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Findings of an Environment Agency seminar PRO4, January 2003

Economic Appraisal and Assessment of Benefits in the PR04 Environment Programme

ENVIRONMENT AGENCY

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Foreword

The Environment Agency is assessing the benefits of discretionary 'choices to be made' schemes in the environmental programme for the present periodic review of the Water Industry (PR04). These assessments will be carried out by Environment Agency practitioners as an important and integral part of their technical assessments and refinement of scheme requirements for PR04.

This report presents the proceedings of a seminar that OXERA organised for the Environment Agency to present our work for peer review by leading academic economists and experts from the water industry, DEFRA, Welsh Assembly Government, Drinking Water Inspectorate, HM Treasury, Ofwat, RSPB and Watervoice. The purpose was to obtain their views to aid our work on benefits assessment not only for PR04 but looking forwards to the implementation of the Water Framework Directive (WFD).

The report describes our work on benefits assessment for PR04 in the context of the overall technical and economic appraisals for PR04. We then report specific comments made by individual peer reviewers and provide a synthesis of points made at the seminar. This highlights important points for our work on benefits for PR04 as well as suggestions for research needs for the future in respect of the implementation of the WFD.

The Environment Agency places considerable importance on constructive substantive dialogue on our economics work on water. This seminar provided valuable discussions and we hope that these proceedings will make a useful contribution to the debate about the environmental programme in PR04.

Martin Griffiths
Head of Water Quality
Environment Agency

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Chairman's Introduction

Dieter Helm
New College, Oxford

When the water industry was privatised, the intention was to facilitate a substantial investment programme to rebuild the water and sewerage systems after a long period of neglect and to substantially improve environmental quality. It was envisaged that the National Rivers Authority (the predecessor of the Environmental Agency, EA) would set the quality requirements in consultation with the Department of the Environment (subsequently the DETR and now Defra) and that Ofwat would ensure that the improvements were efficiently delivered and financed at periodic review. The Drinking Water Inspectorate would have a specific remit too.

Prices were initially to be reset every ten years by adjusting the price limits of the companies, although this was quickly reduced to five. Periodic reviews took place in 1994 and 1999, and there has been much 'learning by doing'. The quality enhancements have been driven largely by EU Directives and mandatory action. However, even here, there have been questions of interpretation and timing. In addition, a host of discretionary quality improvements have been considered.

It is now widely recognised that good regulation is premised upon an assessment of costs and benefits, and that new projects should have benefits in excess of costs—and demonstrably so to the customers and taxpayers who provide the supporting revenues. In the water case, Ofwat has the task of assessing costs, and it is for the EA, supported by Defra, to focus on the benefits.

Benefit assessment is, however, typically much harder than cost estimation. Most of the environmental outputs are not market ones, having no direct price. The values therefore have to be gleaned from indirect methods, focused on attempts to reveal demand through willingness-to-pay and other proxies. There is now a formidable economic toolbox of techniques to address these valuation questions at hand.

As the 2004 periodic review (PR04) progresses, the EA has, with the assistance of consultants, been applying these techniques, and to this end a seminar was organised in January 2003 to subject its work to peer review. This volume summarises both the EA's progress and the assessment of it by a number of experts and interested parties.

The volume is structured to bring out the principles, context and results of the EA's benefit-assessment work. The first chapter deals with the underlying regulatory approach to PR04 (Dieter Helm).

There follows an overview of the EA's work programme on benefit assessment, and a description of the way it has approached this task (Jonathan Fisher). The initial assessment is then presented (Hilary Sunman), with the methodology and the findings for each benefit category.

This is followed by a summary of the guidance developed for the EA (Meg Postle and Teresa Fenn) to use for the main non-statutory schemes. This is assessed by the two discussants (Ken Willis and Ian Dickie). The guidance provides one step in a longer process towards the EA's

benefit assessment, and there is much scope to build upon it and to develop more sophisticated and convincing analyses. Here, the more general lessons for benefit assessment are presented (Ece Ozdemiroglu) and the longer-term programme requirements are set out (David Pearce).

Finally, the main results of the seminar are summarised, with practical recommendations for the short-, medium- and longer-term work programme (Jonathan Fisher). A concluding chapter reflects on the consequences of the benefit-assessment exercise for the future of environmental regulation and how it might be extended to incorporate wider concerns about diffuse pollution, agriculture and integrated pollution control (Dieter Helm).

Chapter 1

Benefit Assessment: The Context

Dieter Helm
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1. Introduction

The periodic-review process requires a five-year cycle of fixing the capital investment programme of the water industry. This programme is the outcome of considerations of the legal requirements (typically defined by EU directives), desirable environmental improvements and the willingness of consumers to pay. Defra has the role of striking this balance in its guidance to the EA and Ofwat; the EA has the role of proposing the requirements; and Ofwat has the duty to set the prices and hence determine the functions that are to be financed.

In this chapter, the process as it has evolved so far will be briefly reviewed (section 2). The rationale for benefit assessment will then be set out and its role in the review process considered (section 3). The integration of the EA's benefit assessment into PR 04 is then commented on (section 4), before drawing out the longer-term implications of benefit assessment for the EA and water regulation more generally.

2. The Process So Far

Preparations for PR 04 began in late 2002 with the development of Ofwat's methodology consultation process. At this early stage the priority was to put in place a process which would follow the principles of good regulation, and to develop a timetable and programme of work to bring the periodic review to a conclusion in time for there to be appeals to the Competition Commission, should these be triggered by any of the companies rejecting Ofwat's determination.

While consultation on the Ofwat methodology proceeded, Defra was trying to work out its own position, and in doing so to fit in with the EU Framework Directive. It produced its own guidance in a series of steps. The second ministerial guidance paper[1] published in early 2003 reiterated Defra's overarching priorities, organised around the sustainable development concept, and attempted to temper the environmental ambitions. In particular, Defra pointed to the scale of the EU directive requirements and the challenge of the Framework Directive. The Defra guidance hinted at the desirability of pushing back as much as possible beyond 2010 and hence beyond the next price-control period.

Defra was also concerned to identify which capital projects were statutory, unavoidable and would incur infraction procedures if they failed to be included in the capital programme. This allows a base capital expenditure (CAPEX) to be established, and to see what the effects on prices might be. At this early stage in the process, only the broadest indications are possible, and the Defra position therefore leaves the EA to propose a CAPEX programme which

[1] DEFRA (2003) Initial Guidance from the Secretary of State to the Director General of Water Services: 2004 Periodic Review of Water Price Limits

includes its own assessment of the statutory requirements and its shopping list of discretionary spending. It is for the EA to demonstrate the benefits of its proposals.

The EA was therefore put in the position of having to justify the environmental improvements it sought to bring about, under the shadow of an unspoken, yet very real constraint of the prices that politicians and Ofwat was prepared to see imposed through this price review. This constraint was widely assumed to be in the range of RPI – 0 to perhaps RPI + 2.

It is worth reflecting that this assignment of the burden of proof reverses both the polluter-pays principle and the precautionary principle. Environmental improvements are driven by the politically acceptable prices, and from the outset the EA has had to seek improvements at the margin of this constraint.

Finally, the periodic review of the water industry focuses solely on getting water customers to pay for control measures to clean up the water industry's contribution to water quality and resource problems. However, the *causes* of pollution are well known, and many lie with agriculture. Diffuse pollution is especially problematic, and the obvious economic instruments of pesticide, herbicide and nitrate taxes have not been imposed for fear of upsetting the farming lobby. There is, furthermore, the possibility of using general government funds from taxation for some of the wider public goods associated with bathing beaches, special environmental areas or other national assets. At present, beaches will be paid for by *local* water customers whatever their wider national public benefit.

3. Benefit Assessment

Benefit assessment does not command universal support, even within the EA. Some critics argue that the environment is beyond monetary valuation, and hence deny the validity of the exercise. Others focus on the practical difficulties of measuring people's preferences, focusing on the lack of information, the sample selection, the use of values transferred from one area to another, the way the future is discounted, and how to incorporate uncertainty into the calculations. Thus, there are both principled and practical objections.

It is well beyond the scope of this chapter to address all the various concerns. However, it is important to make some remarks about the principled objectives, and in particular the consequences of *not* undertaking benefit assessment. At the heart of the debate lies a fundamental confusion between the claim that an environmental asset or condition is *worth* a particular monetary sum, and the quite distinct claim that a certain amount of resources should be spent improving it. When someone claims an environmental good is 'priceless', they presumably do not mean that all of national income should be devoted to preserving or enhancing it. Resources are scarce, and the task of the EA is both to encourage us to spend more on the environment and to ensure that what is spent is most environmentally effective.

To achieve this, projects must be ranked in importance, and benefit assessment creates a calculation within which to do this. It does this by placing the ranking very much in the hands of the people and their preferences. It tries to work out how much people are willing to pay for environmental goods, and how much they need to be compensated for the consequences of environmental quality reductions. Thus, at the heart of benefit assessment lies the assumption that what matters is people's preferences.

There are many environmentalists—and many scientists—who jibe at this reliance on preferences, and would prefer that such discussions were placed in the hands of 'experts'. How can ill-informed people without the appropriate training in biology, ecology and other sciences know what is the appropriate environmental standard to be striven for?

Though many economists would be tempted to respond by claiming that the scientific approach is anti-democratic, the apparent divergence of views is less than it seems. A couple of related distinctions help to bridge the gap. First, we need to distinguish between *general* preferences for the quality of the environment, and *specific* preferences about specific environmental outputs. We may agree about wanting a level of sustainable development, but not know whether it would be better to plant oak or birch trees on a site to achieve it. Second, it matters greatly whether the preference is based on the relevant set of knowledge or is 'uninformed'. How much information is provided to people who are asked their willingness to pay is a crucial input into benefit assessment.

There is a final practical point about benefit assessment that needs to be borne in mind. If no benefit assessment is conducted, then we need some other criterion to rank projects. What is this? Is ecological value paramount? Does amenity value count? With no currency to aggregate these considerations, the outcome too readily becomes political. The EA 'negotiates' and 'lobbies' politicians in this model and the outcome is decided through the political process. Without the assistance of proper benefit assessment, prejudice and short-term considerations about the impact of prices can easily outweigh the more diffuse and longer-term environmental interests. The result, too often, is that the environment loses out—as historically it has done. At the last periodic review, the politicians dictated that the consumers would have an initial price cut of 10% followed by prices at RPI – 0. The environmental case was thereby squeezed out and the EA had no empirical evidence to do much about it.

4. Integrating the Outcome of Benefit Assessment into PR 04

The EA's benefit assessment is due to be completed in the summer (2003), and to provide an input to ministerial decisions on the capital programme. Once these decisions have been taken, the next step for Ofwat is to take the results and complete the price determination.

In this process, the first question is how exactly the EA should incorporate the benefit assessment into its bid to ministers. There are two possible approaches: to use the benefit assessment as a check on its predetermined view, based upon its internal expert opinion; or to let the benefit assessment determine its preferred programme. These are clearly very different approaches. In practice, the EA will need to take an iterative approach: the projects it tests with benefit assessment have to come from somewhere, and that is usually from internal sources; but benefit assessment provides its own parameters which may encourage a rethink.

It will also be important to take account of how well the benefit assessment is done. The exercise under way at present is inevitably quite crude, done to limited budgets and timescales. Simplifications have had to be made due to the lack of primary data. Values from one context have been transferred to others, for example. The range of uncertainty is very large.

Practical techniques—such as sensitivity analysis—will help. It is important to know whether a significant change in the inputs to the benefit assessment would make much difference;

whether the costs are so great that even large increases in the benefit valuation would still be less than the costs, and so on.

The incorporation of benefit assessments will also be important after the ministerial decisions in late summer (2003). As Ofwat develops its position, it will take the companies' own business plans, which incorporate ministerial decisions and survey customers for their views. It is to be expected that this consultation will be premised on guideline prices, and presumably when confronted with paying higher bills for a programme *as a whole*, customers will opt for a lower capital programme.

While Ofwat may take this as an important indicator, it cannot be decisive, since the functions that have to be financed remain with ministers and the EA to determine in large measure. The benefit assessment of projects that might be squeezed out by Ofwat's customer consultation exercise will therefore need to be very carefully checked.

5. Longer-term Implications

PR 04 is an altogether more sophisticated periodic review than its predecessor, and the introduction of benefit assessment by the EA is a major advance. Inevitably, it will be somewhat crude, but it does lay the foundation for developing a continuous analytical process within the EA, which extends well beyond the water case.

The EA has the potential to act as a sponsor and focus for the numerous and diverse work on cost–benefit analysis throughout universities, developments and private companies. Once PR 04 is complete, some stocktaking will be appropriate, and a longer-term programme of research can be defined.

The applications of benefit assessment are wider than project appraisal. As momentum gathers to introduce more market-based instruments in the form of taxes, tradeable permits and other incentives, benefit assessment provides an important input into the setting of tax levels and the appropriate quantities in permit schemes. Benefit assessment becomes then a wider tool for environmental policy.

Chapter 2

The Agency's Approach to Economic Appraisal for the Environmental Programme in PR04

Jonathan Fisher
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This paper provides an overview of the tailored economic appraisal techniques and processes to be used for the following three categories of schemes in the Ministerial guidance[2]:

- "Essential and clear " (Defra) or "established requirements" (Welsh Assembly Government, WAG);
- "Essential when clarified" (Defra) or "expected requirements" (WAG); and,
- "Choices to be made" (Defra) or "subject to policy decisions" (WAG).

In particular, the paper outlines the Environment Agency's work on benefits assessment for PR04 and show how it relates to the other economic appraisal processes in PR04.

The economic appraisal of the environment programme for the 2004 Periodic Review is being carried out in stages:

- Stage 1. By autumn 2002, provide an initial summary of benefits and costs to support advice to ministers (see Chapter 4);

- Stage 2. By summer 2003, the Environment Agency will set the environmental requirements of every scheme and appraise the costs and benefits of schemes where there are 'choices to be made'. Also, assess the benefits of the overall programme;

- Stage 3. By 5 November 2003, provide further analysis for a small number of large outstanding schemes.

Figure 2.1 sets out the economic appraisal techniques being applied to the Ministers' categories for Stages 2 and 3. Table 2.1 shows what techniques are being applied for specific drivers in the environmental programme in PR04.

Stage 2

An **analysis of cost-effectiveness** is carried out for **all** schemes, as follows:

- The Environment Agency and English Nature examine the risk of a breach of statutory requirements and the risk of environmental impacts. We look at causes and the options for tackling the problem. This leads to a set of environmental requirements for each

[2] DEFRA (2003) Initial Guidance from the Secretary of State to the Director General of Water Services: 2004 Periodic Review of Water Price Limits

scheme, for example, limits on discharge quality. The Agency Quality Assures and checks technical aspects of the schemes. Where possible and appropriate, we also aim to identify the contribution to risk of causes outside the water industry, and to map out the options to tackle these. The Environment Agency's normal pragmatic technical review of options will filter out schemes that are not worthwhile.

- The water companies cost the scheme requirements.

- OFWAT's reporters scrutinise the water companies' estimates of costs. Ofwat liaises with the Environment Agency to check that companies apply effective solutions.

Assessing the risk of non-compliance. For schemes categorised as 'essential when clarified', the Environment Agency and English Nature work with Defra and WAG to assess the risks of failure to meet statutory obligations and propose investigations where necessary. We then assess the extent to which schemes will reduce these risks.

Assessment of environmental benefits. The Agency will apply its Benefits Assessment guidance (BAG) for all schemes categorised in Defra Ministerial guidance as "choices to be made".

This BAG guidance provides a systematic process for describing benefits in qualitative terms and then assessing them quantitatively (e.g. the length of rivers improved), and then valuing them in monetary terms as far as possible (see Chapter 4). This guidance was based on an extensive review by EFTEC of the available monetary valuations for the environmental benefit categories relevant for PR04.

As part of the preparation of this guidance, RPA carried out an extensive review of the merits, limitations and practical experience with the existing guidance to assess environmental benefits. They then selected the best features of the various guidance that are most appropriate for the needs and circumstances of PR04; in particular, the fact that a large number (> 500) of schemes would need to be assessed in a short time (of less than 6 months). Consequently the guidance had to be based on benefits transfer – transfer of existing valuations. Moreover, the Agency's practitioners had to carry out the assessments so as to integrate them into their development of the schemes. RPA paid particular attention to addressing the practical problems that had been encountered with earlier guidance so as to overcome them as far as possible either in the way the guidance was prepared or in how it was rolled out. Thus the Environment Agency carried out 3 training courses for Agency staff, Ofwat, Defra, EN and CCW on how to apply the guidance. In addition, we provided surgeries and a help desk to assist Environment Agency staff in each region apply the guidance.

In some particular cases, companies also may choose to apply part 5 of the guidance to assess other environmental costs of implementing schemes (e.g. the external environmental costs of additional energy).

The Environment Agency will combine the assessments of the environmental benefits of the schemes with the Water companies' estimates of the financial costs and environmental costs of the "choices to be made" schemes as soon as the financial cost estimates have been reviewed by Ofwat. The Environment Agency will then submit to Defra a ranking of the choices to be made schemes in terms of their Benefit:Cost ratios and other non-monetised

factors such as: when a failure of a statutory standard is likely to arise; whether the scheme would help a bathing water achieve blue flag status; and economic regeneration benefits.

The Agency will also assess the **environmental benefits of the overall environmental programme** for each company. We shall present these for three groups of schemes in line with the Ministers' categories: "essential and clear"; "essential when clarified"; and "choices to be made". This will include qualitative and quantitative benefits and monetary values where appropriate and possible.

Links to Water Resource Plans

Environment Agency specifies environmental requirements for PR04 – as above.

Water companies forecast supply and demand for water in their zones and assess the incremental social costs and benefits (Average Incremental Social Costs (AISCs)) of options for filling any water resource gap. They will then submit in August 2003 their draft Water Resource Plans for review by Ofwat and the Environment Agency.

Stage 3

Stage 3 aims to provide extra analysis for a small proportion of schemes to help Ministers make decisions on them. Defra and WAG will select the schemes.

All schemes in Stage 3 will be subjected to a further scrutiny of the costs and effectiveness of the scheme put forward by the Water Company in their Draft Business Plan.

For the "essential and clear" and "essential when clarified" schemes, the Environment Agency and English Nature would provide further technical analysis of the risks of non-compliance with environmental standards.

For schemes where there are "choices to be made", the Environment Agency will further scrutinise the benefits and provide further information on them, including sensitivity analyses using ranges of estimates of benefits suggested by the Agency's current further review of the existing valuations (See Chapter 9).

Other Sectors

The Environment Agency is putting forward schemes where action is needed on water company assets. We aim to assess where action also needs to be taken for other sectors and pressures, to identify such other options and how they can be pursued . These considerations are factored into our assessment of the value of schemes for water industry assets, and their timing.

