over life of project, £,	Present Value (PV) of cost savings over life of project, £	Present Value (PV) of costs over life of project, £	Net PV Benefits, £	cost benefit ratio	Expected Present Value (PV) of benefits over life of project, £,	Expected Present Value (PV) of cost savings over life of project, £	Expected Present Value (PV) of costs over life of project, £	Expected Net PV Benefits, £	Expected cost benefit ratio
River Itchen and Stow Option A;	232,594	280,000	4,819,902	-	270,531	4,549,370	17.82	4,458,409	0	270,531	4,187,878	16.48
River Itchen and Stow Option B;	431,771	280,000	8,947,326	-	270,531	8,676,795	33.07	8,276,277	0	270,531	8,005,745	30.59
River Itchen and Stow Option C;	93,127	135,000	1,929,815	-	130,435	1,799,381	14.80	1,929,815	0	130,435	1,799,381	14.80

Table 6.4: Summarising results for an appraisal in more detail using the stage 1 valuation; example from the Leam

You can include at least one paragraph analysing your results to make a recommendation.

Where your primary aim is to understand whether the bundle of measures is economically worthwhile or not, then your recommendation may follow this format:

'Despite that not all benefits were monetised (such as educational value, freshwater, erosion regulation, water regulation, nutrient cycling and photosynthesis) the bundle of measures are identified as cost beneficial.'

Where your aim is to choose between a number of competing options to meet an objective, then your recommendation may follow this format:

'Despite that not all benefits were monetised (such as educational value, freshwater, erosion regulation, water regulation, nutrient cycling and photosynthesis) all bundle of measures are identified as cost beneficial. Option B, the fish passage with bypass channel and wetland at confluence of Rivers Itchen and Stowe, although was one of the most expensive options, was found to be the most cost beneficial.

'The cheapest option is option C. Spending around £135k in 2013 would return an expected £15 of benefits for every £1 spent. But spending around £280 in 2013 on option B would return an expected £31 of benefits for every £1 spent. (Expected values take risk into account). It is therefore justified to spend the higher amount.'

(Extract from Benefits Assessment Case Study- Leam, Midlands, Environment Agency, 2013)

If you have undertaken a stage 2 appraisal you may wish to display a greater amount of detail when reporting results. The template below has been designed for an appraisal which compares a number of options (bundle of measures). In this case, the options are numbered, but an alias would be useful to remind the reader of what the options are. These can be changed as appropriate[34].

This can be found within the stage 2 valuation template.

34 It is also useful to remind people what year the prices are valued at.

Summary

Appraisal Summary

Option bundle	Option bundle alias	Expected Net PV benefits	Expected Benefit Cost Ratio
1		£0	#DIV/0!
2		£0	#DIV/0!
3		£0	#DIV/0!
4		£0	#DIV/0!

Cost schedule

(Capex & Opex)

		PV Cost (2013 prices)			
Option bundle	**Option bundle alias**	**year 0-5**	**year 6-20**	**year 21-40**	**Total**
1		£0	£0	£0	£0
2		£0	£0	£0	£0
3		£0	£0	£0	£0
4		£0	£0	£0	£0

Benefit schedule

		Expected PV Benefits (2013 prices)				
Option bundle	**Option bundle alias**	**year 0-5**	**year 6-20**	**year 21-40**	**Total Expected Benefits**	**Annual Average Expected Benefits (40 years)**
1		£0	£0	£0	£0	£0
2		£0	£0	£0	£0	£0
3		£0	£0	£0	£0	£0
4		£0	£0	£0	£0	£0

Table 6.5: Summarising results for an appraisal using the stage 2 valuation (blank template)

Depending upon the audience of your appraisal, using graphs could be a worthwhile way to summarise your results.

Below is an example of good practice derived from the Thames Estuary 2100 flood risk appraisal which used the Flood and Coastal Risk Management Appraisal Guidance, Multi-coloured Manual (and handbook) and a technique known as multi-criteria analysis to estimate benefits.