Figure 2.1: Tailored appraisals for different types of schemes in PR04

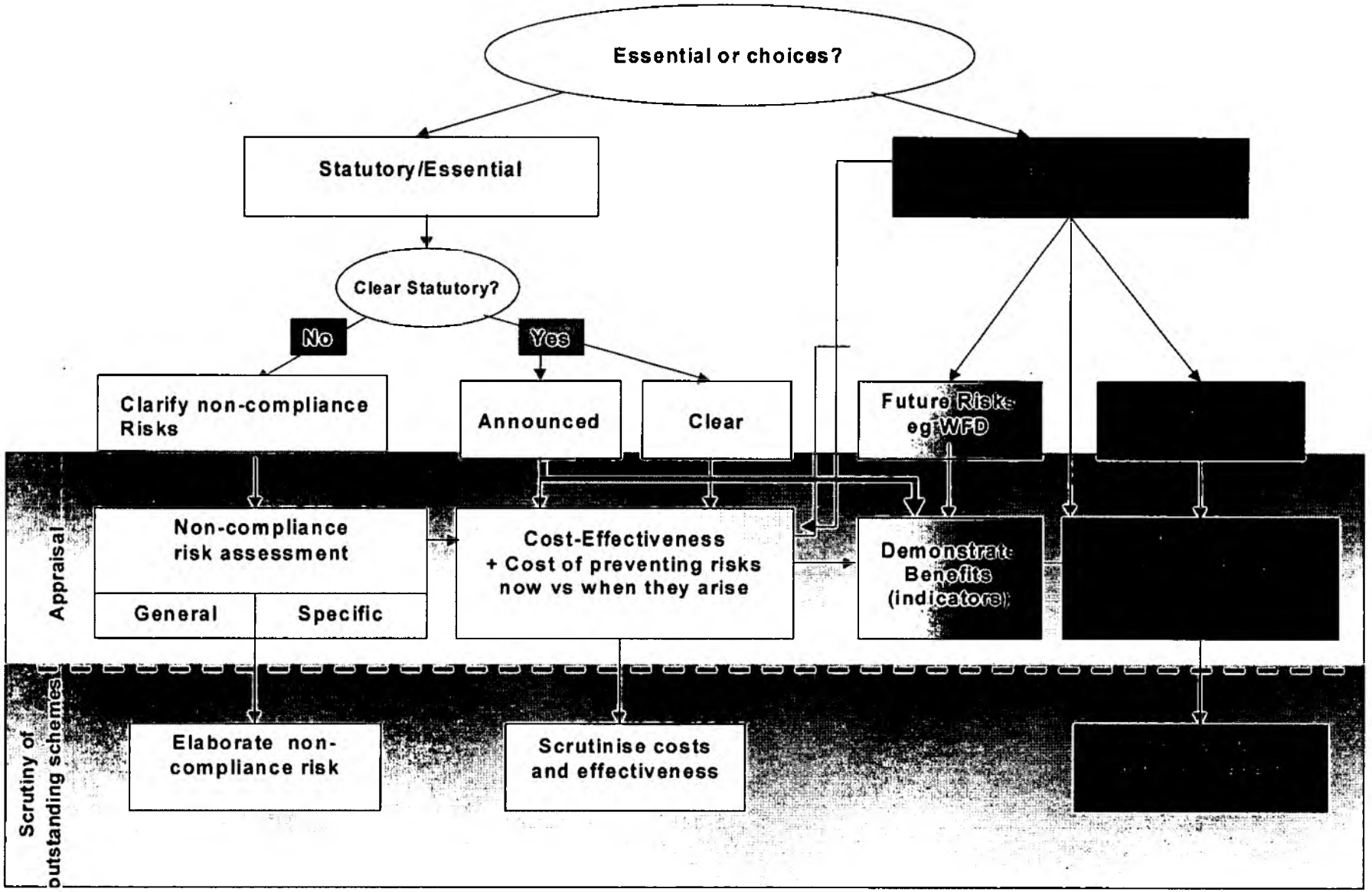

Table 2.1: Types of scheme by driver and appraisal techniques

			Economic appraisal Technique		
Obligation/ Issue addressed	**Ministers' category (Defra/WAG)**	**Drivers**	**Cost Effective (CE)**	**Risk of non-compliance**	**Benefits assessment**
Urban Waste Water Treatment Directive	Essential and clear / established requirements	U1,U2, U4, U5, UID1	X		
Thames Tideway	Choices will be made / subject to policy decisions		Full assessment of BATNEEC and benefits assessment of options that go beyond 1993 guidance of BATNEEC to inform option selection		
Sludge	Cost of sludge treatment is set against benefits		Not Applicable		
Groundwater	Essential and clear / established requirements	G1, G2, G3	X	X	
	Choices will be made / subject to policy decisions	G5, G6, WFG3, WFG5	X		X
Dangerous Substances	Choices will be made / subject to policy decisions	D2	X		X
Freshwater Fish	Essential and clear / established requirements	F1a	X	X	
Freshwater Fish	Essential when clarified / expected requirements	F1b	X	X	
	Choices will be made / subject to policy decisions	F2, F3	X	X	X
Bathing Waters	Essential and clear / established requirements	B1a, B2, B3, B6 (part – 'I' failures)	X	X	
Bathing Waters	Essential when clarified / expected requirements	B1b	X	X	
River Quality Objectives	Choices will be made / subject to policy decisions	R1, R2, R4	X	X	X
Shellfish Waters	Essential and clear / established requirements	S1	X	X	
	Essential when clarified / expected requirements	S1b, S3 (part)	X	X	
	Choices will be made / subject to policy decisions	S2, S7 S8, S9	X	X	X
Surface Water Abstraction	No Schemes				
Nature Conservation and Biodiversity	Essential and clear / established requirements	H1 - H8, Hw1 - Hw3, I1 - I5, Iw1 – Iw2 (levels of certainty 1 - 3) H8, Hw3, I5, Iw2 (levels of certainty 4 & 5 -investigations)	X	X	
	Essential when clarified / expected requirements	H1 to H7, Hw1 to Hw2, I1 to I4 (levels of certainty 4 & 5)	X	X	
	Choices will be made / subject to policy decisions	BAP1, BAP2, BAPw1	X	X	X
Local Priority	Choices will be made / subject to policy decisions	L1, L2, Lw1, Lw2	X	X	X

BRIEF DRIVER EXPLANATIONS

D2	(Dangerous substances) relates to an EQS failure and schemes to move from RE5 to RE2/3 (depending on limiting factors), improving ecological systems and enabling fish populations to become sustainable
G5	Groundwater abstraction that affects water quality in the environment where replacement sources may be required to restore such quality
R1	Achieve the required reliability of compliance with the 1997 RQOs
R2	Forestall future risk of failure to meet the 1997 RQOs
R4	Any requirement to upgrade RE5 objectives to RE4 and achieve them (perhaps as preparation for the WFD)
F2	Schemes to correct reported marginal failures with Imperative Standards for existing and newly designated reaches under the EU Freshwater Fish Directive
F3	Schemes to correct a risk of future failure with Imperative Standards not covered by AMP3, under the EU Freshwater Fish Directive
BAP1	Changes to consents agreed by the conservation agencies and the Agency beyond the requirements of H, I, U, R, and F required to meet a target under the United Kingdom's Biodiversity Action Plan
*BAPw1	Action agreed by the conservation agencies and the Agency beyond the requirements of Hw and Iw required to meet a target under the United Kingdom's Biodiversity Action Plan. Schemes under this driver are likely to be very site-specific and therefore difficult to derive general values for.
L1	Schemes not covered by any other drivers including those resulting from the Agency's Eutrophication Strategy not covered by U, H, I, S, BAP or OSPAR. Will contain a wide mix of schemes, including meeting RQOs for short stretches, reduced eutrophication, and so on.
*Lw1	Existing abstractions where the Agency agrees with water companies that as a result of investigations there is a requirement to revoke or vary and abstraction licence having an unacceptable impact on the local environment.
B4	Schemes to achieve a proposed target of 85 per cent of bathing waters achieving compliance with Guideline Standards in the EU Directive on Bathing waters.

* Water resources driver

Chapter 3

Initial Assessment of the Environmental Benefits of PR04

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1. Introduction and Approach

1.1 Objectives

This paper describes the approach and methodology used by the Environment Agency to estimate in qualitative and quantitative terms the value of the environmental benefits which should be achieved with the environmental programme of the 4th Periodic Review (PR04) of the water companies. The overall objective is to provide en economic justification for the programme.

The approach is as follows. Firstly, we looked at the total costs of damage in the water sector from abstraction and discharges in England and Wales. We have then assessed the proportion of these damages attributable to the water companies, and finally estimated how these damages would be reduced – what the benefits would be – from the PR04 environmental programme. As far as possible, we have estimated the costs of damages and the value of the benefits in monetary terms.

1.2 Impact of PR04 and benefits

The benefits from PRO4 will arise from investments made in response to a number of drivers, some statutory, some discretionary. This exercise looks at the total benefits from both statutory and non-statutory estimates. In undertaking analysis of the overall benefits, the Agency has assessed the environmental impacts in terms of river quality change, or areas of wetlands protected (Annex A). These changes can be expressed in terms of environmental impacts which have a cost/benefit associated with them. The environmental drivers focus on the following issues:

- Eutrophication
- Poor river quality (RE)
- Contaminated bathing waters
- Low flows in rivers, and
- Damage to biodiversity, key natural habitats and SSSIs.

Each of these is associated with potential benefits under PR04, and the type of benefits for each environmental issue are illustrated in Table 3.1, noting a distinction between those associated with water quality and water resources. The matrix structure both clarifies the links between actions taken in response to drivers and the consequent environmental impacts and minimises the risks of double counting.

Table 3.1: Environmental Impacts and benefits

Driver	Impacts on operating costs, remediation reduced, commercial benefits	Regeneration and amenity	Leisure and recreation (including recreational fishing)	Direct human health	Ecological losses avoided/ reversed
Water Quality					
Eutrophication	X	X	X		X
Poor water quality		X	X		X
CSOs	X	X			X
Bathing water quality		X	X	X	X
Habitats etc			X		X
Water Resources					
Low Flows		X	X		X
Habitats etc			X		X

In addition to the benefits listed here, there will be benefits to future generations from improvements in the water quality environment. The paper also does not quantify other environmental damage such as CSOs (problems of aesthetic pollution) or impacts on shellfisheries since we did not have to hand adequate data.

The matrix emphasises that all the environmental impacts have a direct consequence for ecosystems and habitats, which will form the basic focus of objectives aimed at improving water status under the WFD. Note that we have not considered changes in operating costs or reduced remediation costs in this paper.

The approach to benefit estimation is:

- Firstly to estimate the total cost of environmental damage due to discharges and abstractions of water. This covers, as far as possible, all damages, regardless of whether they arise from water company actions.
- Secondly, the contribution to these by the water companies (either by abstraction of surface water, or by discharge of pollutants) is estimated, using Environment Agency data and estimates (e.g. on discharges, reasons for RQO failures) and expert judgements.
- Finally, for each of the main environmental problems discussed here we have prepared preliminary estimates of the impacts and benefits of PR04 – largely in terms of reductions in these damage costs (i.e. avoided damages).

This is the same methodology that the Agency applied in its recent study of environmental damage costs of agriculture and the potential benefits of environmental protection measures concerning agriculture[3]. But the analysis in this paper on the water industry is more refined and thorough than the earlier assessment for agriculture.

It should also be noted that there might be net additional environmental costs associated with PR04 through energy use for treatment plants. These costs have not been calculated.

[3] Environment Agency (2002) Agriculture and Natural Resources: Benefits. Costs and Potential Solutions.

The environmental benefits are presented in a linked way in terms of qualitative descriptions, quantitative measures of the scale of the benefits and any readily available monetary valuations. This highlights not only the monetary estimates but also the quantitative and qualitative assessment, which can be important in understanding the monetary estimates and can enable adequate consideration of those impacts for which robust monetary valuations are not currently available. The analysis draws on recent studies and reports on the damage costs and benefits associated with water in the UK as well as Agency data and expert opinion.

2. Methodological concerns

2.1 Baseline

Our analysis has tried to follow customary procedures in economics of being based on a baseline of the business as usual (BAU) situation in the absence of the policy in question – i.e. in the absence of PR04[4]. However, it has not been possible to set out empirically such a BAU scenario since this requires completion of the analyses needed for River Basin Characterisation under the WFD. Therefore we have based the analysis upon changes from the current situation (which is set out, in terms of water quality values in Table 3.2, section 3). The incremental changes in water quality shown in Annex A take account of the impact of AMP3, and reflect changes after the effects of AMP3 are in place. Furthermore, we allow for the rising pressures in the BAU scenario by also estimating the benefits in terms of the extent to which the PR04 drivers could prevent deterioration in water quality that could otherwise occur due to these pressures in the BAU scenario. These benefits are assumed to arise from year 7 onwards and are discounted back accordingly.

2.2 Measuring benefits

The correct concepts for valuing damage[5] are:

- Willingness to pay to secure a benefit (gain in water quality/volume) (WTPsb)
- Willingness to pay to avoid a deterioration (WTPad),
- Willingness to accept compensation to tolerate a deterioration (WTAtc), and
- Willingness to accept compensation to forego a benefit (WTAfb).

WTA estimates of damages or benefits significantly exceed WTP estimates. A recent study reviewed 45 separate studies reporting WTP and WTA estimates and found that the WTA estimates were 7 times greater than the WTP estimates. They are 3 times greater for ordinary private goods, but up to 10 times greater for public or non-market goods, which form most of the benefits related to PR04[6].

2.2.1 Importance of Prevailing Property Rights in a Clean Environment

Whether WTP or WTA is the appropriate concept to use for valuing damage costs and benefits depends essentially on the prevailing property rights regarding a clean environment. Broadly speaking, WTP by the public is relevant when the property rights to water quality

[4] See for example, the EC's WATECO guidance on the WFD. EC (2002), Economics and the Environment, The implementation challenge of the Water Framework Directive. A guidance Document. European Commission.

[5] D. Pearce - discussion 3/9/02

[6] See Horowitz and McConnell (2000). *A Review of WTA/WTP Studies*. Department of Agricultural and Resource Economics, University of Maryland, mimeo.

(and quantity) rest with the potential polluters, and WTA is relevant when the public has property rights for a clean environment[7].

As a starting point, there is a strong case that the public should have the property rights in a clean environment and clean rivers and can swim at beaches that are not polluted. This is certainly the case concerning compensation for environmental damage costs caused for example by a change or a proposed development. Most of the environmental benefits from PR04 relate to reductions in the environmental damages caused by water companies (see section 2). The case for property rights in a clean environment is particularly strong in respect of existing agreed statutory requirements – as in the statutory drivers for PR04. The WFD will also set the benchmark of achieving good status, which could be construed as assigning rights of achieving this level of environmental protection. Thus we use RE2 water quality level – a surrogate for good status – as our reference point for estimating the damage costs on existing poor water quality in respect of informal recreation benefits. At least the public should be compensated for any damages that the polluters do to water bodies and beaches. This then is one of the rationales for the need to charge polluters for any such damages they cause. Consequently there is a strong case for using the WTA measures, which would be considerably higher than the WTP estimates reported here – as noted above.

However, in this paper, we have followed the conventional practice[8] of using WTP measures because it tends to be lower. In addition, it fits the context of the forthcoming discussions for PR04 in terms of the extent to which individuals would be willing to pay for the environmental improvements in PR04 in terms of changes in water prices. Finally, the valuations we are able to use for estimating benefits of PR04 are based on researches estimating WTP values rather than WTA, so there is a practical reason too for using WTP. But overall, this implies that there will be a consistent conservative bias in the estimates of benefits presented.

2.3 Use and non use values

The values of the environmental quality includes both the value that people derive from (or lose) from use of the environmental resource in question (e.g. for recreation, angling or enhanced property values). In addition, there are important values attributable to the existence of the resource (e.g. natural habitats, ecosystems, fish etc), regardless of whether it is actually used by people – a non-use value. Non-use values may include a value attributed to the simple existence of the resource or attribute, or an altruistic wish to benefit the next generation. In this paper we have tried to bring non-use values for water resources into our estimates of the benefits from PR04. The drivers for environmental improvement are associated with specific changes in river quality or flow, and in many cases benefits can be measured in terms of recreational activities or improved angling, but there are also drivers such as the Habitats Directive where the benefits are less directly linked to activities and cannot be measured solely in terms of changes in for example use benefits from changes in RE level.

We have taken the view that, broadly speaking, non-use values held for water resources are associated with conservation or changes in habitats, biodiversity, or preservation of SSSIs, and have used non-use values in order to estimate the value of the benefits from PR04 in terms of conservation and biodiversity improvements. Section 2.9 discusses in detail the key

[7] The term 'public' can be construed here as all water users other than polluters.
[8] For example, the recommendations of the NOAA Panel in the USA.

issues and problems here, with reference to specific studies and research. However, it does allow us to present a defensible benefit highlighting this very important area.

2.4 The discount rate and life times

The monetised annual benefits are converted into a capitalised NPV using an assumed life of 25 years and a discount rate of 6%. However the Treasury's new Green Book recommends a discount rate of 3.5%[9]. Therefore we report the benefits for both these discount rates. The lower discount rate of 3.5% increases the capitalised value of the benefits by about a quarter.

Moreover, public valuation of environmental benefits rises over time as incomes rise and concern for the environment increases and also as the remaining stock of environmental assets dwindles with growing pressures. This effect is likely to be particularly pronounced for the sorts of environmental benefits associated with PR04 – most notably the important natural habitat and ecological benefits. The recent available research estimates the income elasticity of WTP for the environment to be about 0.3-0.4[10]. So if income grows at 2% pa then the values for the environmental benefits will rise (in real terms) at 0.6-0.8% p.a. We have not allowed for such rises in each of our estimates in this paper. But in effect they mean that the effective 'net' discount rate is 2.8% - i.e. 3.5% minus 0.7% (midpoint of 0.6 – 0.8% range). This overall finding is supported by recent valuations of the use and non-use environmental benefits of low flow alleviation (such as the Mimram study). However, for this study we have conservatively not allowed for such increasing valuations and still used the discount rates of 6% and 3.5%, as noted above.

We have discounted the benefits over 25 years – as was used in DEFRA valuation study on bathing waters. However, the WRC report on the WFD assumed a 42-year life. OFWAT assume, for current cost depreciation (CCD) purposes, an average asset life of 27 years for maintenance expenditure and 43 years for enhancement expenditure. In future analyses it may be appropriate to conduct sensitivity analysis for a longer period of say 40 years.

2.5 Data needs and benefit transfer

2.5.1 Available Data

We have not been able to carry out original research for this study, but have analysed existing secondary source data. Therefore the actual values we are able to use in this exercise are limited by the data and research available and the clarity and manner in which their findings and supporting methodologies are reported. These available data do not always fit neatly our methodology of estimating benefits of PR04. In the paper, we have therefore set out explicitly the broad assumptions we have had to make to convert the available data into a format that is as close and appropriate to our methodology. We also point out whether our resulting estimates are accordingly lower or higher than the theoretically correct measure.

There are a number of studies containing usable material, and they are referenced in the text and where appropriate we discuss this material in the light of our own estimates. Apart from some methodological studies[11], the only study which has a scope comparable to the present one in trying to estimate costs and benefits across all categories of impacts in the UK is WRC (1998) 'Potential Costs and Benefits of implementing the proposed Water Resources

[9] HM Treasury (2002) Appraisal and Evaluation in Central Government: Treasury Guidance (The Green Book).
[10] Personal communication Professor David Pearce. 31 August 2002.
[11] RPA (1998) The environmental costs and benefits of water resources - A preliminary methodology

Framework Directive (WFD)'. This study addressed many of the issues, which we are dealing with, and produced broad estimates of the total benefits that would accrue from the environmental improvements required by the WFD. Where our estimates cover similar ground, we note this in the text, explaining any differences in our findings.

One of the consequences of using limited secondary data is that we have had to treat the damage costs, and benefits foregone in terms of potentially avoided damage costs, as being equivalent. Thus, if there is a valuation based on willingness to pay for the recreation and fishing benefits to achieve or restore current water quality to a good status (RE2), then we have regarded this value as the damage cost ('benefit foregone') with current water quality in the absence of improvement.