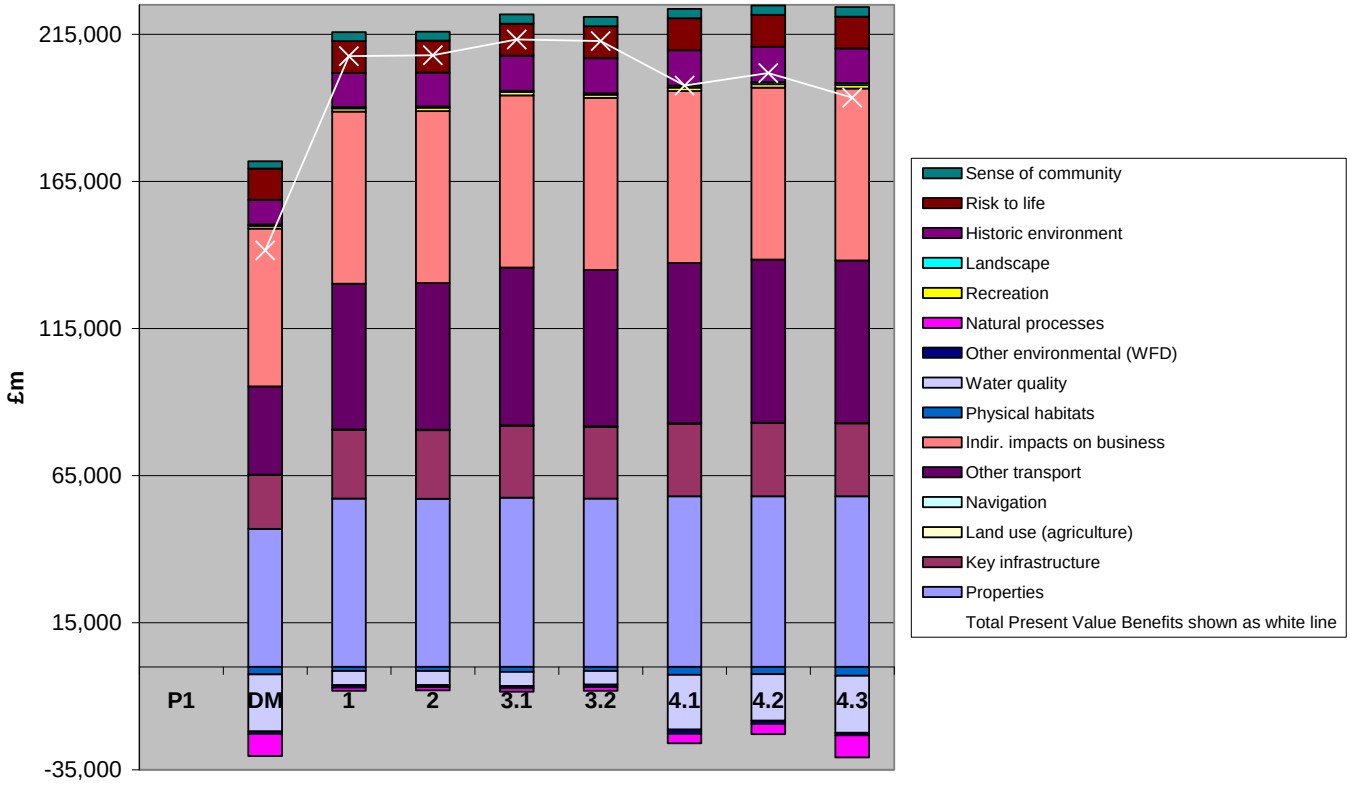

Table 6.6: Presenting results; an example from the Thames Estuary 2100 project

Please note that the values outlined in the table above are for illustrative purposes only. These are benefits related to flood risk management policies and options and the categories may be different to actions which improve the river environment.

Other formats for presentation could also be useful such as pie charts.

Once the appraisal has been summarised a recommendation can be made. Be mindful that economic appraisal can make recommendations to help the decision making process, but does not make the ultimate decision. Factors such as affordability and the distribution of costs and benefits are also important factors in decision making.

7. Sensitivity testing

Sensitivity testing is crucial in understanding the robustness of the appraisal. It can provide confidence where there is uncertainty and help us to understand where more information may need to be sought if applicable.

7.1. How to undertake a sensitivity test

In sensitivity testing we adjust an appraisal input and report what happens to the i) benefit cost ratio ii) net present value and iii) preferred option/final recommendation. If more than one input is changed we can call this 'scenario testing'.