Overall the need to use secondary material is subject to counteracting shortcomings, which we highlight where relevant in the text. On the one hand, extrapolating WTP benefit valuations for fishing and recreation for marginal improvements to achieving good quality in all rivers may overestimate the benefits since there may be limits to the extent to which such increasing recreation opportunities could in fact arise at all rivers and in how much people are willing to pay for them. However, on the other hand, a major change might lead to a significant shift in demand for fishing and recreation associated with water.

Moreover, one of the goals of PR04 will be to reduce past pollution damage and prevent water quality from deteriorating. Research shows that people are prepared to pay more to keep an existing asset (or to WTA in compensation for environmental damages) than their WTP for improvements (see above discussion of WTA and WTP).

Another consideration is the fact that WTP values may change over time and it is likely that values associated with environmental changes are positively income elastic – so this again might mean that some of our valuations are lower than a correct figure.

The net effect of these counteracting limitations is not clear. But we believe that our approach is appropriate and fit for the purposes of the present exercise aimed at giving approximate and broadly credible estimates to help inform discussions regarding PR04 and inform the next phases of the economic appraisal work on PR04. If anything, our estimates err on the conservative side.

Double counting and omission of benefits

We have endeavoured rigorously to avoid double counting or omission of key benefits categories. Table 3.1 showed our basic structure for specifying the various benefits categories for water quality and water resource schemes in a way that is designed to avoid double counting. However, relying as we do on secondary source data, we find that there are often overlaps and gaps between the various available studies and sources which cover different categories of damage. Therefore in analysing and discussing each impact category, we spell out explicitly how we have treated the estimates in each study so as to avoid double counting as far as possible in deriving aggregate estimates. Thus for example, we have only used the portion of the estimates in the eutrophication study that relates to lakes so that this can be added to the estimates in the subsequent sections, which relate to rivers. In discussing impacts of low flows, we have only used estimates of use benefits and do not include the estimates for non-use benefits since we treat such non-use impacts in a separate category of impacts on natural habitats. Almost inevitably, given the constraints surrounding the

available studies, some omissions and some double counting may remain. But we believe that they are unlikely to have any major net effect on our overall findings and estimates.

Benefit Transfer

This paper is based on the transfer of values from the available studies and valuations and therefore is subject to the normal limitations of benefit transfer (BT). We have also had to transfer values from individual studies rather than valuation functions. Moreover, in this paper, we are applying the benefits valuation from specific studies to derive aggregate valuations. It is important to recognise the limitations of this monetisation exercise. These available valuations are dated and have significant gaps – especially in respect of the most important non-use benefits in respect of, for example, natural habitats. We have also been unable to attach monetary values to the implications of improved water quality for local economic development, urban regeneration and other economic activity (e.g. tourism) at this stage, although at regional level this might be possible. Further, a key benefit of PR04 will be to safeguard future water quality of a high standard for present and future generations, and this is also difficult to quantify although it may be captured in 'non-use values'. We have had to make a number of working assumptions for this, which we highlight in the text.

3. Estimating the Environmental benefits of PR04

3.1 The baseline - current water quality

Current water quality is associated with losses in recreational values, both in stream and out of stream; damage to fisheries and losses in property values. Conversely, improved quality in surface waters enhances recreational values and can support economic regeneration and development particularly in urban areas. .

Table 3.2 shows the current status of river quality by lengths of river in England and Wales.

Table 3.2 Current River quality in England and Wales (2002)

River quality	*Length of river (km)*	% of total
Ungraded	138	0.3%
RE1	12,522	31.0%
RE2	14,229	35.2%
RE3	7,257	18.0%
RE4	3,300	8.2%
RE5	2,794	6.9%
Worse	141	0.4%
TOTAL	40,240	
Source: Environment Agency face values, all determinands 2002		

As noted above, we have estimated the cost of current damages to environmental quality based on existing studies, using benefit transfer techniques; and then assessed the impact of PRO4 in reducing damages.

3.2 Overall costs of environmental damages

In the preceding sections we have developed estimates of the current costs of environmental damage in the water sector, across a number of impact types and of relevance to the PR04 drivers. We have then estimated the proportion of these costs that are attributable to water companies, and the benefits that would accrue from PR04. In this section we bring together our findings and assess the uncertainties surrounding them, and draw out the implications for

the overall benefits assessment and for future work in the PR04 process. Tables 3.3 and 3.4 put together the estimates. The monetary value of current environmental damages (or potential benefits foregone) affecting the use of water bodies waters is estimated at between £393 – 432mn per year. These 'use' values include impacts on eutrophication and recreation and angling associated with current water quality and flows and illness from bathing at contaminated bathing Table 3.3 shows that the greatest of these quantified impacts are for angling and bathing illness. The main issues and characteristics of the principal impacts are presented briefly below.

3.2.1 Findings - eutrophication

The total environmental damage costs attributable to eutrophication are estimated at between £42 to 67mn per year[12]. Of this, 80% relates to lakes and reservoirs, and the balance to rivers and canals. The Agency estimates that the contribution by the water companies is about 50% (£21 – 34mn pa). PRO4 will have the effect of reducing the risk of eutrophication in 16% of eutrophic rivers, and 8% of eutrophic lakes (the non-company part, due to diffuse pollution, will not be controlled through PRO4). The value of the benefits from PRO4 in lakes and reservoirs is very small, at between £200,000 – 300,000 per year. (The benefits of reduced eutrophication in rivers and canals are assumed to be captured under the estimates of benefits in terms of informal recreation, see below).

3.2.2 Findings – informal recreation

The total damage cost in terms of informal recreation is estimated at between £30 - £43mn per year[13]. The benefits of improved river quality can be estimated at about £5,750 per kilometre for improvements from RE4 and below to RE2), £4,800 for improvements to RE3, and just under £1,000 per kilometre for improvements from RE3 to RE2. Thus the greatest incremental value is in improvements from worse quality.

Broadly speaking, it is estimated that the water companies account for between 30-60% of the environmental damage. Overall, the impact of PRO4 will be to improve the quality of some 4,000km of rivers, and a further 1,600km will be prevented from deteriorating. On the basis of the expected RE changes, the benefits from PRO4 are expected to be about £12mn per year, rising up to £16mn (as risk of deterioration is reduced.

3.3.3 Findings – fishing and fisheries

Use values for angling have been estimated per kilometre of river, ranging from about £6,650 per kilometre per year for sustainable coarse fishery to around £25,000 per km per year for salmonid fisheries of the highest quality (RE1). The current damage – benefits foregone – is estimated at about £200mn per year[14]. The Agency estimates that water companies contribute about 40% of the current failures to comply with the Freshwater Fish Directive, and the PRO4 measures would improve about 2,360km of river (19% of those currently below RE3) and prevent a further 25,445km from deterioration.

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[12] Derived from estimates in JN Pretty et al (2001) *A preliminary assessment of the environmental damage costs of eutrophication of fresh waters in England and Wales*, report prepared for the Environment Agency.

[13] Based on WRC and Oxera (1998) *Potential costs and benefits of implementing the proposed Water Framework Directive* , for DETR

[14] The estimates are based on RPA (1998) *The environmental costs and benefits of water resources*, and supported by Spurgeon et al (2001) *Economic evaluation of inland fisheries – Module B, indirect Economic Values* and Radford et al (2001) *Economic evaluation of inland fisheries – Module A Economic evaluation of fishing rights.*

Based on these data, it is estimated that the measures to meet the Freshwater fishery directive under PRO4 could yield about £17mn per year by improving waters currently failing, and the prevention of future deterioration could add a further £21mn per year (assumed to become effective after year 7).

3.3.4 Findings – impacts on economic development

We have not been able to derive and include any monetary values for the benefits of water quality and water resources for economic development at this stage. There is in fact limited economic valuation data but the evidence of the significance of improved water quality for regeneration and economic development is compelling. It is true that inclusion of benefits of economic development and regeneration from improved water quality are only valid if these are net additional benefits for the country as a whole (i.e. the development is truly additional and does not displace development elsewhere). However, regional economic development and regeneration benefits of PR04 water improvements may well be valid and important in a priority regeneration area or region (e.g. assisted, regeneration budget or European structural fund areas) and where the Regional Development Agency considers such improvement a priority element in their Regional Economic Strategies. This is in line with the approach in DTLR's economic appraisal of road schemes and the Government's draft guidance on regeneration, neighbourhood renewal, or regional economic development (3R).

It should also be noted that there is a higher concentration of lower grade rivers in urban areas, suggesting a disproportionate benefit for such areas, and it is also noted that WRC (op cit) estimated the potential benefit from regeneration at £1-3.5bn, which is roughly equivalent to £110 – 274mn per year. Various studies have estimated a considerable premium on property values from proximity to good quality water[15]. Similarly, sorting out CSOs would have a real impact, as well as having impacts on ecosystems, but we have not been able to quantify these effects as yet.

3.3.5 Findings - bathing waters

The main benefits from improved quality bathing waters arise from health effects (direct and indirect), plus regeneration/tourism impacts. The value based on reducing risk of ill health is estimated at about £100mn pa. Contamination of beaches derives from water company discharges, urban run off, agriculture and birds. While the causes will be location specific, overall, the Agency considers that the water companies will contribute some 30-60%, or between £32 and 64 million. The PR04 drivers are focused on the existing Directive. However, they are also expected to deliver reductions in discharges from sewage treatment works, which will contribute towards achieving 85% compliance with the proposed Directive according to Environment Agency estimates. In monetary terms, this is somewhere between £27 and 55mn per year.

3.3.6 Findings – non use values

The estimation of non-use values has been somewhat problematic, as there are no tailored estimates for the value of current conservation damages. Monetary valuations are not currently available for the impacts on natural habitats, ecosystems and biodiversity (non-use

[15] Willis & Garrod (1993) *The value of waterside properties: estimating the impact of waterways and canals on property values*, ERM and Willis (1997) *Economic Appraisal of the Environmental Costs and Benefits of Potential Solutions to Alleviate Low Flows in Rivers* for Environment Agency, SW Region and ERM & Willis (1993) *An economic analysis of the benefits derived from the alleviation of low flows in the River Darent* for NRA Southern Region

values), which are of particular concern to people and key stakeholders. We derived values for these important impacts by reviewing a number of studies of both use and non-use values for rivers, which suggest that these ecosystem impacts (non use values) associated with rivers, are likely to be between 2 and 5 times the use values and give a conservative value for them of between £786 - £2,160mn per year.

It is our view that it is most important to provide some indication of the likely benefits from protecting and enhancing habitats and biodiversity, as these aspects are a fundamental component of the benefits of PR04. We have therefore derived a value for habitats and conservation through a cautious application of available numbers. There are two further caveats: firstly, use values may include a non use component, but this can be assumed to apply equally in all the studies above, and so the ratio approach still holds. Secondly, we are applying this ratio also to use benefits associated with bathing waters and coastal areas so that our estimates also encompass a non- use value for bathing waters for which there are no estimates in the literature, but which could be considered to be significant.

We are confident that this approach provides a plausible but conservative assessment of the PR04 benefits, but we recognise the crucial importance of these benefits.

3.3 Bringing it all together – the benefits of PRO4

Table 3.3 brings together a set of very broad-brush estimates of the current value of damage to the environment and the share attributable to the water companies. The cost of all these environmental damages/benefits foregone is then estimated to be between £1.2 – 2.6bn per year. Of this, overall, about 50% is estimated to be attributable to the water companies, equivalent to around £0.6 – 1.5bn per year. The table shows the value of the benefits of these effects for each of the categories for which damages costs are available. Capitalised over 25 years, the quantified benefits from PR04 are between £4.5 – 11 billion (using a 6% discount rate) and between £6 – 14.5 billion at a discount rate of 3.5%. At this stage 1 of the analysis, we are using a mid range estimate of £5 – 12 billion for the capitalised value of the environmental benefits of PR04. Some of the results of PR04 will be to yield additional benefits in terms of protecting water quality from deterioration in the future, which we assume will arise from year 7 onwards, so that the benefits increase over time.

Table 3.3: Environmental damage from water, and the contribution of the water companies

Environmental Impact and nature of damage	Value of damage	Share attributable to water companies
Habitats, SSSIs, biodiversity Potentially very high damage costs, benefits from protection, but no quantified values (see discussion in text)	Value much greater than all quantifiable damage costs (more than 2 times monetary values)	About 76% of discharges and abstractions) causing such damage are probably linked to company activities (see section 2.5)
Eutrophication in lakes and reservoirs	£42– 67 mn pa,	£21 – 34 mn pa (about half)
Water quality in rivers Includes impacts on: Informal recreation (Table 6) Angling (Section 2.4.1) Property values and economic activity, as well as habitats and SSSIs		Overall – between 30-60%
	Informal recreation £30 – 43 mn pa	30 – 60% £9-26 mn pa
	Fishing and fisheries £207 mn pa	£83 mn pa (40%)
	Economic development, regeneration and property values. Premium of about 10% on property values, strong regeneration role. Water Company contribution significant	
CSOs – Aesthetic pollution, but no estimation of value of damage of WTP for rectification. Need data on extent and significance of problem	About 1200 sites cause both aesthetic pollution and ecosystem damage.	All related to water company assets
Bathing and contaminated beaches Direct health impacts expressed as income losses and s WTP; also economic development/tourism impacts (not quantified)	£108 mn pa, plus impacts on local economy	Overall between 30-60% - depends strongly on different locations and economic activity £ 32 - 64 mn pa
Low Flows Use values only	£7.5 mn pa.	About £6 mn (76%)
Value of Quantified Impacts	>£393 - 432	>£150 - 212 mn pa
Conservative value of unquantified impacts on habitats, biodiversity	>£786 - 2160 mn pa	About 60% > £470 - 1295 mn pa
All quantified and derived impacts	>£1,180 to 2590 mn pa	> £ 620 – 1510 mn pa
NPV Capitalised value (over 25 years at 6%)	£15 to 33 billion plus impacts of CSOs and impacts on economic development	£ 8 - 19 billion plus impacts of CSOs and impacts on economic development
NPV Capitalised value (over 25 years at 3.5%)	£ 19 to 43 billion plus impacts of CSOs and impacts on economic development	£10 - 25 billion plus impacts of CSOs and impacts on economic development
Notes: prices in £(2000) unless otherwise specified		

Table 3.4 brings all the values together for the benefits of PRO4 and shows that these benefits are broadly estimated to be about £0.3 to £0.9 billion per year, which represents about 5 – 13% of the turnover of the water industry.

Table 3.4: Potential benefits from PR04 investment programme

		Extent PR04 will reduce problem	
Type of Benefit	**Benefits**	**Water cos damages**	**Total problem**
Reduced risk of eutrophication in lakes (see Table 4)	£0.2 to 0.3mn p.a.	10%	5-6%
Informal recreation benefits of improved river quality (Table 7)	£12mn rising to £16mn p.a. from year 7 onwards	>60%	25%
Better angling from Compliance with Freshwater Fish Directive (Table 11)	£17mn rising to £38mn p.a. from year 7 onwards	50%	20%
Regeneration and regional economic development	Not possible to estimate value at this stage		
Reduction in intermittent spills of storm sewage (Combined Sewer Overflows (CSOs))	Most CSOs dealt with. Not possible to quantify and value these benefits	Most	Most
Compliance with proposed EC Bathing Waters Directive (Less illness after bathing) (Section 2.4)	£27 to 55mn p.a.	85%	25 – 50%
Protection of natural Habitats, SSSIs, ecosystems and Biodiversity (Table 19)	£280 to 780mn pa	Not clear – assumed around 60%	About one third
Low flow alleviation	Not estimated (small)		
Quantified benefits (£mn pa)	£336 to 860mn p.a. rising to £365 to 890mn p.a. from year 7 onwards		
Capitalised value (at 6% over 25 years)	£4.5bn to £11bn		
Capitalised value (at 3.5% over 25 years)	£6bn to £14.5bn		

This is equivalent to a net present value of £4.5 to £11 billion capitalised over 25 years with a discount rate of 6 per cent and £6 – 14.5 billion capitalised at a discount rate of 3.5%. At this stage 1 of the analysis, we are using a mid range estimate of £5 – 12bn for the capitalised value of the environmental benefits of PR04. This estimate takes into account the substantial achievements under AMP3, which has significantly improved the quality of rivers and coastal areas, and has ensured that legal obligations have been met for many Directives.

3.4 Issues and Outstanding Research Needs

That there are a number of difficulties in deriving these estimations has been made clear throughout the discussion, and a combination of risks of omissions, double counting, and inconsistent source data mean that the estimates should be regarded as indicative at this stage.

In general, we have used willingness to pay figures where they are available, which means that the values elicited are lower than if willingness to accept compensation values were available. This means that the values used tend to be conservative. On the other hand, when estimating non-use values, we have used a factor relative to use values, and it should be noted that the use values might include a non-use component. We consider that we have adequately accounted for this by using conservative 2 and 5 factors to derive non-use benefits estimates,

since the available surveys indicate that, on aggregate, non use values exceed use values by many times or more.

To date, we have been unable to develop values for amenity improvements, for aesthetic changes deriving from CSOs, or for the economic regeneration effects associated with improved water quality or flows. These omitted benefits are likely to be substantial.

In respect of valuing specific benefits, there are a number of counterbalancing factors. For example, our angling benefits may be underestimates since they reflect only the consequences of the Fisheries Directive, and other drivers may have an impact on fish. On the other hand, there may be limits to the extent to which such increasing recreation and fishing opportunities could in fact be realised at all rivers with improved water quality and flows. There may also be limits in how much people are willing to pay for them. Some improved stretches may not be readily accessible, so benefits may not apply, although fish (and fishermen) in adjacent reaches will still benefit. Nevertheless, on the other hand, a major change in water quality and flows might lead to a significant shift in demand for fishing and recreation associated with water. On balance we consider that our benefits estimates are realistic and represent well the implications of PR04.

One of the areas where new research is needed is to improve estimates of the beneficiaries for the non-use benefits (e.g. ecosystem benefits), and allowing for the way in which individuals' values change with increasing distance from relevant environmental sites.

This report is a starting point for considering benefits from PR04 at a high level. We consider that the benefits estimates presented in this paper are plausible, defensible and if anything tend to the conservative. It is clear that the costs of environmental damage and the potential benefits from PR04 are substantial, and this evidence presented here provides a strong starting point to the development of more detailed assessment in the coming months.

Annex A: Potential outcomes of the new environment programme

Improved rivers and Bathing Waters	Km	Km^2	No
River with reduced risk of eutrophication	1900		
Lakes with reduced risk of eutrophication		5	
Estuaries/coastal waters with reduced risk of eutrophication		100	
River currently significantly failing Freshwater Fish Directive	1800		
River currently marginally failing Freshwater Fish Directive	580		
River prevented from deteriorating to fail Freshwater Fish Directive	2400		
River currently failing River Quality Objectives	1000		
River prevented from deteriorating and failing River Quality Objectives	1600		
River upgraded to the RQO of RE4 (moderate coarse fishery)	120		
River improved to meet local water quality needs	1600		
River improved to meet local water resources needs	1200		
Bathing Waters improved currently failing or at significant risk of failing Imperative standards			30
Bathing Waters improved currently failing or at significant risk of failing Guideline standards			60
Shellfish Waters improved currently failing or at significant risk of failing Class B of the Shellfish Hygiene Directive			35
Improved conservation and habitats	Km	Km^2	No
River improved towards International requirements by water quality schemes	940		
River improved to national requirements by water quality schemes	550		
River improved for the Biodiversity Action Plan by water quality schemes	470		
River moved towards international requirements by water resource schemes	530		
River improved to national requirements by water resource schemes	170		
River improved for Biodiversity Action Plan by water resource schemes	370		
Wetlands	Km	Km^2	No
Number of wetlands of international status improved or protected			73
Number of wetlands of national status improved or Protected			79
Number of watercourses/wetlands of BAP status improved			63
Number of wetlands improved for Local Needs			7
Total outcomes	Km	Km^2	No
River improved	6500		
River prevented from deteriorating	3300		
River considered by the Agency as brought into compliance with the Water Framework Directive	3700		
Still and coastal waters improved or prevented from deteriorating		7500	
Number of wetlands improved			110

Chapter 4

Benefit Assessment Guidance For Water Resource and Water Quality Planners: Summary and Example

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1. Introduction

In order to assist the water management planning processes and to meet statutory requirements, the National Rivers Authority and its successor the Environment Agency funded the development of benefits transfer-based methodologies for placing monetary values on the environmental benefits/costs arising from water quality improvement, low flow alleviation and water resource schemes. This work gained in importance with the formation of the Environment Agency given the duty placed on the Agency to consider the costs and benefits of those decisions that were at the discretion of the Agency.