The first step to sensitivity testing is to list the inputs which have the greatest uncertainty. These could be; cost, time period, or aspects of environmental improvement (such as step change or km improved in the stage 1 valuation). One way of forming this list could be by looking at the results of the appraisal and identifying aspects which feel unreasonably high or low.

You should note down the benefit cost ratio of the original appraisal, known as the 'base case'.

Two preferred methods of sensitivity testing include:

1. Changing the input using 'high' or 'low' estimates and recording the results
2. Increasing or decreasing the input until a tipping point is reached; either the benefit cost ratio changes from above 1 to below[35] 1 or if the preferred option changes (under an options appraisal). Assess whether this change is viable.

If any of the viable input changes cause the preferred option to change or become un-cost beneficial, these can be reported as key uncertainties. A judgement will then have to be made on the importance of this key uncertainty and more information on this factor could be sourced.

7.2. Automated sensitivity tests within the Stage 1 Valuation Sheet

Since a number of common sensitivity tests will be needed, the stage 1 valuation sheet has automated some of the sensitivity testing. This includes testing the effect of having underestimated costs and overestimated benefits.

The sensitivities are run by pressing the 'Run' button on the "Sensitivity Tests" page. Macros need to be enabled when the spreadsheet is opened.

Sensitivity Calculations

- Scaling by factors of 5, 2 and 0.8 on whole life costs. All cost entries are scaled by the relevant factor. This includes all one-off costs and all annual costs. Cost *savings* are not included in the scaling.

35 Or changes from below 1 to above 1.

- Change in one off costs for BCR = 1. A factor is applied to all one-off costs (but not annual costs or cost savings). The factor required to reach a BCR of 1 is reported in the sensitivity tests.
- 50% decrease in km benefited. The number of km benefited is scaled by 50%. The same scaling is set for all categories (8a, 9a etc).
- Three WTP sensitivity cases. These are calculated by setting 'X's in the low, central and high cases. The same WTP selection (e.g. "low") is set for all categories (8b, 9b etc).
- Risk of Failure. The risk of failure is set to the corresponding percentages; 0%, 25% and 50%.

7.3. Example of automated sensitivity tests.

The sensitivity tests are run by typing 1 into the update column, entering the water body UID or name and the UID number and pressing the 'Run' button on the 'Sensitivity' tab in the Stage 1 valuation sheet. Macros need to be enabled when the spreadsheet is opened.

Update? [1/0]	Water Body UID or name	1a. Unique Identification (UID) number	1b. Unique Identification name	BASE	Whole life costs x 5	Whole life costs x 2	Whole life costs x 0.8	Change in one off costs for BCR = 1
1	EXAMPLE	1234567	*Unique Identification Name*	*15.32*	*3.06*	*7.66*	*19.15*	*15.26*

50% decrease in km benefited	Using low WTP value	Using central WTP value	Using high WTP value	Risk of failure is 0%	Risk of failure is 25%	Risk of failure is 50%	Status of Sensitivity Calc
7.66	*12.56*	*15.32*	*18.07*	*16.12*	*12.09*	*8.06*	*OK*

Table 7.1: Example of automatic sensitivity test results

More explanation on the tests can be found on the guidance tab within the Stage 1 Valuation sheet.

Thresholds have been used to control coloured icons. Where a sensitivity test is flagged as amber or red, some consideration of the test variable should be taken. For example, if the 'risk of failure is 50%' test is flagged red, then the assessor should take a closer look at the effectiveness of the measure to see whether this change in input is viable. This discussion should be summarised in an appraisal report.

7.4. Example of sensitivity testing undertaken manually.

The following is an extract from the Benefits Assessment Case Study – Leam, Midlands (Environment Agency, 2013). The base case results for option A are presented below. Option A is not the preferred option. Inputs have been altered manually.