To date, assessing the benefits of water quality improvements and of water resource management issues has been based on the use of separate methodologies. Although, the methodologies may appear to vary considerably, in reality there are many common aspects to them. This includes the sharing of particular benefit transfer values (e.g. for angling) and the sharing of underlying assumptions concerning participation rates. The methodologies, however, were always intended to be 'living' in the sense that they would be up-dated as new studies became available and assessment practices improved and changed.

2. Aims of the Guidance

The assessment guidelines developed for AMP3 are now out of date, with regard to the recommended methodologies, transfer values used within them and some of the assumptions and approaches adopted. In particular, the use of a multi-criteria analysis based approach is not considered appropriate within the context of the Periodic Review. Given the importance that having sound assessments of environmental and social costs and benefits can play in gaining discretionary expenditure as part of the Periodic Review, however, it is important that the cost-benefit analysis based methodologies are revised so as to improve their reliability (and validity).

As a result, the Environment Agency has commissioned the development of a revised comprehensive methodology and associated guidance for assessing the environmental and social costs and benefits of water resource and water quality management schemes. More specifically, the Guidance:

- has been developed for use by both Agency planners and water company planners to ensure consistency across the different decision-making contexts within the Periodic Review;

- builds on existing methodologies and expands or revises these as appropriate;
- provides a means of evaluating the environmental and social costs and benefits of schemes proposed under the Periodic Review in a manner that can be applied at a desk-top level;
- is based on cost-benefit analysis, where as many of the impacts (positive as well as negative) as possible are measured in monetary terms;
- requires the non-monetary assessment of benefits/disbenefits using qualitative and quantitative descriptions.

Because the number of schemes that will need to be assessed is likely to be several hundred, the resource implications for both the Agency and water companies restricts the amount of time that can be spent on average in assessing schemes. As a result, the Guidance relies on the use of standardised assessment approaches and utilises data that are readily available.

Although every effort has been made to provide the most robust set of guidance possible within the circumstances, it is important that the limitations of the approaches set out in the Guidance are understood. In particular, monetary valuation relies on the use of benefit transfer techniques, which borrow values from previous studies and apply them to current decisions. Furthermore, average or typical estimates of those who would gain from a particular type of benefit may need to be relied upon in the absence of site specific data.

These factors combined mean that the results of any assessment can be assumed to provide only rough indicators of the benefits or disbenefits that will be delivered by any single scheme. This does not mean that there is little point in applying this guidance, only that the uncertainty surrounding the results should be acknowledged.

3. The Approach

The Guidance has been developed with reference to the existing methodologies, progress made since their development in assessment practice and other new data sources. In particular, it relies in part on a literature review prepared by Eftec for the Environment Agency to support these guidelines. This has included the development of a database of valuations, with summary tables of the studies included in this database provided as an Annex to the main document.

Care has been taken to compile the Guidance in a clear and approachable manner. It has been specifically written for water quality and water resource planners who may have little or no experience of economic analysis. Default data and worked examples are provided to support the text and to guide the user through each calculation on a step-by-step basis. Reference lists are provided at the end of each Part for those who require further explanation, greater detail or have a particular interest in the subject area.

The Guidance has been subject to a peer review and testing process. Peer reviewers have included the relevant policy stakeholders (the Agency, DEFRA, Ofwat, English Nature), academics and a water company economist.

It is also being tested by Agency staff through application to three trial resources and proposed schemes (linked to different drivers). These include a fisheries driven scheme on a river, a water resources scheme, and a coastal scheme. Although the testing is on-going, it has highlighted areas where the Guidance required further clarification. It has also demonstrated,

however, that Agency staff are able to apply the step-by-step approach once they have had some (limited) training.

4. Organisation of the Guidance

As indicated by Table 4.1, the Guidance has been divided into a number of Parts to make it easier for users to identify which areas are applicable to a particular scheme. The aim has been to create each Part so that it can act as a stand-alone document.

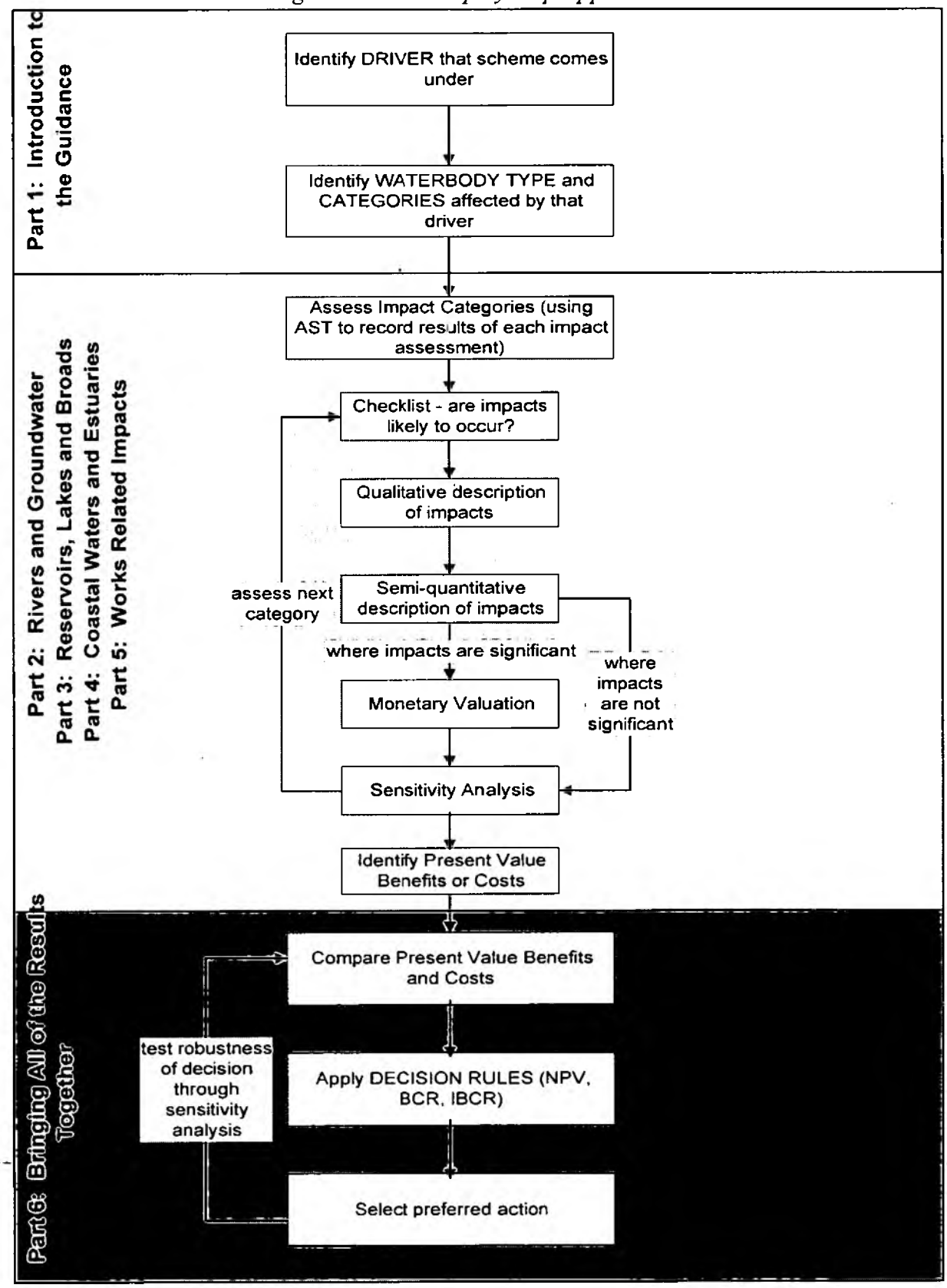
Table 4.1: Overview of Guidance Materials

Part	Issues/Benefit Categories Covered
Part 1: Introduction to the Guidance	• Introduction to Cost Benefit Analysis • Analytical Issues • Applying the Guidance
Part 2: Rivers and Groundwater	• Benefit Assessment Methodology • Informal Recreation • Angling • Commercial Fisheries • In-Stream Recreation • Amenity, Property Prices and Regeneration • Abstractions • Heritage, Archaeology and Landscape • Biodiversity and Non-Use Values • Bringing the Results Together
Part 3: Reservoirs, Lakes and Broads	• Benefit Assessment Methodology • Recreation • Heritage, Archaeology and Landscape • Amenity, Property Prices and Regeneration • Land Take (including recreation) • Biodiversity and Non-Use Values • Bringing the Results Together
Part 4: Coastal Waters and Estuaries	• Benefit Assessment Methodology • Informal Recreation • Coastal Bathing • Water Sports • Recreational Fishing • Shellfisheries • Biodiversity and Non-Use Values • Bringing the Results Together
Part 5: Works Related Impacts	• Benefit Assessment Methodology • Land Take • Landscape Impacts • Property Based Disamenity Effects • Traffic Related Impacts • Energy and Global Warming Potential • Bringing the Results Together
Part 6: Bringing All of the Results Together	• Calculating Present Value Benefits • The Decision Rules • Sensitivity Analysis

The approach that has been adopted is a progressive one, and Figure 4.1 shows how these different Parts combine to provide the different stages involved in the assessment of a scheme

and the step-by-step approach that is provided in this Guidance. The Steps are discussed in more detail below.

Figure 4.1: The Step by Step Approach



Step 1: Identification of Drivers

It is expected that schemes will be defined so as to meet desired water quality or water resource objectives. Therefore, the first step is to determine what drivers a scheme may deliver. Schemes promoted by the Agency may be listed under a single driver or may relate to the achievement of a series of drivers. The Guidance stresses the need to ensure that double counting of benefits does not take place, highlighting that benefits/dis-benefits stem from the change in environmental quality and not from individual drivers. For example, the informal recreation benefits produced by a scheme should be assessed in relation the change in environmental quality as a whole and not repeatedly for each driver delivered by the scheme; the latter would result in double counting.

Step 2: Identification of Water Body Type and Benefit Categories

Tables are provided in the Guidance that make a link between the drivers and the different benefit categories listed in Table 4.1. These enable users to identify which benefit categories may need to be assessed given the drivers that will be delivered by a scheme. This should ensure that only relevant categories are assessed, minimising the amount of time spent on collecting and analysing information that would not add significant value to the overall appraisal.

Users then identify what Part of the Guidance they should apply, with there being four main Parts relating to i) rivers and groundwaters, ii) reservoirs, lakes and broads, iii) coastal waters and estuaries, and iv) works related impacts.

For example, if a scheme would deliver driver S4 (schemes to correct for statistically significant failures with Operational Standards under the Shellfish Directive), users are referred to Part 4 (Coastal Waters and Estuaries) for the categories of non-use, informal recreation, bathing, sea angling and shellfisheries.

Once the user has identified relevant type of water body (e.g. river or coastal waters), he/she then moves to the appropriate Part of the Guidance, with each of these Parts using the same step-by-step approach to undertaking the economic assessment. Some schemes may relate to improvements that affect more than one water body type.

Step 3: Qualitative Assessment of Impacts

For each identified benefit category, users are required to check that the category is relevant to the specific scheme and then, if so, to describe the impacts in qualitative terms. This enables a decision to be made as to whether the impacts are likely to be significant enough to affect a scheme's justification.

Guidance is provided on what factors should be considered in describing predicted benefits or dis-benefits. This draws in some cases on the 'New Approach to Appraisal' (NATA) which is used by DTLR in assessing the impacts of road schemes and other sources of information.

Step 4: Quantitative Assessment of Impacts

Where impacts may be significant, a more quantitative assessment is then undertaken, involving calculation of the area affected, number of users and visits per annum, etc.

Specific information requirements for each benefit category are described in the various sections. Formulae are given to assist users in preparing the necessary calculations. Default data are also provided for use where site specific information is not readily available.

Data collection may involve obtaining site specific information from maps, consultation with local organisations, and use of information from the I-drive of the Environment Agency's Intranet. Water company resource planners may need to consult with the Agency or use alternative sources of information. Where such alternative sources have been identified as part of preparing the Guidance, details of the sources are provided.

Step 5: Monetary Valuation

Where appropriate, monetary valuation of benefits (dis-benefits) is undertaken based on existing valuation data. This is based on an approach referred to as benefits transfer. It involves the transfer of a value developed for an environmental quality change at one site to the same (or similar types of) change at another site. In some cases, the appropriateness of valuation may be limited and caveats and warnings are included in the Guidance.

Summaries of appropriate valuation studies are provided, together with detailed instructions on how best to apply the different valuations. This includes both sensitivity testing and how to aggregate across the relevant populations.

As a result of limited valuation data, some sections of the Guidance recommend against the use of monetary valuation and suggest that users rely on the qualitative/quantitative assessments alone. Different types of sensitivity analysis are suggested to ensure a robust analysis.

Step 6: Bringing the Results Together

An Appraisal Summary Table (AST) is provided for each water body type, tailored to include only the relevant benefit categories. The AST should be used to record all of the assumptions made during an assessment as well as the results at each stage of the qualitative, quantitative and monetary assessment. Annex A to this paper provides a completed AST for a hypothetical water quality scheme, to illustrate the overall approach and the information produced through the assessment process.

Once the previous three steps have been completed for all the relevant benefit categories, the results from the various parts are brought together in tables, firstly as Present Values so that all the costs and benefits can be compared on equal terms, and secondly, to allow the decision rules to be applied. This includes bringing together qualitative or quantitative descriptions of any non-valued impacts, and undertaking any appropriate sensitivity analysis.

Detailed guidance on how to bring the results of the assessment together, convert benefits and costs to present value terms and to use the decision rules is provided.

Additional Resources

Several annexes have been provided to support or illustrate the Guidance. These are:

- Annex 1: Discount Rates;
- Annex 2: Worked Example for Rivers and Groundwater;
- Annex 3: Population Densities;
- Annex 4: Eftec Summary Tables;
- Annex 5: Shellfish Areas; and
- Annex 6: Habitat Action Plans and Priority Habitats.

5. Future Up-dates

The literature review carried out by Eftec as part of the development of the Guidance highlighted the fact that there are few existing valuation studies that can be called upon to provide transfer values for use both water quality and water resource assessments. This has limited the degree to which monetary valuation can be undertaken in a robust and valid manner.

Research is being commission by the Agency and DEFRA to fill in the most important of these gaps. With this in mind, the Guidance has been prepared in a manner which should allow the easy introduction of new or revised data into the assessment.

Annex A: Worked Example for Rivers and Groundwater

This Annex contains the completed AST and summary tables for a hypothetical water quality scheme on the River Meander.

The example is based on a fictitious river, although the information used in compiling the example assessment has been drawn from real data for a number of different rivers. In this way, the example includes features that relate to all of the assessment categories and maintains some of the natural complications that arise when assessing a real situation. For example, the assessment takes into consideration the likelihood of significant impacts on abstractions and commercial fisheries and, as a result, highlights where it is necessary to undertake monetary valuation.

The example is designed to illustrate how each of the steps in the assessment works, rather than to accurately reflect the likely impacts of the Freshwater Fish driver F3. However, we have made the example as real as possible in order that it provides you with an understanding of how the Guidance can be applied in practice.

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
Informal recreation	Benefit	Qualitative descriptions based on Table 2.3 Site count taken along whole affected stretch with a 1 km buffer. Part of the town of Morley is included in the count. Water quality improvement, therefore considering benefits transfer values given in Table 2.9.	Access is GOOD (Many local footpaths). Facilities are FAIR. There are no official car parks or toilets along the stretch, although there may be suitable alternative facilities within the village of Cloxton. Site is locally important and may attract visitors from between 15 and 30 km (MODERATE). Water quality in the affected stretch is MODERATE (RE3). The River Meander is designated as a sensitive [Eutrophic] water.	***Default data:*** Locally important site (Upper importance). Number of visits per year is 292,311(10,591 * 27.6) using actual population data (taken from Census data on a 1km buffer on GIS) and 31,188 using the population density table in Annex 3 (3.14 * 1 * 360 =1130 * 27.6). Table 2.7 estimates visits to be 30,000 approximately for a local site of upper importance. ***Alternative site:*** There are three	Green and Tunstall (1991): £0.13 per visit	Considers a move from RE4/3 to RE3/2. This is what the driver aims to create.	User upper bound of 73,077 visits per year (based on reality check) and value of £0.13 per visit gives benefits to informal recreation of: **£9,500 per year**	Taking 7,500 visits per year and £0.13 per visit gives benefits of **£975** per year. Taking 73,077 visits per year and £0.65 per visit (Green & Tunstall, 1991 – move from RE4/RE5 to RE3) gives benefits of **£47,500** per year.

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
				alternative sites all of local importance within 1 km, reduces estimates to 73,077 for population data and 7,797 for data used from population index and 7,500 from table 2.7.				

Notes/comments on assessment:
-default data: facilities (from qualitative assessment) are ranked as fair, therefore 292,311 is likely to be an over-estimate. Actual population data taken from GIS census information.

-alternative sites: visits per year are divided by four (three alternative sites, plus site).

-reality checks: 73,077 visits ÷ 365 = 200 then ÷ 11.9 (km) = 16.8 visitors per km per day. Using population density data, 7,797 visits ÷ 365 = 21.36 then ÷ 11.9 (km) = 1.7 visitors per km per day. Using table 2.7 data , 7,500 visits ÷ 365 = 20.5 then ÷ 11.9 (km) = 1.7 visitors per day. The upper estimate using this check appears to be more appropriate.

-sensitivity analysis: a value of £0.65 per visit is expected to give an over-estimate of potential benefits as the water quality is already RE3 and will be improved to support freshwater fish (one class up).

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
Angling	Benefit	If the water quality is improved by F3 the fishery may improve in quality and support a high status coarse fishery.	The river is accessible for angling along most of the stretch. Current fishery is rated as good coarse, moderate trout & poor salmon (from Table 3.3). The river currently has a new fish pass at Mirkacre and another proposed at Duckspool Mill Weir. Some parts of the river are engineered but there are few man made barriers (apart from those noted above). The characteristics of the river are generally lowland and pool & riffle. The river is annually stocked due to pollution incidents. In 2002 86,000 fish were introduced (from fry upwards). If the scheme is implemented the fishery may be improved to	***Default data*:** There is one known angling club on the stretch, but due to time constraints data on members cannot be gathered. Annual number of trips to the stretch has been estimated as 288,651 (30km buffer, 1,688,022 adults * 4% = 67,520 * 17.1 = 1,154,607 ÷ 4) (lower bound) and 540,160 (67,520 * 32 = 2,160,640 ÷ 4) (upper bound) using actual population data (census 1991). Using Annex 3 data the figures are 173,968 (3.14 * 900	Green and Willis (1996): £2.34.	If F3 is implemented the fishery could improve from moderate to good status.	Using 18,088 visits per year (based on reality checks – lower bound): 18,088 * £2.34 = **£42,325 per year**	Taking marginal value of poor to moderate fishery as £0.23 per angling trip gives benefits of **£4,160** (lower bound) to **£124,236** (upper bound using actual population data).

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2) (annual benefits)**	**Results of Sensitivity**
			achieve high coarse & good trout. Therefore a good game fishery in sea trout is created. There is one angling club known to the EA - Cloxton & Blethern Angling Association. Other parts of the fishery may be open access.	* 360 * 4% * 17.1 ÷ 4) (lower bound) and 325,555 (3.14 * 900 * 360 * 4% * 32 ÷ 4) (upper bound). ***Fisheries Officer estimate:*** 0.5 anglers per 25m per weekend day. Annual number of trips therefore, 11900m ÷ 25 = 476 * 0.5 (no anglers per 25m) =238. 238 * 76 = 18,088 visits per year.				

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
Notes/comments on assessment: *Reality checks:* actual population default data -lower bound 288,651 * 78% ÷ 76 = 2,962 trips per weekend day; 11,900m ÷ 2,945 = 1 angler per 4 m. Upper bound 540,160 * 78% ÷ 76 = 5,543 trips per weekend day; 11,900m ÷ 5,543 = 1 angler per 2m. Both of these appear to be poor estimates. Using population density data from annex 3 the figures are as follows; lower bound 172,951 * 78% ÷ 76 = 1,775 trips per weekend day; 11,900m ÷ 1,775 = 1 angler per 6 m. Upper bound 325,552 * 78% ÷ 76 = 3,341 trips per weekend day; 11,900m ÷ 3,341 = 1 angler per 3 m. The lower bound estimate seems most likely from all of these calculations although fisheries feel that 0.5 anglers per 25m is more appropriate. *Alternative sites*: there are 3 alternative sites								
Commercial fisheries	N/A	The stretch is unlikely to generate a commercial fishery before or after the scheme.						
In-stream recreation	N/A	None is carried out on this stretch.						
Amenity	N/A	No new works are planned in the locality. See Morley B.C Local Plan.						

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
Abstractions	N/A	No abstractors are known to 'treat' water prior to usage.						
Heritage, archaeology and landscape	N/A	Water quality will not affect landscape.						
Non-use (conservation value/biodiversity)	Benefit	Functions based on descriptions given in table 9.3, 9.4, 9.5 & 9.6.	The 11.9km stretch contains County Biological Heritage Sites. There are two small sites that are of importance - Meander Valley at Pinbury, which is designated for Swamp & Fens, and Woodland & Scrub. This site is just downstream of Morley STW. The next site on this stretch (further on) is Meander Bank which is designated for Woodland & Scrub on the river.	The Nature Conservation Evaluation is 'Local' (from Table 9.3), therefore the distance assumed relevant is taken as (small degree of change) 30 km. The number of households present within this area is estimated using census data and Annex 3 using the populations density formula.	Georgiou *et al* (2000) value of £0.05 - £0.19 per km per household per year (for a move from RE3 to RE2) Over the 11.9km stretch, total WTP is £0.60 - £2.26 per	The most appropriate value for a potential improvement from RE3 to RE2 if driver F3 is implemented	***Upper bound:*** £1,658,663 per year ***Lower bound:*** £332,451 per year The upper bound value is quite high and therefore the lower bound value has been used.	Taking Willis & Garrod gives benefits of £642,600 to £654,500 per year. The sensitivity analysis shows that

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
			The water quality may improve by an RE class if the scheme is implemented. This water will therefore have reduced ammonia within it which should impact on the level of benthic invertebrates due to increased reproduction rates. Ammonia has also been found to prevent sphagnum moss growth in preference for faster growing grasses which could have a negative impact on the swamp and fen communities at the Meander Valley site at Pinbury. The ammonia levels may impact on nutrient retention and nutrient export (Table 9.4). The stretch is also home to water voles. Great Crested	***Upper bound:*** Households = 733,922 (census). (1,688,022 ÷ 2.3) ***Lower bound:*** ((3.14 * 30 * 30) + (2 * 30 * 11.9)) * 360 = 1,274,400 ÷ 2.3 = Households = 554,086 (Annex 3)	household per year.			the non-use benefits are expected to be high, with the estimates based on Willis & Garrod (1996) giving results closest to the lower bound values using Georgiou *et al* (2000). This supports the suggestion that the lower bound may be the most appropriate

Appraisal Summary Table for Rivers and Groundwater								
Site Name	**River Meander**							
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.							
Site Specific Assumptions	Length of affected stretch of river = 11.9 km (out of a total length of 27.2 km) Aiming to prevent future deterioration from RE2 to RE3.							
Category	**Benefit/ Dis-benefit Likely?**	**Category Specific Assumptions**	**Qualitative Description**	**Quantitative Assessment (1)**	**Transfer Value Taken (2)**	**Reasons for Taking Transfer Value**	**Monetary Valuation (1 x 2)* (annual benefits)**	**Results of Sensitivity**
Non-use (conservation value/biodiversity)	Benefit	Impact Ratings based on Tables 9.3, 9.4, 9.5 & 9.6.	Newts exist in the ponds surrounding the stretch. The river at this stretch does not offer a floodplain. The Nature Conservation Evaluation is 'Local' (as there are two County Biological Heritage Site)-Table 9.3, while the Biodiversity Impact is considered to be 'minor positive' (Table 9.5) as the ammonia levels won't significantly improve the biodiversity. This means that the impacts (from Table 9.6) are assessed as having a 'small benefit' for biodiversity.					estimate.
Notes/comments on assessment: *Default Data:* Actual population taken from Census and default data.								
Notes: * include adjustment factors where required and note site specific assumptions								

Table 10.1: Timing of Costs and Benefits (Rivers and Groundwater)											
Site Name	**River Meander**										
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.										
Scheme Costs											
Category	**Annual or Capital Benefits**	**Year Benefits Expected to Start**	**Year Benefits Expected to End**	**Calculated Discount Factor (3.5%)**			**PV Monetary Benefits**	**Water Company Discount Factor (taken as 6%)**			**PV Monetary Benefits**
				Discount Rate in Year Benefits Start (1)	**Discount Rate in Year Benefits End (2)**	**Discount Factor (2-1)**		**Discount Rate in Year Benefits Start (1)**	**Discount Rate in Year Benefits End (2)**	**Discount Factor (2-1)**	
Informal recreation	£9,500	2	24	1.90	16.06	14.16	£134,520				
Angling	£42,325	2	24	1.90	16.06	14.16	£599,322				
Commercial fisheries											
Water sports											
Amenity											
Abstractions											
Heritage, archaeology and landscape											
Non-use (conservation value/ biodiversity)	£332,451	2	24	1.90	16.06	14.16	4,707,506				
TOTAL PV MONETARY BENEFITS (to two significant figures)							5,441,348				

Table 10.2: Relative Importance of Benefits (Rivers and Groundwater)					
Site Name	**River Meander**				
Scheme Description	Improvement of wastewater treatment works to protect against any risk of failure with Imperative Standards for newly designated reaches (driver F3). Without the scheme there would be a risk of failure of freshwater fish directive should the wastewater treatment works discharge its full consented load.				
Scheme Costs					
Category	**Description (where monetary valuation was not possible or does not cover all of the impacts)**	**Discount Rate of 3.5%**		**Water Company Discount Rate (taken as 6%)**	
		PV Monetary Benefits (from Table 10.1)	**% of Total PV Benefits**	**PV Monetary Benefits (from Table 10.1)**	**% of Total PV Benefits**
Informal recreation		£134,520	2.5		
Angling		£599,322	11.0		
Commercial fisheries	None present or to be created.				
Water sports	None undertaken.				
Amenity	No new developments in locality.				
Abstractions	No abstractions know to be currently treated before usage, or will alter river flows significantly.				
Heritage, archaeology and landscape	No change to landscape to be generated.				
Non-use (conservation value/biodiversity)		£4,707,506	86.5		
PV TOTAL		£5,441,348	100		

Chapter 5

Economic Appraisal of Environmental Attributes in the Water Industry: PRO4

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Introduction

The Benefits Assessment Guidance (BAG) for non-statutory schemes in AMP4, prepared by RPA (2003), provides a means of evaluating the environmental and social benefits of proposed schemes. It draws upon the results of existing studies. The BAG manual is essentially designed to be used at a desk-top level. The BAG manual aims to assess the environmental benefits and costs of schemes impacting upon groundwater, river ecosystems, freshwater fisheries, habitats (BAPs), bathing waters, shell fish waters, low flow alleviation in rivers, water supply options (e.g. reservoir developments), and local priority schemes (e.g. eutrophication).

The BAG manual focuses on non-market or non-priced aspects of changes in water quality and associated environmental externalities from water schemes as they impact upon rivers and ground water, reservoirs, lakes and broads, and coastal waters and estuaries. The manual is comprehensive in its coverage of environmental attributes.

The basis of the BAG manual is benefit transfer. Benefit transfer (BT) involves taking an estimate of the value of an environmental attribute from an existing study at one site, and transferring it to a new site. The BAG manual reviews all available studies which value environmental attributes associated with water, and by introspection suggests a value for each environmental attribute that can be applied in different contexts.

The BAG manual approach raises the question: how accurate will these environmental values be in different contexts? This is partly a theoretical question, and partly an empirical question.

Benefit transfer accuracy

There are several procedures by which benefit transfer (BT) can proceed:

(1) Unadjusted transfer: this assumes that mean willingness-to-pay (WTP) from an existing study at one site (A) can be transferred to a new site (B). It assumes that the BT is robust to differences in site characteristics. This is the procedure adopted in the BAG manual.

(2) Simple adjustment transfer: values generated at site A are identical to those at the site B after adjustment for changes in consumer prices and average differences in income.

(3) BT function: the function estimating the marginal value curve of the environmental attribute from site A is applied at site B. If differences existed in site and population characteristics between sites A and B then the value of the environmental attribute will differ, despite the fact that the same basic relationship is assumed. This procedure assumes that values generated with the coefficients from site A and site B characteristics are identical to the values that would be obtained by commissioning a new study at site B.

Numerous studies have shown that BT function transfer provides a more accurate estimate of the value of the environmental attribute at the new site (B) than either the simple transfer of mean WTP or simple adjusted transfer of mean WTP.

For example, Loomis (1992) assessed the validity of the transferability of travel-cost model (TCM) benefit estimates by comparing site specific benefit estimates with those derived from transferring TCM equations. A multi-site TCM demand equation for steelhead fishing in Oregon was estimated for n-1 of the Oregon steelhead rivers and then the equation used to predict the nth or missing (i.e. new) river. Transferring the equation to the new river, rather than simply using an average benefit per trip value from existing rivers, provided a more accurate estimate of benefits for the new river. Accuracy was established by comparing transferred function and average benefit mean WTP values with those of an actual survey and TCM estimate of the benefit to anglers at new rivers. Compared with TCMs of angling benefits at new rivers, the transfer of mean WTP per trip frequently had percentage differences of 25% or greater, while the BT equation mean WTP per trip only once differed from the actual site specific estimate by more than 10%.

Hence it is important to consider attributes of the new site and socio-economic characteristics of population that might visit the new site, if an accurate estimate of the benefits of the new site are to be established. For example, a recent study of Yorkshire Water customers (Willis and Scarpa, 2002) revealed that WTP for one particular water supply attribute for households in lowest income quartile was approximately 20% less than 'average'. It is not only economic characteristics that affect BT between sites. In another study testing the reliability of transferring WTP to avoid water pollution between two towns along the Pacific coast of Costa Rica, Barton (2002) argued that sanitation, use, and environmental attitude related variables were driving transfer errors across transfer contexts, rather than the more readily available socio-economic household characteristics; underlying the importance of including such variables in the definition of 'site similarity' prior to conducting a BT.

So theoretically, BT though equation or function transfer invariably produces more accurate estimates of benefits at the new site, compared to simply using a mean WTP value from an existing site. Whether it is worth in practice using a BT function approach or using BAG manual values is an empirical question. It depends upon transactions costs and whether it changes the benefit/cost (B/C) ratio for a particular non-statutory scheme. It may take 10 to 20 times more time to implement a BT function than simple adopting a mean WTP transfer value approach. Estimates from simple mean WTP and benefit function transfers are unlikely to differ by more than 50%. So, if in a sensitivity assessment, a 50% difference in the value of a particular environmental attribute does not affect the B/C ratio, then the simple mean WTP value in the BAG manual might be accepted.

WTP and multi-scheme PR04 programs

The Hicksian compensating surplus (CS) measure for an environmental change is the maximum (minimum) amount of money that can be taken from (or given to) an individual in order to leave her indifferent between her *ex ante* and *ex post* program situations. Conventional contingent valuation (CV) procedures tend to value each environmental improvement (q) of a program as if it was a single independent element, maintaining all other elements at their initial level. This independent valuation and summation (IVS) measure can be written as:

$$CS(q^1, q^0, u^0) = y\text{-}e(p, q_1{}^1, q_2{}^0, q_3{}^0, \ldots q_k{}^0, u^0) + y\text{-}e(p, q_1{}^0, q_2{}^1, q_3{}^0, \ldots q_k{}^0, u^0)$$
$$+ y\text{-}e(p, q_1{}^0, q_2{}^0, q_3{}^1, \ldots q_k{}^0, u^0) - y\text{-}e(p, q_1{}^0, q_2{}^0, q_3{}^0, \ldots q_k{}^1, u^0)$$

Hoehn and Randall (1989) have shown that such independently valued elements of a program cannot be used directly in a cost-benefit analysis (CBA) of individual schemes without biased results. This occurs because the IVS measure is equal to CS only if the K program schemes are independent, which is unlikely to be the case in PR04 where a large number of non-statutory schemes are included in the 5 year program. IVS will over-estimate the true valuation of environmental benefits if program elements are substitutes. As the number of non-statutory schemes increases, substitution effects increase, so to the extent to which the values in the BAG manual for a series of environmental attributes are derived from a different "independent valuation" studies, IVS will over-estimate CS. Too many of the non-statutory schemes will pass the cost-benefit test!.

A program of non-statutory water scheme improvements can be correctly valued by either a sequentially (SEQ) approach or a simultaneously (SIM) approach. When elements of a program are measured sequentially, the order in which the subcategory benefits are valued influences the values ascribed to these elements. Environmental attributes that are valued first are valued more highly than environmental attributes valued later. The value ascribed to each element is not unique, but depends on the sequence selected. This path dependency has been revealed by Santos (1998) in the valuation of environmental attributes in an environmentally sensitive area (ESA) program.

The sequential (SEQ) path approach derives separate valuations for the K components or schemes in PR04 by a valuation path beginning at ($q_1{}^0, q_2{}^0, \ldots q_k{}^0$) and ending at ($q_1{}^1, q_2{}^1, \ldots q_k{}^1$). A sequential path shifts program schemes one at a time from their initial *ex ante* position to their *ex post* program prescription, in a sequence of valuation changes, $q_1{}^0$ to $q_1{}^1$, then $q_2{}^0$ to $q_2{}^1$, and so on until all the program schemes are complete with $q_k{}^0$ to $q_k{}^1$.

$$CS(q^1, q^0, u^0) = y - e(p, q_1{}^0, q_2{}^0, q_3{}^0, \ldots q_k{}^0, u^0) + e(p, q_1{}^1, q_2{}^0, q_3{}^0, \ldots q_k{}^0, u^0)$$
$$- e(p, q_1{}^1, q_2{}^1, q_3{}^0, \ldots q_k{}^0, u^0) - e(p, q_1{}^1, q_2{}^1, q_3{}^1, \ldots q_k{}^0, u^0)$$
$$- e(p, q_1{}^1, q_2{}^1, q_3{}^1, \ldots q_k{}^1, u^0)$$

The first term values the change in q_1 with all other q_i at their initial level. The second term values the change in q_2 with q_1 at its *ex post* level and the other q_i at their initial levels. This reduces to a quantity identical to the aggregate valuation for the overall policy:

$$CS(q^1, q^0, u^0) = y - e(p, q_1{}^1, q_2{}^1, q_3{}^1, \ldots q_k{}^1, u^0)$$

The simultaneous (SIM) path approach evaluates the derivative of the expenditure function between the *ex ante* and *ex post* environmental program schemes,

$$CS((q^1, q^0, u^0) = \delta[de(q_1, q_2, \ldots q_k, u^0)/dq_1]dq_1 + \delta[de(q_1, q_2, \ldots q_k, u^0)/dq_2]dq_2$$
$$+ \ldots\ldots\ldots \delta[de(q_1, q_2, \ldots q_k, u^0)/dq_k]dq_k$$

In the simultaneous approach, respondents value PR04 as a whole, and also value each scheme or attribute within the PR04 program as a part-worth.

Economic theory predicts that IVS will lead to higher estimates of benefits across a program such as PR04 than either the SEQ or SIM approaches. Thus the adoption of an IVS approach will over-estimate the benefits of each non-statutory scheme, with too many schemes passing the CBA test, and too much investment in non-statutory water schemes.

A study of the benefit of reductions in nutrient leaching into the North Sea from three Norwegian rivers [the Halden (H), Glomma (G), and Vansjø-Hobøl (V)] confirmed these effects predicted by theory, in terms of mean WTP per respondent:

(1) 1836 Norwegian Kronor (NOK), for IVS (HGV) [independent valuation summation of the benefits of nutrient reductions in each river H, G, and V].

(2) 1653 NOK for SEQ (HGV) [WTP for the sequence H, G, V, although the difference between 1836 and 1653 results was not statistically significant].

(3) 1344 NOK for SIM (HGV) [WTP for the simultaneous valuation of rivers H, G, and V, and statistically significantly different from IVS at 10% level]. [The simultaneous valuation was derived by determining WTP for HGV in total, and then asking respondents to allocate this total WTP between each river] (see Mangussen, 1996).

A similar result was also derived by Santos (1998) who demonstrated the effect of IVS bias. Each of the three attributes of the Yorkshire Dales ESA scheme [dry stone walls and field barns; flower rich meadows; broad-leaved farm woodland] were valued independently. This produced values of £43.01, £42.62 and £42.90, respectively for each attribute. If these independent values are summed [i.e. 43.01 + 42.62 + 42.90] [the IVS result], the total value for the ESA scheme as a whole would be estimated at £128.53 per household per year. However, a SEQ valuation of the Yorkshire Dales ESA scheme attributes indicated a total value of £72.05 per household per year.[16] This implies that the IVS procedure overestimated the value of the total ESA scheme by 78%; compared with its true value accounting for substitution effects between attributes.[17]

[16] The SEQ approach was implemented by asking respondents:

(a) given that you are WTP £*X* for attribute *A*, what is the maximum additional amount you would be willing to pay for attribute *B* if this was to be subsequently provided; and

(b) given that you are WTP £*Z* for attributes *A* and *B*, what is the maximum additional amount you would be willing to pay for attribute *C* if this was also to be subsequently provided.

[17] Santos (1998) extended Hoehn's approach based upon a second-order Taylor series of constant curvature, with a third-order Taylor series, adding a third-order interaction term among the three program elements (i.e. P1*P2*P3). This third-order interaction term increases the flexibility of the WTP model compared to the second-order approximation, in that it allows for pairwise substitution effects to change in size, and even to change in sign, along the valuation sequence. A change in sign implies that two attributes or programs that were initially substitutes become complements later in the sequence, or *vice versa*.