Unique Identification name	Total benefits per annum, £	Whole life cost, £	Present Value (PV) of benefits over life of project, £,	Present Value (PV) of cost savings over life of project, £	Present Value (PV) of costs over life of project, £	Net PV Benefits, £	cost benefit ratio	Expected Present Value (PV) of benefits over life of project, £,	Expected Present Value (PV) of cost savings over life of project, £	Expected Present Value (PV) of costs over life of project, £	Expected Net PV Benefits, £	Expected cost benefit ratio
River Itchen and Stow Option A;	191,548	280,000	3,969,331	-	270,531	3,698,799	14.67	3,671,631	0	270,531	3,401,099	13.57

Table 7.2: Base case results example; Option A on the Leam

'Benefits monetised include aesthetic, recreation and non-use benefits for fish, invertebrates, plants, clarity, condition of river channel and safety for contact. Benefits not monetised include fresh water, climate regulation (local temperature/ precipitation, greenhouse gas sequestration), water regulation (timing and scale of run-off, flooding, etc.), erosion regulation, water purification and waste treatment, intellectual and scientific, educational, nutrient cycling and photosynthesis (production of atmospheric oxygen). The most significant of these unmonetised benefits could be any water company cost savings from reducing water treatment.' (Environment Agency, 2013)

Sensitivity testing was undertaken by both scenario testing and tipping point analysis. The inputs were adjusted and the results were summarised.

Water Body UID or name	Factor of change	Uncertainty in the appraisal	Value in the appraisal	Value under sensitivity	Change (%)	Result (expected cost benefit ratio)	Notes
	Base case						
River Itchen and Stow, package of actions A	*cost*	*Costs were estimated from previous projects*	*£280,000*	*£4,760,000*	*1600%*	*1*	*For the cost benefit ratio to change to less than one, costs would have to increase by around 1600%. This cost increase is very unlikely.*
River Itchen and Stow, package of actions A	*cost*	*Costs were estimated from previous projects*	*£280,000*	*£150,000*	*-46%*	*33.26*	*For option A to be preferred to option B, costs must decrease by 46% to £150,000*
River Itchen and Stow, package of actions A	*benefit indicators*	*Overestimating the numbers of indicators improved*	*10km were improved for 5 indicators. 1km was improved for 1 indicator.*	*10km were improved for 1 indicator*	*5 less indicators improved*	*3.49*	*The cost benefit ratio is still positive when benefits are underestimated.*
River Itchen and Stow, package of actions A	*km benefited*	*Overestimating the reach of river improved*	*10km were improved for 5 indicators. 1km was improved for 1 indicator.*	*km values divided by 10.*	*-90%*	*1.65*	*The cost benefit ratio is still positive when the km of river reach improved is underestimated.*
River Itchen and Stow, package of actions A	*Life time of benefits (years)*	*Climate change could cause the benefits to last for a shorter time*	*40*	*5*	*-88%*	*2.86*	*The cost benefit ratio is still positive if the benefits last 5 years instead of 40.*
River Itchen and Stow, package of actions A	*Risk*	*over confidence*	*90% certainty of reaching 100% of benefits and 5% certainty of reaching just 50% of benefits*	*5% certainty of reaching 100% of benefits and 5% certainty of reaching just 50% of benefits*	*-80%*	*1.1*	*The cost benefit ratio is still positive if the project delivers as expected 5% of the time or delivers 50% of what is expected 5% of the time.*

Table 7.3: Manual sensitivity test example; Option A on the Leam

'Tipping analysis identified that, all other things equal, costs would have rise by over 1600% in order for the benefit cost ratio to be less than 1. All other things equal, costs would have to reduce by 48% to £150k for this option to be preferred over option B.

All other things equal, if benefits were over estimated, and only 1 of the NWEBS components benefited over 10km, rather than all 6 benefiting, the benefit cost ratio would still be above 1 (it would be around 3.5).

All other things equal, if we reduced the 40 year life time to 5 years, the benefit cost ratio will still be above 1 (it would be about 2.86).

All other things equal, if we reduced the km length by dividing it by ten to 1km, the benefit cost ratio will still be above 1 (It will be about 1.65).

If we changed the risk parameters by reducing the certainty of delivery from 90% to 5%, the benefit cost ratio will still be positive.

Thus the sensitivity tests have illustrated that the benefit cost analysis is robust. This option is cost beneficial.' (Environment Agency, 2013)

7.5. Reporting sensitivity results

You can copy the results which are already within the stage 1 valuation sheet and provide and explanation of the numbers as shown in 7.3.