Goods valued as an element of a larger entity produce a smaller WTP than when goods are valued alone. Hence, there is no price for a good independent of its context, so that context must be recognised in using the BAG manual. It is also important to recognise this in BT, and in attempting to apply environmental values in from an existing site to a new site.

Thus, PR04 program of non-statutory water schemes, that simultaneously alters several related resource services which households view as either substitutes or complements for one another, creates particular problems for a CBA appraisal. They ought to be valued either through a SEQ or a SIM approach.

The values in the BAG manual are derived from a variety of studies. Some of these were studies of a particular environmental attribute, or site, independent of changes to other environmental attributes and other sites, to which the respondent might be asked (or would have) to contribute. This was essentially the approach adopted for example in the Thames Tideway study (Eftec and MORI, 2003). Contingent valuation studies invariably adopt this "independent valuation" approach. For example:

> "All the impacts of sewage outflows on the Thames are now reduced to the lowest possible level. Would you be willing to pay £5 per year on top of your water bill for an engineering solution to achieve these improvements?"

Some studies value specific environmental attributes of one particular scheme. Thus Eftec (2002) valued different attributes associated with bathing water quality [decreasing probability of stomach upset; reducing number of unsafe swimming days; advisory system for poor water quality days; reduced beach litter; improved beach amenities (toilets, life-guards)]. This framework values the attributes of bathing water only; not the value of bathing water simultaneously with other water quality improvements that the water company might be implementing (e.g. reducing lead content of water, interruptions to supply, and accidental discharges from sewage works into rivers, etc.). This framework (the value of one particular issue) also characterised the study of low flow alleviation (LFA) in the River Darent in Kent (Willis and Garrod, 1995). In this case respondents were asked their WTP for LFA in 40 rivers, and of that amount the proportion they would be WTP for LFA in the River Darent.

Fewer studies have attempted to value a specific scheme in the context of other schemes which could be implemented in a particular Ofwat price review period. Yet this is precisely the situation that pertains in PR04. Water company customers will simultaneously have to pay for statutory and/or non-statutory improvements to other aspects of water supply, water quality, and waste-water disposal. Hence this is why the simultaneous evaluation framework is so important. The value that water company customers place on any particular attribute or water service factor, depends on other service factor improvements for which they will have to pay. The simultaneous valuation approach was adopted by Willis and Garrod (1998) for a study of low flow alleviation (LFA) in rivers in south-west England, where the Environment Agency (EA) was also conscious of the need to instigate programs to improve river water quality and bathing water quality as well as LFA. Hence, WTP for LFA was evaluated in the context of customers' preferences and simultaneous WTP for improvements to these other two environmental attributes in south-west England.

A simultaneous framework was also adopted in a study for Yorkshire Water. This study estimated the benefits to Yorkshire Water (YW) customers of changes to the level of service provided across 14 attributes: (1) SOS: security of supply (2) ITS: interruptions to supply (3) DWB: drinking water biological and chemical (4) DWD: drinking water discolouration (5) LKG: leakage (6) IMP: inadequate mains pressure (7) LD: lead in drinking water (8) SF: sewage flooding into properties (9) AF: areas flooded by sewage (10) OF: nuisance from odour and flies from sewage treatment works (11) PI: pollution incidents in rivers (12) RQ: ecological quality of rivers (13) AM: ability to use inland waters for recreation (14) BB: bathing beach water quality (Willis and Scarpa, 2002). The study adopted a stated choice (SC) experiment approach. When utility is specified as a function of the value of each attribute, then the relative contribution to utility of each separate attribute can be determined. Inference can be used to determine the change in utility that customers derive from changes in attribute SF levels. Moreover, the part-worths for each attribute can be added together to derive the total utility for different combinations of changes in SF levels, or across all attributes to derive the total utility of a holistic change.

The approach of Yorkshire Water to evaluation in PR04 is innovative. It seeks to value the benefits to customers from all service factors which could be improved in PR04 using a simultaneous approach (see Willis and Scarpa, 2002). Yorkshire Water also estimated marginal cost schedules for implementing these service levels within the firm. The combination of the incremental (or marginal) cost and benefit of service provision enables the optimal or economic point to be identified, where the benefit of an extra unit improvement in service is exactly equal to the extra cost of provision. This was achieved through a linear programming optimisation model (see Acutt, 2002).

The framework pioneered by Yorkshire Water maximises benefits to both customers and shareholders, and this framework ought to be the recommended approach to identifying the costs and benefits of non-statutory schemes in periodic price reviews. Although the number of service factors was only 14, the simultaneous choice modelling approach can be successfully extended to cover many more service factors. Indeed, over 50 service factors have been included in some transportation studies.

Separability, double counting and functional form

The potential for double counting benefits exists when trying to estimate values for all environmental aspects of a PR04 scheme. Many studies, not through any fault of their authors, have estimated recreational values that are partly confounded with landscape values; of biodiversity values that are confounded with recreation values or landscape values, of both! Where this occurs some over-estimation of environmental benefits will result. Thus using results from two separate studies, one purporting only to measure recreation, and the other purporting only to measure biodiversity, when in reality their respective values are confounded, will result in some over-estimation of the benefits of a PR04 scheme. Some double counting will also occur if the value of a landscape view is derived from a hedonic house price model, and added to a landscape value is derived from a TCM of visitors to the area. Hence it is important to ensure that values for different environmental attributes are separable when aggregating to obtain a total value for the scheme. The BAG manual rightly places great emphasis on this need to avoid double counting.

Most environmental valuation studies estimate WTP as a linear function of an environmental attribute. Over a specified (small) range of an attribute WTP might be linear. However, inaccuracy in valuation is likely to arise if this value is extrapolated outside the original range

of the environmental attribute over which the WTP was evaluated. Thus reducing fish kills from river pollution incidents from 10 to 8 per year may not be applicable to people's WTP for reducing fish kills from 4 to 2 per year. Diminishing marginal utility would suggest that additional increments to water quality are valued less and less. In other words over larger ranges of an environmental attribute the relationship between WTP and the attribute level will be non-linear. Few studies have investigated whether a non-linear relationship exists between WTP and the level of a water service factor. But those who have investigated this issue have often observed such a non-linear relationship over part of the range of the attribute. Indeed for some water service factors, utility might actually decrease as the attribute level increases.

Other externalities subject to uncertainty

An early version of the BAG manual argued that the externality costs of energy consumption were fully accounted for by the Climate Change Levy (CCL). That is, the CCL reflects the full value of environmental externalities arising from any increased energy use. The raises the question of the extent to which the CCL tax equates with a reasonable estimate of the social cost of carbon ?

The CCL is a tax on fossil fuels and electricity. However, whilst explicitly introduced as a climate control tax, it does not vary directly with the carbon content of fuels. Pearce (2003) calculates that the pre-allowance CCL tax rates are: coal: 0.15 pence kWh; gas: 0.15 pence kWh; electricity: 0.43 pence kWh; which implies carbon tax rates for coal of £16 per tonne carbon (t/C); gas £30 t/C; electricity £31 t/C. If CCL was a pure carbon tax, the tax rate per t/C ought to be the same across energy sectors. Clarkson and Deyes (2002) suggest the social cost of carbon is £70 t/C. This would suggest that the CCL does not fully account for the social cost of carbon. On the other hand, Pearce (2003) argues that the 'base case' estimate of the social marginal cost of carbon is £2.66 to £6 tC without equity weighting and using a constant discount rate. Applying the lowest an equity weight[18] (ε = 0.5) to the highest discount rate (i = 6%), and the highest equity weighting (ε =1.5) to the lowest discount rate (i = 1%) produces a social cost of carbon estimate range of £2.40 to £15 per tonne. This range also encapsulates the price at which carbon permits trade in the UK Emissions Trading Scheme. Whilst the price has varied since the scheme was launched from £3 to £12.50, probably due to the slow adjustment of market dynamics,[19] permits are currently (February 2003) trading at £3 per tonne of carbon dioxide equivalent (IPC, 2003).

Estimating the number of visitors

The BAG manual details how to extrapolate survey visitor numbers to annual visitor numbers. There is a lot of useful information here. But attention must be devoted to detail in estimating visitor numbers to a site. The BAG manual suggests estimating the number of visitors from car park numbers: number of cars parked * 2.3; where 2.3 is number of adults per household. However, not every member of the household might be a visitor. It would be more accurate to use the average occupancy of the cars visiting the site.

[18] Where ε is the elasticity of the marginal utility of income (a measure of 'inequality aversion').

[19] Companies were slow in having their baselines verified, which delayed allocated allowances, causing an initial shortage of supply and price rise. Companies have now gone through their first reconciliation deadline, and this has led to a fall in demand for permits. Companies meeting their targets receive an 80% discount from the Climate Change Levy tax on business use of energy.

Moreover, sampling 'on-site' samples visits not visitors, and this can lead to biased estimates of the number of visitors. Assume a site has two types of visitor (a) 120 visitors who visit 5 times per year (b) 120 visitors who visit once per year. Assume visits are evenly distributed over the year: January has 50 visits from (a) visitors and 10 visits from (b) visitors, as has February to December. If a 10% sample of visits were randomly selected in any month, the sample would consist of 5 type (a) visitors and 1 type (b) visitor. However, the true proportion of type (a) and type (b) visitors is 1:1. The true proportion of visitor types can be derived for the site.[20] However, site selection bias has implications for aggregation. Consumer surplus per visit will differ from consumer surplus per visitor if some visitors make frequent visits. In theory the marginal visit will be worth less than intra-marginal visits. Transferring a single recreational value from an existing site might under-estimate or over-estimate the recreational value of the new site if the distribution of visitor frequencies differ between the two sites. Frequent visitors such as dog-walkers value each visit much less than purposeful visitors to sites.

Distance decay functions

The BAG manual rightly identifies the need to apply distance decay functions for non-use WTP for local 'public goods'. People's value for a local public good declines with distance, as knowledge of the good declines and as the good becomes less significant in the respondent's set of goods (because there are more substitute goods available). Unfortunately there are no reliable estimates of these distance decay functions across a comprehensive range of environmental goods. Indeed, the Eftec / MORI (2003) study failed to detect any statistically significant decline in WTP for water quality improvement in the Thames tideway with distance of residence from the Thames, although annual WTP additional water bill amounts did vary with frequency of use of the Thames. So the criterion suggested in the BAG manual is the best available judgement that can be made, but it is arbitrary and may not be terribly accurate.

Conclusions

BAG manual is a creditable attempt to produce estimates of the value of changes to environmental attributes for non-statutory schemes in PR04. There clearly needs to be sensitivity in the application of these values. Care also needs to be devoted to identifying the number of visitors and visits, and the profile of each. Any error in estimating the total environmental value is just as likely to occur with respect to the number of customers or people as it is the WTP value of each customer or person.

In the longer term each water company might derive more accurate and reliable estimates of the environmental benefits of changes to water service factor levels and non-statutory schemes in its area by adopting a simultaneous evaluation framework. The water company could also estimate the marginal cost schedules it faces for improving each individual service factor level. It can then relate these marginal cost and marginal benefit curves to identify the optimal investment of each service factor and non-statutory scheme with their associated environmental attributes, over the next periodic review period.

[20] Site selection bias can be corrected by weighting the number in the visit sample by its reciprocal to derive the true proportion of visitors: in this case [(50 (1/5)) + (10 (1/1))].

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Chapter 6

Benefits Assessment for AMP4: Oxford Seminar Discussant Comments

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After the Multi Attribute Technique was applied during AMP3, a more detailed assessment of the environmental benefits, including economic valuations, was asked for in relation to AMP4. Generally, RPA's work does this as well as can be expected given available knowledge, and any problems with using monetary valuations were largely predictable. Therefore, those that asked for this approach must respect both its results and its limitations.

The suggested approach for AMP4 has carefully defined benefits categories and structures, which are important in order to be precise about benefits while avoiding double counting. The impacts being valued are important to many people, including 1 million RSPB members, who are also water customers. It is the job of economists to measure this value, taking account of the uncertainties involved. The importance of the environment should not be reduced because of these uncertainties, especially in comparison with industry costs, which are presented with much greater certainty. We are certain that environmental goods and assets are of value, the uncertainty is only over their monetary valuation.

The problems associated with monetary valuation of the environment are still significant, and are important in the context of AMP4. In particular, it is still not clear that ecosystem and natural habitat benefits are properly covered. These benefits are long term and occur across catchments (people can get benefits from nature conservation outside their own catchment). We have an important duty to respect the needs of future generations in relation to environmental impacts, especially the long term and irreversible.

The significance of environmental benefits is thus not fully known. It is important that thorough consideration is given to the types of benefits that make up the total economic value of the environment. A first step is to consider the ratio of non-use and use values. Available information indicates that non-use values are less well understood, but may make up the majority of total value. It is also possible to describe, measure, and sometimes value, individual environmental functions.

Major difficulties arise when attempting to identify and value marginal changes expected from environmental management: they can be difficult to measure or estimate scientifically; difficult for the public or consumers to understand; and difficult to calculate from the available data. Therefore, economic values should be used very cautiously in cost-benefit ratios or net present value calculations, especially for individual projects. Currently their main use is as a measure of scale of the benefits that can be achieved.

Although many concepts are difficult to assess, especially at individual scheme level, they must be included in non-monetary terms in the overall benefits assessments. These should

also seek to include 'glue value' - the overall health of environmental systems that other parts rely on - which is additional to the sum of the individual elements of total economic value. Biodiversity is an indicator of this overall value, and this should be recognised when assessing the benefits of contributing to BAP targets. Preserving basic levels of biodiversity in each catchment will preserve some 'glue' value.

Finally, we must remember that the environment is not important because it has value; it has value because it is important. Valuation is not being carried out for its own sake, it is a tool to ensure the sound use of environment resources.

Chapter 7

Way Forward for Benefits Assessment for PR04 and Beyond

Some suggestions for future research, stated preference technique and an example of current research

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This paper reports the three topics I covered as one of the two discussants to Session 4 of the Environment Agency PR04 Seminar:

I. Some suggestions for future research to fill the gaps that need filling in the context of the Periodic Review (PR) process.

II. The workplan for a stated preference study. Stated preference techniques use carefully worded and structured questionnaire to elicit respondents' willingness to pay (WTP) or willingness to accept compensation (WTA) for the change in the environmental (or cultural) resource in question. A stated preference study is a process of design-test-revise-retest and so on. The more complex the research or policy question the more rounds of design - test - revision are required and subsequently the more time and resources need to be expanded.

III. A brief summary of a recent stated preference study conducted by eftec for Thames Water. Although the results of the study are not yet publicly available, some basic design characteristics and study requirements are summarised here as an illustration of what stated preference techniques can do in this context.

1. Future work

The analysts who include environmental and social impacts into their appraisal of the PR schemes strive for standard, 'off-the-shelf' values that can easily be transferred to all schemes in all locations. However, such values are hard to come by since the experience with economic valuation to date has shown that WTP / WTA estimates are specific to resource, change and population studied. Therefore, the aim of new research to fill the gaps in the literature should try to cover as large a section of the variety of resources and PR scheme (and hence impact) types as possible.

Eftec's view on what the current gaps are in the relevant sections of the economic literature is presented in our report to the Environment Agency (eftec, 2003c). Here, it suffices to say that the gaps should be identified not just for the sake of furthering the research but in order to generate values that can be used in the appraisal of the schemes that are part of the PR process. Without going into too much detail on the gaps with respect to specific resources, locations or schemes, we can look at further work from three angles.

The first relates to the expression of environmental impact, or in other words, the issue of translating the environmental impacts expressed in physical / scientific / technical terms to the changes that the general public may experience and hence may have some preferences for or against. For example, in a technical report, the effect of a scheme on a river could be

expressed as a change in the RE class change. In the economic literature, however, this measure is not valued directly. Instead, proxies for RE class such as changes in visual appearance of the water, the quality of the angling experience and so on are valued. This translation process could benefit from looking at the existing studies to see how they have expressed complex physical impacts. In fact, the review eftec conducted for the Agency (eftec, 2003b) has done this to a certain extent and found that in most cases, the impacts are described in rather general terms and the studies lack the scientific evidence to back up these descriptions. The translation process can also benefit from focus group discussions to inform the experts of what people observe and understand about the impacts.

The second angle is the variation of the economic value estimates per unit of environmental impact due to the scale of the change and the scale of the affected population. While most of the existing literature deals with large discrete changes (e.g. the economic value of preserving an SSSI), recent schemes within the PR process seem to lead to mostly marginal changes (e.g. the loss of 1 ha of a SSSI to a pipeline). Similarly the literature shows us that use and non-use values are likely to be different. However, there is very little evidence in the literature on how the non-user population could be defined. Therefore, studies that look at marginal changes and that aim to define user and non-user populations for different type and quality of resources would be valuable. Finally, for some impacts, there is simply no or insufficient literature. The quality and quantity of groundwater, and cumulative effects of abstraction is one example of such gaps.

The third angle is aggregation. Aggregation over the affected population requires the definition of user and non-user populations, which is also touched upon above. Aggregation over time leads to the interesting issue of how people value time differently in the context of the PR process. Most studies do not specify a time period over which WTP / WTA payments will be made or over which the change will occur. The effect, if any, of a time-bound valuation scenario (tied to the lifetime of the PR scheme – including both construction and operation phases) on the WTP / WTA responses would be a valuable addition to our economic valuation tool-box for assessing the impact of schemes more precisely.

2. Workplan for a stated preference study

The process of design-test-revise that is necessary for a successful stated preference study involves following an eight-step workplan.

1. Initial research

This step involves identifying the research or policy questions to be answered or the objectives of the study. Consultation with the Client, other stakeholders and experts and review of relevant studies previously undertaken are among the actions undertaken in this step. Although usually the objective of a study is apparent at the outset of the study, sometimes it is shaped as the study gets underway.

In the context of the PR process, the Agency guidance on benefit assessment, this seminar and the subsequent work form part of this step.

2. Valuation technique and survey method

The two approaches of the stated preference techniques, namely, contingent valuation and choice modelling (choice experiment or contingent ranking), both have advantages and disadvantages that make their use appropriate in different contexts. For example, choice

modelling is generally preferred when the study is focused on the individual characteristics or attributes of a resource, while contingent valuation is preferred when the study is focused on the whole bundle of characteristics that makes up the resource. In addition, when changes to the quality and quantity of the resource or its individual attributes are uncertain, choice modelling gives greater flexibility to subsequent analysis of results since it can cover a larger set of changes than contingent valuation can.

Before a decision can be made about the most suitable valuation technique, possible approaches should be tested at least in focus groups and ideally also in a pilot survey. These tests will reveal whether a technique that is preferred in principle can also work in the field.

Like the choice of valuation technique, different survey methods (face-to-face, mail, telephone or mix) also have relative merits. While face-to-face interviews are usually the most expensive option, they also enable the most complex of designs to be implemented. On the other hand, mail surveys while usually the cheapest method, can lead to self-selection bias, in which results are biased since majority of those who return the surveys could tend to be those who have prior interest in the subject of the survey.

3. Choice of population and sample

The affected population is defined as all those who are affected by the change. This may include users, non-users or both as well as the local, regional or national population. In the particular context of the PR process, the affected population should include both those who will be affected by the environmental change and those who will be financing the schemes that will lead to this change. The affected population is usually defined at the outset of a study, while revisions are also possible through focus groups and pilot surveys.

Random or quota sampling can be used to select the survey sample. Whichever method is used, the sample should be representative of the population affected. The size of the sample depends on the number of sub-samples for which separate estimates of mean WTP / WTA are required and the number of versions of the questionnaire, which in turn is a function of the complexity of the design. A rule of thumb is that about 200-250 respondents should be sufficient for each sub-sample or around 500-1000 respondents for the whole sample.

4. Questionnaire design

A stated preference questionnaire usually consists of four sections:

- attitudes, opinions and uses;
- valuation section;
- follow-up questions; and
- socio-economic characteristics.

The questions in each section aim to:

- collect information that is valuable in its own right;
- get the respondents thinking about the context of the survey as a warm up to the valuation scenario;
- check the consistency of the answers to similar questions in different sections;
- estimate the mean and median WTP / WTA; and
- explain the variations in choices and hence WTP / WTA.

In the context of PR schemes, the first section could contain questions on the following topics among others:

- how important the water environment is perceived to be compared to other environmental and social issues;
- general attitudes towards and experience / knowledge of water quality / quantity issues;
- opinions about the current state and the future of the resource in question;
- types and frequency of uses made of the resource; and
- perceptions / knowledge / use of alternative rivers or other water bodies.

The valuation section should provide information about the resource and the change in question, institutional setting in which this change will be provided, and mechanism through which respondent would be paying or receiving compensation (also known as the payment vehicle).

Follow up questions are asked to explain the motivations behind respondents' WTP / WTA statements. These motivations usually fall into categories of use and non-use values for those who state positive WTP / WTA responses. The answers to these questions also differentiate between valid and protest zero responses, which is used in the subsequent econometric analysis.

Finally, socio-economic questions such as income, age, education, membership of environmental or local organisations, newspapers read, household size and structure and so on are used to determine the representativeness of the sample and to explain the variation in WTP / WTA responses.

The wording of most crucial questions (especially the valuation scenario), the choice of valuation technique, the options in multiple choice questions (e.g. the various uses made of the resource) and elicitation format, if contingent valuation technique is used (e.g. open-ended, dichotomous choice or payment ladder) are all tested in the next step of the workplan.

5. Testing the questionnaire

There are three tests that a questionnaire should ideally go through. The first two, namely, focus groups and pilot surveys, contribute to the design of the questionnaire. The last test, i.e. the main survey, is the final testing ground for the final version of the questionnaire.

Focus groups are semi-structured discussion groups led by a moderator, in which participants are given a topic and left more or less free to discuss the issues surrounding it. In this way, attitudes about the issues can be reflected in the design of the questionnaire so as to make it credible, meaningful and easily understood. In general, a maximum of six focus groups is conducted since beyond this the feedback tends to become repetitive. Each group generally consists of 6-8 people and participants are paid for their time.

Based on the outcome of the focus group discussions, the questionnaire is revised and piloted on a sample preferably of at least 50 respondents at a time. Piloting the main questionnaire provides an invaluable assessment of how the wording, structure and content of the questions work in the field, and ensures that valuable time and money is not wasted by asking ineffective questions, or questions that cannot be easily understood or answered by members of the public. Once the responses are analysed and further iterations of the questionnaire are developed after the first pilot results, if necessary, a second pilot may be conducted.

Finally, the main survey involves fieldwork and data entry having decided on the sample size and sampling method. Fieldwork should be undertaken by trained interviewers. At least the

field supervisors should be briefed about the objective and contents of the questionnaire prior to the survey.

6. Econometric analysis

Econometric analysis involves summary statistics, central tendency measures such as mean and median WTP / WTA, and estimation of the bid function that explains the WTP / WTA responses as a function of resource and respondent specific variables. Statistical design techniques are also used earlier in the process of designing a choice modelling

The details of the econometric models that can be used are widely discussed in the literature (for an overview see Bateman et al, 2002). This discussion is not repeated here. It suffices to note that econometric analysis should be undertaken by qualified experts and could take a couple of weeks or more depending on the complexity of the questionnaire design and number of observations.

7. Validity and reliability testing

The hypothetical nature of stated preference techniques gives rise to concerns about the validity of the responses received and the reliability of these responses across studies and across time. Concerns about validity need to be taken into account during the design stage of the survey to avoid invalid results since after the main survey, econometric analysis can do very little more than detect the problems of validity.

Nonetheless, a number of tests are devised to test the validity of the results. These include the following:

- Content validity refers to whether the study asked the right questions in a clear, understandable, sensible and appropriate manner with which to obtain a valid estimate of willingness to pay. Most of these concerns relate to the way the questionnaire is designed and that is why the questionnaire goes through a number of iterative design-test-redesign stages as stated above.
- Construct validity examines whether the relationships between WTP estimates produced by stated preference study and other measures are in accordance with prior expectations based on economic theory (expectations-based validity) and empirical evidence from previous studies (convergent validity).

In cases where the validity of the results is doubtful, the existence of 'biases' should be tested. The term bias refers to the case where the stated WTP / WTA is different than the true WTP / WTA of the respondents. For example, protest bids (e.g. zero WTP due to the belief that 'government or water companies should pay' or unrealistically high WTA amount) are a form of bias. Respondents consistently refusing to answer certain questions or certain group(s) of respondents refusing to join the survey could also lead to biases in mean WTP / WTA estimates by leaving out important information or threatening the representativeness of the sample. For a complete coverage of biases, see Bateman et al, 2002.

Reliability of results can be tested by:

- comparing the WTP distributions from the two independent but statistically equivalent samples from the same population; and
- comparing whether repeated applications of the same questionnaire produces similar results.

Given the limited resources available for individual studies, these reliability tests cannot be reasonably expected from each study. However, if individual studies are commissioned as part of a concerted research programme, as the case may be for the PR process, questionnaire design and testing could include factors to enable reliability to be tested.

8. Aggregation and reporting

There are three approaches to the aggregation process:

- aggregation across the change in question. This is especially relevant for the choice modelling technique, in which WTP / WTA for marginal changes in individual attributes can be aggregated to estimate the WTP / WTA for bundle of attributes under different scenarios;
- aggregation across the affected population, which, given the affected population is correctly identified and the sample is proven to be representative of this population, involves simply summing individual WTP / WTA across the population for the change of concern. A slightly more complex process involves aggregation using the so-called 'distance-decay'[21] or 'exposure-decay' functions. These functions show the relationship between the distance of residence from the resource or the frequency of use of the resource and WTP / WTA responses. If these relationships exist, WTP for each separate population group (that fall into different distance or exposure bands) should be aggregated separately. Note that if the study is required to estimate these functions, the sampling strategy (Step 3) and/or questionnaire design (Step 4) should take this requirement into account.
- aggregation over time using the standard approaches to discounting.

The final step of the workplan is reporting. Consistent reporting aids interpretation of the results by providing all the available information on each step of the study workplan. It also aids subsequent validity testing, especially that for convergent validity.

The complexity of design, and size and diversity of sample are the main determinants of the time and effort required for a stated preference study. Studies that cover subjects that are familiar to respondents and / or have previously been researched by economists are likely to require less design and testing time. On the other hand, studies that are designed to value small changes and unfamiliar resources are likely to require more effort to ensure that respondents understand what they are asked to value.

The total cost of a stated preference study consists of the cost of staff time for design, testing and analysis; and the cost of fieldwork for focus groups, and pilot and main surveys. The time required for a stated preference study could vary between a few months to over a year again depending on the number of test - redesign rounds that are required and the sample size which will affect the time taken for the fieldwork.

3. A recent stated preference study: Thames Tideway combined sewage outflow

The Thames Tideway is the working term for the estuarial River Thames and covers the stretch of the river from Teddington to the seaward limit. However, the main study section ends at about QE2 Bridge. The current intercept sewage system built in the 19th century

[21] In fact, a 'distance-increase' function could also be observed. For example, for a reservoir scheme, those who are in the vicinity of the site may not be willing to pay in favour of the reservoir since they may oppose the landscape change, while those who live further away may be willing to pay for the reservoir since they are not affected by the landscape change in any way and may value the security of water supply afforded by a reservoir.

carries both human waste and storm water and overflows at times of severe storm events. These are called Combined Sewer Overflows (CSOs). Overflows from the sewage network occur at some 63 CSO outfalls along the Tideway during heavy downpours as the capacity of the system becomes overloaded. With the overflows, sewage litter and pollutants are deposited in the river without any treatment causing visual disamenity (due to the sewage litter), as well as elevating the risk to human health (e.g. mild stomach upset) from recreational use of the river and to fish species, especially fish fry.

In light of these concerns, a strategic study is being carried out to investigate the issue of CSOs and identify possible solutions for implementation post 2005. The strategic study is overseen by a steering group consisting of representatives from DEFRA, the Environment Agency, Thames Water and the Greater London Authority, with Ofwat represented in an observer status. The scale and complexity of the investments required to address the overflow problem mean that the decision making process needs to take a large number of factors into account. Three working groups, also representing Thames Water, regulators and independent experts, were therefore set up to report to the steering group on different strategic issues.

The working groups are referred to as the Objectives, Solutions and Cost/Benefit working groups and each have different roles to play. The Objectives working group's role is to identify the potential statutory and non-statutory objectives that could be applied to the Tideway, while the Solutions group is given the task of developing and costing engineering solutions to meet the objectives set. The Cost/Benefit group is charged with estimating the relative costs and benefits to society of the solutions devised by the Solutions group.

Acting through Cost/Benefit Working Group, Thames Water commissioned three studies to estimate different components of benefits and costs. One study looks at the costs and benefits that can be observed in the market and measured with market prices, such as potential impacts on economic sectors. However, many of the benefits and costs of the solutions are often not traded in markets, such as benefits to recreation, the environment and amenity. These are referred to as non-market benefits and costs and are valued using non-market valuation techniques. Given the wide range of non-market costs and benefits, two studies were commissioned – one covering the non-market costs, and the other (the study summarised here) covering the non-market benefits.

The non-market benefits study commissioned in July 2002 used both choice experiment and contingent valuation (dichotomous choice) techniques - the latter as a backup for the former. The following attributes were used in the choice experiment design:

- **sewage litter** - human excrement and other toilet litter such as condoms and sanitary towels. Sewage litter took on four levels (10% of general litter in the current situation; 3%, 1% and 0% (total elimination));
- **water sports: human health** - the number of days a year when there is an increased risk of suffering minor illnesses – such as mild stomach upset – due to the effects of sewage overflows on water quality. Water sports – human health took on five levels (120 'unsafe' days a year in the current situation; 60,10,4 and 0 days);
- **fish kills** – number of overflows a year that are big enough to pose a risk to fish populations, potentially killing all the young of a particular species born in that year. Two different values for the current situation with regard to fish kills were used to reflect the scientific uncertainty surrounding this impact. Therefore, fish kills took on five (8 fish kills a year in current situation; 4, 2, less than 1 and 0) or four levels (4 fish kills a year in current situation; 2, less than 1 and 0) depending on the current situation assumption;

- **cost** – increase in annual water bills which would be needed to finance the new investments to reduce the overflow problem. Cost was randomised using eight values in total (£0 in current situation; £5, £15, £23, £36, £45, £77 and £115; and
- **general litter** – such as cans and plastic bags that are thrown into the river. Tideway Strategy would not change the presence of general litter in the river. This attribute was included in the choice sets to make it very clear to the respondents that it does not change. Therefore, it took only one level: 'present'.

The highest levels of improvements were also valued as a discrete change in a dichotomous choice contingent valuation question.

The survey had 16 versions in order to:

- estimate willingness to pay for the **range of levels and attributes** presented in the choice experiment (by spreading the 32 choice sets required for estimation of the model amongst four sub-samples so that each respondent only received eight cards each, i.e. a manageable number);
- test whether respondents were sensitive to the **time-scale** over which the environmental improvements would be delivered (two scenarios presented: 3 to 6 years and 10 to 20 years);
- allow the **dichotomous choice** contingent valuation question to be estimated (eight bid levels required); and
- test different **baselines for number of potential fish kills** (four and eight fish kills a year) to account for scientific uncertainty.

Both distance and exposure-decay functions were sought through the sampling strategy and the questions on the types and frequency of use of the River. The results show that there is no significant distance-decay function but the exposure-decay function exists and is significant. In other words, all else remaining the same, those who use the River more frequently, are willing to pay more for its improvement.

Six focus groups were conducted in August 2002 in central and north London and in Berkshire. A two-stage approach was used for the pilot study (over August and September 2002), in order to maximise the research value of this testing stage. Each stage consisted of about 50 face-to-face interviews under taken over two weeks with two weeks in between to allow any lessons from the first stage of the pilot to be incorporated into the questionnaire for the second stage. During the main survey, which took place between late October and early December 2002, 1,214 respondents, all Thames Water bill payers, were interviewed.

The project was conducted between July 2002 and February 2003. The project cost around £120,000 including all personnel time, fieldwork and other expenditures. An interesting aspect of the project implementation that is highly recommendable for future application was the set up of the steering group, which included Thames Water, Environment Agency, OFWAT, DEFRA and Southern Water. The three regulators and Thames Water are in close cooperation to administer different aspects of the Tideway Strategy. The particular individuals who were part of the Cost Benefit Working Group (and the steering group) were all informed about stated preference techniques and some had even undertaken or managed studies using these techniques. This overall interest in the strategy and knowledge of the techniques by the steering group ensured collaboration throughout the study leading to a satisfactory product that all stakeholders were willing to accept.

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Chapter 8

The Way Forward for Benefit Assessment

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1 Benefit assessment and the Environment Agency

My first reaction to the recent work that the EA has undertaken in the context of cost-benefit approaches to water resource issues is that it is gratifying to see the Agency taking economics more seriously than it has in the past. While the resources allocated to economic analysis within the EA are still clearly very modest, there are encouraging signs that they are being increased. Judicious use of outside consultants can leverage this work very effectively. I am also pleased to see a more open recognition of the comparative merits of cost-benefit analysis (CBA) compared to other evaluation techniques such as multi-criteria analysis (MCA). MCA has its place but, however it is presented, it remains a cost-effectiveness procedure, not a cost-benefit procedure. There are important differences between the two. In CBA the objective function is clear: it is the maximisation of economic efficiency, although it is perfectly valid to temper this with distributional concerns – i.e. an interest in who gains and who loses - by adopting distributional weights (Pearce, 2003). In MCA there is no explicit objective function. It is whatever the decision-makers declare it to be, and, indeed, the point of MCA is to accommodate a wide range of decision-maker goals. While this appears to be an advantage over CBA, in my view it invites woollier thinking and the potential for inconsistent or overlapping goals. Put another way, there is a strong temptation to ask that policies and projects achieve too many things at the same time. Second, MCA, like narrower cost-effectiveness rules, can only provide a *ranking* of alternatives. It cannot tell us whether anything is worth doing. Put another way, we may rank A higher than B and B higher than C, but MCA gives us no idea whether we should adopt any of A or B or C since they may all be undesirable, and the ranking may simply tell us which is the least undesirable.

This does not mean that cost-benefit analysis is easy to do or non-controversial. It has a set of self-contained requirements that follow from an underlying value judgement that, in this case, water resources and water quality should reflect individuals' preferences. Like all value judgements, we have no 'meta judgement' by which to say this is the best possible value judgement to adopt. But it has the virtues of being democratic and of making Agency decisions accountable to the public interest. While some opposition to the philosophy of cost-benefit analysis is likely to remain for a long time, the real issues involve the practice of cost-benefit. A few of these issues are raised in what follows.

2 On the use of cost-benefit analysis

The Agency could be somewhat clearer about the questions it is trying to answer when it makes use of benefit assessment. In the case of the 4th Periodic Review (PR04) of the water companies, the rationale is stated as being one of providing some social justification for the environmental component of that programme. But it is not clear to an outsider what the decision process is that would ensue if costs were found to be greater than benefits for any individual scheme. The division of schemes into statutory and non-statutory could also be expanded upon. Statutory schemes have to be carried out, and the imperative with such schemes is therefore cost effectiveness rather than cost-benefit analysis. Nonetheless, there is growing evidence that the legislation, much of it emanating from Brussels, that makes

schemes statutory itself fails a cost-benefit test (Pearce, 2002a). I would suggest this conclusion applies to the Water Framework Directive which I argue elsewhere owes more to the emergence of the 'public trust' or 'strong sustainability' doctrine than it does to rational economic appraisal (Pearce, 2002b). I would take the view that there is a duty on the Agency to evaluate all schemes with cost-benefit analysis. Even if it cannot make a difference to schemes in the pipeline, it may help to build up a body of analysis that can be used to inform the European Commission and others that they are failing to abide by the cost-benefit requirements of the Treaty of Union – see Article 130R. In other words, even if the Agency has to work with the statutory-non-statutory distinction, which it clearly does, the proper role of economic analysis is being thwarted by not appraising statutory schemes in terms of costs and benefits. Effectively, optimisation is being practised across a subset, and arguably a less important subset, of the investment portfolio in PRO4.

3 Benefits transfer

The methodology espoused, in the main, by the Agency is benefits transfer, which might better be termed 'value transfer' since it is not just estimates of benefits that get transferred. Value transfer involves taking existing studies and 'borrowing' either the mean values of benefits from those studies, or borrowing a benefit function which shows how benefits (willingness to pay) varies with determinants such as income, social characteristics, characteristics of the water body etc. Function transfer therefore involves taking a function such as

$$WTP = a_1 C_1 + a_2 C_2 + ... + a_n C_n$$

where WTP is willingness to pay, $a_1 \ldots a_n$ are the estimated coefficients and $C_1 \ldots C_n$ are site and valuer characteristics. Applied to a new study area, the relevant values of $C_1 \ldots C_n$ at the new site can be substituted to obtain a predicted WTP for the new site. A more sophisticated approach is to take WTP functions for several sites, then use some meta-function from those studies to predict WTP at yet another site, but simultaneously conducting a primary study at the new site. Predicted and 'actual' WTP can then be compared, as can the values of the relevant coefficients. For example, we may have WTP equations for n sites. The meta-equation for n-1 sites can then be used to explain the values at the nth site. Predicted and 'actual' WTP can be compared. But function transfer is sometimes interpreted as taking a function at one site and applying the whole equation to another site where no primary study has been conducted and inserting the relevant values of the second site variables. This second approach is marginally more sophisticated than borrowing unit values since the unit value approach would not allow for the fact that the unit values may vary with income, age, education etc. But it should be obvious that we have no test for the validity of this transfer.

The use of value transfer is entirely understandable, not least because it appears to avoid the cost of 'primary' studies. But there is a paradox in value transfer. Transfer values are what we would use when we have an adequate stock of primary valuation studies on which some meta-analysis might be performed. In other words, value transfer is seen as the *end result* of a process, which may well be a long one, of experimenting with different valuation techniques and applying them in as many contexts as possible. To a decision-maker, however, value transfer is what one starts with because (a) decisions have to be made now and cannot wait until the academics are satisfied that enough primary studies exist; and (b) primary studies cost money, take time to do and the kinds of budgets available for this kind of work tend to be trivial. In other words, for the decision-maker, value transfer is the start, not the end of the process. It is encouraging to hear that the Agency is persuaded of the case for co-sponsoring

further primary work, and that it has already commenced that process. In the meantime, and really for the foreseeable few years, value transfer is all we have. Unfortunately, as is well known (Brouwer and Spaninks, 1999; Bateman et al. 2000), we have very few tests of the reliability of BT. Ignoring geographical area, meta-analyses relevant to the water contexts has been conducted for recreation, recreational fishing and wetland functions only. Conspicuously absent are meta-studies of water quality and even water demand. If we impose a restriction on the studies being relevant to the UK or Europe, we have even less to go on. Moreover, the values used in the RPA study for the EA are unit value transfers and generally do not arise from transferring benefit functions. While there is a presumption that transferring benefit *functions* is better than transferring *unit values*, not all of the literature is agreed upon this. Accordingly, we must be honest and say that we do not know the error attached to the kinds of values that the Agency is using. This is not a criticism of the Agency, since we all do it, and it has, for example, even been taken to the level of country-specific recommended values for air pollutants in Europe (Holland and Watkiss, 2001). But we also need to be honest and remind ourselves that we do not know if the values currently being used are accurate or not.