Or you may wish to report you results using the following template. See below an example of tipping analysis undertaken on the cost parameter:

Water Body UID or name	Factor of change	Uncertainty in the appraisal	Value in the appraisal	Value under sensitivity	Change	Result (expected cost benefit ratio)	Notes
River Itchen and Stow, package of actions A	***Base case***					***7.5***	
River Itchen and Stow, package of actions A	*cost*	*Costs were estimated from previous projects*	*£280,000*	*£4,760,000*	*1600%*	*1*	*For the cost benefit ratio to change to less than one, costs would have to increase by around 1660%. This cost increase is very unlikely.*

Table 7.4: Alternative sensitivity results template

This should be accompanied by a comment on the robustness of the appraisal. The results from these tests are important and could be presented with the results to demonstrate a more comprehensive assessment.

8. Final appraisal report

8.1. Content

It is important to ensure that you present relevant information within your final appraisal report.

You should include:

- A description of the objectives (see section 2.1).
- A list of the bundle of measures assessed and their individual costs. (See section 2.3).
- The Appraisal Summary Table (as an appendix). This outlines the qualitative and quantitative description of impacts. (See section 3).
- The stage 1 valuation results. (See section 4.7).
- Comment on which further impacts could be monetised in a stage 2 valuation if necessary. (See section 4.2).
- Stage 2 valuation results (if undertaken). (See section 5).
- Discussion on sensitivity tests (see section 7).
- Final recommendation.

A more comprehensive check list can be found in Appendix C. Graphs can be used, where helpful, to illustrate results.

A number of case studies have been provided to accompany this guidance document. These can be used to understand the level of detail useful for the final appraisal report.

If your appraisal is for River Basin Management Planning, please ensure that you have recorded the measures, associated costs and results of your appraisal within the CPS system (or relevant recording system). For more information please refer to the Operational Instruction for catchment appraisal.

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Appendix A - Glossary of Terms

(updated from Eftec, 2012)

Term	Meaning
Cost-benefit analysis	A form of economic analysis in which costs and benefits are converted into money values for comparison over time.
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.
Discount rate	The annual percentage rate at which the present value of a future pound is assumed to fall away through time.
Double counting	Valuing an impact, cost or benefit more than once.
Do nothing baseline	The baseline under a 'walk away' scenario. This baseline changes over time as a result of natural and climate changes.
Economic Appraisal	An appraisal that takes into account a wide range of costs and benefits, generally those that can be valued in money terms.
Equivalent Annual Values (EAV)	The discounted value of a stream of future costs or benefits presented as annualised values.
Monetised	Where benefits have been valued in £s.
Net benefits	Is the total amount of benefits minus disbenefits or trade offs.
Non use values	Non-use values are those associated with the knowledge the resource exists in an improved state whereas bequest values are associated with values for future generations and altruistic values for others' enjoyment of the resource.
Optimism Bias	HM Treasury's Green Book notes that appraisers tend to overstate (or understate) benefits and understate (or understate) timings and costs. As a result, it indicates that explicit adjustments should be made by increasing estimates of costs and decreasing and delaying estimates of benefits.
Option	A measure or bundle of measures which meets a set objective. There may be a number of options which meet the objective. Cost benefit analysis can help choose the preferred option from a number of do something option choices.
Present Value	The discounted value of a stream of future costs or benefits.
Risk	Information representing the variance of an outcome. Risk, unlike uncertainty, is quantified.
Sensitivity Analysis	The analysis of how an appraisal will be affected by varying the projected values of the important variables.
Transaction Cost	Costs involved with the buying or selling of goods e.g. administrative costs.
Trade off	The process of giving up goods or services for other goods or services. This is generally done because the goods or services received will bring more utility than the ones that are given up.
Uncertainty	Stems from a lack of information, scientific knowledge or ignorance and is characteristic of all predictive assessments.
Valuation of benefits	Placing a monetary value on benefits; defining benefits in £ units.
Value Transfer	The method of transferring benefit estimates from past valuation studies to the present study, in order to reduce appraisal costs. The validity of the approach depends on the degree of similarity between the various studies, e.g. the environmental good or service being valued, the characteristics of the population and the robustness of the previous benefit estimates.
Willingness to pay	'Willingness to pay' for the continued provision of an environmental good or service or for a change in the good or service.

Appendix B – The Assessor's Checklist

This checklist summarises the information required to undertake a benefits assessment. For more information please refer back to the relevant sections within the guide. Follow the headings which are relevant in your case. For ease of reading, the 'describe', 'decide', 'user input value' and 'calculated value' categories have been outlined.

i. Framing the appraisal (section 2.1)

Outline:

1. DESCRIBE: Objective/s of the project. In general the key objective will be 'to improve the water bodies within the catchment towards Good Status'. If you are comparing a number of options (bundles of measures) they all must meet the project objective/s collectively.
2. DESCRIBE: Aim of the appraisal. Is this to understand whether a bundle of measures are cost beneficial or not? Is it to compare a number of competing bundle of measure options which meet the objectives to recommend the most economically worthwhile option?
3. DESCRIBE: The baseline condition of the water body under the 'do nothing' scenario.
4. DESCRIBE: The bundles of measures (packages of catchment actions), which meet your objectives. You may wish to call one a 'do minimum' option if this option reflects general maintenance works for example. In order to provide this, an unconstrained, 'long list' of options should have been cut down to a 'short list' by sifting out options which are not technically feasible or cost effective.
5. USER INPUT VALUE: The cost of the measures. These can be estimated using the Environment Agency Cost Effectiveness Database (2012), 'Environment Agency CEA tool' for water resources, or evidence from previous projects or contractor quotations.
6. USER INPUT VALUE: The time period that we can assess the benefits for. This will be dependent upon the life time of the benefits of the longest living asset. Where not applicable, we suggest using 40 years to be consistent with the water industry appraisal periods.
7. USER INPUT VALUE: The size of study area/length of the study river in km/size of the study water body.

A list of measures which contribute to a bundle of measures should be created for an audit trail. Measures and costs can be summarised in the bundles, measures and costs spreadsheet, outlined in section 2.3 (if the Water Resources CEA tool has not been used).

ii. Qualitative and Quantitative description of the benefits (section 3)

Create a version of the Water Appraisal Summary Table (AST) for each bundle of measures.

1. DECIDE: Assess the category prioritisation for each ecosystem service related to the outcomes of the package of catchment actions. This is to filter out the ecosystem services which are not significantly affected and prioritise your effort.

2. DESCRIBE: Qualitatively describe the current baseline evolution of the baseline under 'do nothing' and 'carry out measures' scenarios for the most significant ecosystem services affected. The purpose of this section is to tell a story about the expected impacts of an option. For example, describe a more specific description of the ecosystem services affected, the visible impacts, the magnitude of change (in both positive and negative directions),

relevant geographical characteristics[36], a description of users, the degree of user accessibility, the local importance and extent of use, the availability of alternative sites or substitutes, and any other relevant information for example species types (especially fish species), names of local recreation clubs etc.

3. DESCRIBE: Quantitatively describe the current baseline evolution of the baseline under 'do nothing' and 'carry out measures' scenarios for the most significant ecosystem services affected. The content could be similar to the qualitative assessment except that it can be provided with number estimates. Where this is not possible an indication of 'High', 'Medium' or 'Low' status can be identified. The type of information which may be relevant to discuss can include the number of waterbodies at what states, the number of users[37], the frequency of use[38], the number, respective quality and distance of alternative sites or substitutes, the quantitative magnitude of change (in both positive and negative directions), the time horizon of impact and any other relevant information such as local membership rates for recreation clubs such as angling clubs or canoe clubs if available. Please ensure that secondary effects are also identified.

iii. Stage 1 valuation (section 4)

Open the stage 1 valuation sheet. In summary, under the GES tabs you can input:

1. DESCRIBE: Unique name for the bundle of measures, relevant catchment, river basin district and most relevant significant water management issue to be tackled by the bundle.
2. USER INPUT VALUE: The NWEBS components impacted (see section 4.3), the predicted step change (NWEBS bad/poor/moderate/good) and the number of km/km² affected.
3. USER INPUT VALUE: One off and annual cost.
4. USER INPUT VALUE: Risk of failure.

iv. Reporting the results from the stage 1 valuation (section 4.7)

In the appraisal report, you should:

1. CALCULATED VALUE: Note down the expected net present value benefits and the expected benefit cost ratio.
2. DESCRIBE: List down the data inputs which exist the greatest uncertainty (e.g. cost, number of km improved etc)
3. CALCULATED VALUE Undertake sensitivity tests (see section 4.8 and section 7.2) to see whether these uncertainties are significant.
4. DECIDE: Is the benefit cost ratio between 0.5 and 1.5, or does a realistic sensitivity test show the benefit cost ratio tipping into this range? If so, decide whether it would be proportional to seek more information on the uncertain input. If this input is the benefits, then decide whether a stage 2 valuation is necessary.

v. Stage 2 valuation (section 5)

For a stage 2 monetisation of benefits refer to the Defra value transfer guidelines and the Review of Benefits Transfer excel sheet. It is important to use the results from the AST for this stage

[36] For example biological, chemical and hydromorph characteristics which are relevant to the impact category

[37] Split by distance from water body if applicable. For example, users within 0-0.5km, 0.5-3km, 3-12km and 12-60km.

[38] Take into account seasonal differences.

1. DECIDE: Ensure you have explained why you have used certain benefit transfer values.
2. USER INPUT VALUE: Ensure you have uplifted all values into present day values.
3. USER INPUT VALUE: Ensure you have discounted the costs and benefits.
4. USER INPUT VALUE: Ensure you have integrated the risk of failure by calculating the expected benefits (see section 6.2)
5. CALCULATED VALUE: Note down the expected net present value benefits and the expected benefit cost ratio.
6. DECIDE: List down the data inputs where the greatest uncertainty exists (e.g. cost, benefit transfer values used)
7. CALCULATED VALUE: Undertake sensitivity testing where there is greatest uncertainty (see section 7). If there were alternative values which could have been used for benefit transfer, test these in sensitivity testing to see if the use of those values would have made a difference to the appraisal outcome. Analyse these results.

vi. To sum up all assessments (section 8)

1. DECIDE: Make a recommendation for a preferred option (or 'do nothing'; whereby an alternative objective would be needed).
2. DECIDE: If the outcome of the appraisal is not clear (e.g. where the appraisal and sensitivity tests report results with benefit cost ratios which fluctuate around 1, then recommend where more accurate information would help any future appraisal.
3. DESCRIBE: Outline your findings within an appraisal report. Include a copy of the Appraisal Summary Table as an appendix.
4. DESCRIBE: Ensure that the tools and spreadsheets that you have used are available for audit purposes.

Appendix C – The Reviewer's Checklist

This note describes a checklist that appraisal reviewers can use to audit economic appraisal for business cases. This checklist is a guide and is not exclusive.

1) Describe the problem and set objectives

Is the problem under consideration clearly defined (i.e. why is a project required)? Is it spelled out objectively, in a way that does not prejudge a solution?
Are the boundaries of the projects clearly defined?
Is timing of interventions clearly justified (i.e. in terms of urgency, end of assets life, etc)?
Are objectives linked to the problem? Are they Specific Measurable Achievable Relevant Time constrained?

2) Define the baseline

Is the baseline clearly defined in terms of current status and do-nothing scenario?
Does the 'do nothing evolution of baseline' take into account future changes (incl. climate change)?

3) Identify, develop and short-list options

Have alternative options been considered?
Is ruling out of potential promising options transparent and clearly justified?
Will options short-listed deliver outcomes in line with proposal's objectives?

4) Describe, quantify and value costs and benefits

Are all assumptions clearly spelled out?
Are the impacts described qualitatively and quantitatively using the Appraisal Summary Table?
Are all economic costs and benefits clearly calculated for each year covered by the proposal with Net Present Value calculated correctly?
Are there any decisive unquantified cost/benefits and are they clearly explained?
Are there appropriate sensitivity analyses?
Is optimism bias properly included? Are the risk probabilities and expected values justified?
Are wider impacts described qualitatively (e.g. ecosystem services which have not been monetised)?

5) Compare and select the preferred option

Are results of each option presented clearly?
Is the preferred option selected by comparing costs and benefits of all feasible options with the current or do nothing baseline?
Does the preferred measure or bundle of measures show Value for Money? If not do unquantified benefits justify the cost?
Do sensitivity tests confirm appraisal robustness or flag up any issues which need further attention?