All this immediately suggests one action the Agency could take in the immediate future, namely a critical review of the transfer literature and where we stand on its reliability. The paper by Bateman and others (Bateman et al. 2000a) would be a good starting point.

4 Non-use values

There is an understandable concern with non-use values, partly because, if relevant, they may be large in unit value terms, and partly because, even if they are small, their aggregation across large populations can produce very large numbers. As with value transfer, I think it would be worth exploring where we stand on non-use values. One dominant issue is *motivation* for non-use values. This concerns whether non-use values reflect some ethical motivations and whether those ethical motivations are consistent with cost-benefit analysis. My impression is that most of the literature has failed to elicit motivations for respondent answers, or, if it has sought to define motivations has done so in a fairly non-rigorous fashion. Motivational studies should also help us understand better when non-use values are relevant and when they are unlikely to be important. This issue has been widely debated in the literature (see, for example, Johansson-Stedman, 1998), and a review would be valuable before launching into new studies. The other issue, as the Agency has noted, is distance-decay, i.e. whether value decline with distance from the object of valuation. We seem to have comparatively few studies that seek to measure distance-decay and what we have seem to produce inconclusive answers. For example, Georgiou et al. (2000) conduct a contingent valuation and contingent ranking exercise for willingness to pay to improve water quality in the River Tame, Birmingham. Respondents were users and non-users and a clear distance decay function emerges. But the independent variables explained only three per cent of the variation in willingness to pay, perhaps due to the open-ended format of the questionnaire and the failure to identify respondent incomes. While the low explanatory power of the WTP equation does not invalidate the distance-decay association, the result leaves an uneasy feeling that the distance-decay outcome is not robust enough for generalised value transfer purposes. More reassuring are the results from the study of the Mimram (Hanley et al. 2003). They find that non-use and use values exhibit distance-decay, the former less markedly than the latter. The general lesson, however, is that more studies of this kind are needed before distance-decay functions can enter into value transfer in a credible fashion. Studies also need to probe the reasons for distance decay (or its absence) in order to inform any meta analysis.

5 Future priorities

The previous discussion suggests at least two short-term priorities. The first is a review of the credibility of value transfer, including distance-decay transfers for both use and non-use values. The second is a closer look at non-use values and the fairly significant but varying literature surrounding the issue of motivations. So, I would suggest first commissioning a thorough review of the benefits transfer literature with the primary focus being on water and water quality. This need not be a lengthy review but it should take the existing literature and interpret it for a wider audience. Nearly all the benefits transfer literature is written for academics. Second, commission a similar review of non-use value, its legitimacy in cost-benefit analysis, and what the literature tells us about motivations and distance decay. Again, some of this has been done but a readable review would be very valuable. Third, assemble a small 'Blue Ribbon' panel of eminent environmental economists, of which the UK has an excellent endowment. Give this panel a clear terms of reference which should relate explicitly to the questions that the Agency wants answered. Then let the panel devise a research strategy for primary studies with no restrictions on the forms of the studies, but with an hypothetical (but realistic) budget. Without prejudging the terms of reference, it would seem eminently sensible to have this panel devise detailed terms of reference for conducting primary studies across several sites with one aim being the testing values transfer. One of the problems of relying on existing studies for the purposes of value transfer is that the studies vary in quality and approach: some standardised procedure is needed and we now know enough to establish what is 'good practice' in stated preference studies (Bateman et al. 2000b).

Finally, these recommendations imply that there are things it is not worth doing. I do not think it is worth trying to 'mine' the existing literature any further. It is more important to sort out what the priority questions are and what a dedicated research programme would look like. I also do not think it is sensible to commission further primary studies without first going through the Blue Ribbon panel process.

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Chapter 9

Summary of Key Issues and Proposed Next Steps

Jonathan Fisher
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1. Introduction

This paper highlights issues and suggested next steps from a detailed review of the Agency's guidance on assessing environmental benefits for PR04. This draws on comments made by discussants (see Chapters 5, 6, 7 and 8) and participants at the seminar in Oxford. It also draws on subsequent discussions on this subject, including the Agency's initial application of the guidance and feedback from pilot exercises and training. It uses the terminology in the initial Ministerial guidance[22].

2. Overview of Guidance.

The seminar considered that the Agency's work on benefits assessment is serious and creditable and much better than that for AMP3. The BAG guidance for assessing benefits of "choices to be made" schemes was considered as being the best that could be done for PR04 and a good basis for the future. The methodology and values were considered to make the best use of the available data.

The main "choices to be made" schemes in roughly descending order of costs are: Freshwater Fish Directive (F3 and F2); RQOs (R1, R2, R4); shellfish (S2); local priority (L1); bathing waters (B4); and BAP schemes. These cover most of the main environmental benefits highlighted in Section 3 below. The shellfish and bathing waters drivers concern impacts on shell fisheries and reductions in risks of illness from bathing, respectively, but could also yield other wider non-use benefits.

The Oxford seminar stressed the importance of the following aspects that are addressed in RPA's Benefits Assessment Guidance (BAG):

- BAG assesses the specific effects of schemes on environmental outcomes by grade change. Need to check whether customers can perceive these environmental benefits.
- BAG is more clearly linked to possible schemes and drivers in PR04 and the technical and scientific assessments of their effects on key environmental outcomes to be valued, which Eftec highlight as being crucial. However, allowing adequately for the considerable uncertainties surrounding the science and the risks of environmental impacts arising is a major challenge.
- BAG examines whether impacts likely to arise. It applies valuations specifically for them (i.e. it is does not just assume that benefits will arise everywhere). Thus we allow explicitly for whether or not there is accessibility in estimating benefits for informal recreation.
- Willis rightly points out the dangers of double counting in using many of the existing studies. BAG avoids double counting far as possible. The guidance explicitly has factors to adjust benefits values (e.g. for amenity impacts on property prices) in respect of

[22] DEFRA (2003) Initial Guidance from the Secretary of State to the Director General of Water Services: 2004 Periodic Review of Water Price Limits

possible double counting with use values that are estimated separately in the use benefits categories.

- Willis rightly points out the problems of extrapolating values for one major environmental change to a much smaller one. BAG tries to avoid these problems as much as possible by transferring values that relate to a set of specific environmental changes (i.e. use one set of available values for changes from RE3 to RE2; and another for changes from RE4 to RE3).
- Importantly, BAG sets out transparently the steps involved in calculating the benefits and the basis and assumptions behind the valuations and estimates.
- BAG allows for sensitivity analyses to be carried out using the spreadsheet calculator.
- BAG enables and facilitates pragmatic focus on how to use this benefits assessment to aid decisions on whether benefits exceed costs. It does not get unnecessarily worried about uncertainties and precision – i.e. if sensitivity analysis shows that a reasonable range of best available estimates of benefits exceed costs then scheme should go ahead. Thus we can then focus the analyses on those costly contentious cases where balance of costs and benefits is not clear.

RPA's report obviously includes good work by the authors who carried out the extensive studies used in the FWR manual (e.g. Ken Willis, Vivian Foster, Colin Green et al). But the BAG guidance also provides the following value added contributions:

- BAG was based on a review of the merits, usability and limitations of various existing pieces of guidance. It has accordingly incorporated various lessons to overcome some of the problems with past guidance. For example, we explicitly include reality checks to overcome earlier problems with mechanical application of the FWR manual.
- It is as user-friendly as possible, with worked examples. It focuses on an output matrix (AST tables) with hypertext links that enable the reader quickly and easily to go to the appropriate elements needed to derive the valuations.
- We have used the best BT values available. Eftec carried out for us a comprehensive review of the present valuation literature. Possible gaps in the studies we covered include an unfinished study on benefits of reduced CSOs for Thames Tideway. Eftec's review found that many of the existing valuation studies do not specify clearly the environmental changes in question or are not directly useable for assessing benefits of PR04 since they do not relate clearly to the sort of environmental changes achievable by PR04 schemes.
- RPA draw on some more recent studies for the Agency, such as ERM (1997), and Jacobs Gibb's (2002) study of the Mimram. They recommend using these studies for non-use values for low flow alleviation schemes and for recreation benefits of a minor river with poor access even though they give lower values. But, for non-use values for water quality changes, they suggest use of the older Willis and Garrod (1995) values for the FWR manual rather than the higher more recent values in Georgiou et al (2000). This is because of possible double counting of use benefits being included in the benefit values in the latter study.
- BAG allows for distance decay effects differentially with respect to whether the site is of local, regional, national or international importance and the degree of environmental change. The FWR manual just used the number of households in the water company region, which was criticised in the Axford case. Defra ministerial guidance highlights the importance of local differentiation for local priority schemes.
- BAG contains considerably more detail on estimating relevant populations. It allows for extent of accessibility of site and uses latest Agency data (e.g. rod licences).

We have focused on doing benefits assessment for the several hundred "choices to be made" schemes so as to enable the economic appraisal to be of most help to aid Minister's decisions on the outstanding choices they face in PR04 (see Fisher's paper). Pearce suggests that cost-benefit analysis should also be applied to existing statutory schemes, as part of an evaluation of the requirements. The purpose of any such evaluation should be to improve analyses for future decisions, which is what we are doing here in applying cost-benefit analysis for the "choices to be made" schemes. Requiring benefits assessment for the much larger number of statutory schemes as well would considerably increase and stretch the resources required and constrain the extent of benefits assessments that could be carried out. This would limit the ability to address the issues raised by the seminar concerning the benefits assessments. Moreover, such benefits assessments of statutory schemes would not improve the decisions to be made on them in PR04 – since cost-benefit considerations are not valid considerations in an infraction proceedings.

The Agency has carried out the following tasks to address issues and criticisms made at Oxford seminar:

- Completed quickly process guidance that is as easy as possible for area staff to apply so that they complete the assessments ASAP.
- In response to Willis and Pearce's comments, we used DEFRA's ranges for costs of climate change to derive ranges for the external climate change costs of energy for treatment options (over and above the climate change levy already paid by the water companies and included in the financial cost estimates).
- Chapter 2 in this report clarifies the role of the benefits assessments in decisions on the "choices to be made" schemes.

3. Outstanding Issues Raised by the Seminar

The Oxford Seminar and subsequent discussions have highlighted the following outstanding issues regarding specific environmental benefit valuations about which there may be some uncertainties:

A. Non-use valuations, about which there are concerns regarding:

i. The estimates of beneficiaries, which is the most important factor. We allow for distance decay effects differentially with respect to whether the site is of local, regional, national or international importance and the degree of environmental change. However, as Willis acknowledges, we are restricted to using the only two available useable studies of local water problems; Mimram (Jacobs Gibb (2002) and Georgiou (2000)). Georgiou has a greater distance decay effect and a smaller boundary for valuation of water quality improvement in an urban river while Jacobs Gibb found little distance effect and find non-use values for water resource improvements 120kms away from a rural river. Pearce questions the validity of Georgiou's findings. Similarly Eftec found no distance decay effect in the values for the benefits of reduced incidence of Combined Sewer Overflows in the Thames Tideway study. RPA apply a reasonable but perhaps lower bound compromise of a 30km boundary for estimating beneficiaries for small changes and 60km for large changes at a river of local significance and 150 kms for large changes at a river of national or international designation and importance (see Table 9.1). There is currently an important gap as to what is the appropriate scope of beneficiaries for national and internationally important assets, on which there are no

directly useable studies. Willis states that the boundaries applied in BAG are arbitrary but concludes that they are the best available judgement that can be made.

Table 9.1: Distance Decay Assumptions for Determining non-use Population

Conservation Importance (1)	Degree of Environmental Quality Change	Distance (radius) Assumed Relevant for Aggregation
Local only	Low	30 km
	Moderate	40 km
	High	60 km
Regional	Low to Moderate	60 km
	High	120 km
International/National	Low to High	60 km to 150 km

Source: Environment Agency (2003) Guidance for the Assessment of Benefits for Water Quality and Water Resources Schemes in the PR04 Environment Programme.
Notes: (1) Defined in Table 9.3 of Environment Agency (2003)

ii. Dickie questions whether BAG's non-use values capture fully individuals' views, especially regarding intangible environmental benefits, future benefits, irreversible impacts, ecological benefits and impacts on ecosystems from water improvements (see Table 9.2). Pearce stresses our lack of knowledge about motivations behind the non-use values elicited in the existing studies and how these can motivations should be used in a benefits assessment. The available valuations appear weakest for those impacts about which people are most concerned. Dickie stresses that, as a result, such concerns must not be downgraded in the assessment.

Table 9.2: Functions and Services Provided by Rivers and Wetlands

Function	Description
Flood water retention	Storage of floodwater Detention of surface runoff
Groundwater recharge	Infiltration of floodwater into the wetland surface followed by percolation to a significant aquifer
Global life-support	Carbon storage
Sediment retention	Net storage of fine sediments carried in suspension by river water during overbank flooding events Net storage of fine sediments carried in suspension by surface run-off from other wetland units of the contributory area
Nutrient retention	Plant uptake of nutrients (nitrogen and phosphorus) Storage of nutrients (nitrogen and phosphorus) in soil organic matter Absorption of nitrogen as ammonium Adsorption and precipitation of phosphorus in the soil Retention of particulate nutrients
Ecosystem maintenance	Provision of plant and overall habitat structural diversity Provision of microsites for: - Macro-invertebrates - Fish - Reptiles - Bird - Mammals
Food web support	Biomass production Biomass import via physical processes

Function	Description
	Biomass import via biological processes Biomass export via physical processes Biomass export via biological processes
Landscape and amenity	Already included in BAG under: Section 6: Amenity, Property Prices and Regeneration Section 8: Heritage, Archaeology and Landscape
Agricultural and commercial outputs	Grazing marshes, reed cutting, sedge production, willow, biofuel production, fishing, wildfowling, etc. (direct uses of the wetland)
Recreational services	Already included in BAG under: Section 2: Informal Recreation Section 3: Angling Section 5: In-stream Recreation
Non-use values	Existence Values
	Incidental use (i.e. enhanced enjoyment of visit (e.g. to a village) because of good quality river even though not visit river - see Mimram study)
	Option value
	Ethical concerns and values
	Bequest values for future generations

Source: Maltby et al (1996) in RPA (2001); English Nature (2001); English Nature (2002) reported and used in sections of the BAG as shown above (Environment Agency (2003)

iii. Old Studies. The Suggested BT values are based in places on studies carried out in the mid 1990s for the FWR manual. But, for Water Resource schemes, we use the more recent values from the Mimram study (Jacobs Gibb (2002)). For Water Quality schemes, we suggest use of the study for non-use values of water quality changes (Willis and Garrod (1996)) rather than the higher more recent values in Georgiou et al (2000) to avoid possible double counting of use benefits in the latter study. But Willis and Garrod's values appear low, especially in respect of rural and semi-rural sites. There are some odd differences between the findings of the various studies, which are difficult to explain without a detailed investigation of them.

B. Whether the values take full account of income constraints?

BAG bases the BT values for Water Resource schemes on surveys for Mimram (2002). This builds in income constraints by first estimating values for an overall programme of all low flow schemes in the region and then asking what proportion of this total would respondents be willing to pay to alleviate low flows at a specific scheme on a local river (the Mimram). However, some participants at the Oxford seminar suggested that Yorkshire Water's survey better takes account of income constraints for an overall package of all schemes affecting households in an area (see Chapter 5). But there are doubts as to whether it is possible to cover fully all the environmental benefits of PR04 in the limited four environmental benefit categories out of the 14 that can be handled in such a wide ranging survey (see Chapter 5). Note the problems above as to whether even the individual CV studies can adequately capture all the non-use benefits shown in Table 9.2. It is also not clear that the Yorkshire Water Survey adequately reflected incremental changes in the environmental benefits. There are also concerns as to whether this survey gave respondents sufficient information on the environmental benefits that consumers can less readily discern compared with tangible water services in their homes. Hence there are concerns that these considerations could mean that Yorkshire Water's comprehensive survey could accordingly underestimate the benefits.

C. We have transferred valuations from studies of major discrete changes. Eftec point out that, in reality, PR04 would achieve marginal environmental improvements. Moreover, Willis questions whether the values from studies of discrete changes are appropriate for the sequential effects of the improvements in environmental outcomes from a "choices to be made" scheme over and above that of a statutory scheme (see Chapter 5).

D. Constraints on ability to transfer values from studies to all scheme sites in AMP4, especially for highly local and distinctly different impacts and variations in key factors, such as existence of substitute sites, although RPA guidance allows for this for use value categories. We have transferred individual valuations that relate to specific schemes. Ideally we need to develop and apply a Benefits Transfer function to derive appropriate valuations for specific cases (see Chapter 5). But there is currently not enough good systematic UK studies to develop a proper BT function.

E. The amenity impacts on property prices are based on a thorough USEPA study that formed the basis of the FWR manual's treatment of this subject. This included a full literature review and 7 specific case studies where water quality improvements had taken place[23]. Discretionary schemes in PR04 would probably affect the clearness and algae criteria and possibly also the colour criteria identified in this study as affecting property prices.

F. Need in-depth analysis of economic regeneration benefits for contentious cases.

G. Gaps in valuations for wetlands since the available studies do not cover the types of environmental changes that could arise from PR04 schemes, with the exception of Garrod (2000). There are also gaps in non-use and wider environmental benefits of bathing waters and shell fish drivers, which may be different and wider than non-use benefits of rivers (e.g. more upstream benefits, impacts on migratory fish etc).

H. Uncertainties about estimating visitor numbers (see Chapter 5); but there are practical constraints on the extent to which the Environment Agency staff can derive better estimates in the time available for the assessments.

I. Angling benefits. BAG inadequately covers blocks to migratory fish and upstream benefits of measures to overcome such blocks and does not allow adequately for major quality changes leading to significant non-marginal changes such as opening up new recreation and fishing opportunities.

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[23] Study found that effective pollution abatement on badly polluted water bodies can increase the value of single-family homes situated on waterfront by 8 – 25%, and can affect property values up to 4000 feet away from the water's edge. It was also found that the measurable water quality parameters which have the greatest influence on property values are dissolved oxygen concentration, fecal coliform concentrations, clarity, visual pollutants (rubbish and debris), toxic chemicals, and pH. Study did not develop a new index relating changes in property-value-to-changes-in-the-most-frequently-measured-water-quality-parameters because the technical data necessary to define and use such an index was lacking. Measurements for the many parameters required to derive a meaningful index were not collected and recorded systematically or at enough places for us to do a useful analysis. Therefore the study used the results of interviews to derive the relationship between peoples' awareness of water quality changes at each site and tangible impacts on property values which we measured using regression analysis.

J. Old Studies. Some of the non-use values for water quality improvements are based on Willis and Garrod (1995) (see above). The angling benefits in BAG are based on 1996 studies for FWR manual. In-stream and informal recreation benefits are based on 1990/1/2 studies. Values might have risen since with rising incomes and increasing scarcity of environmental assets, but may also have fallen due to diminishing marginal utility for environmental improvements and because customers have since paid for environmental improvements since then. Need to check how values have been derived in terms of the water quality conditions at that time and the validity of applying these values to current improved conditions today. There may also be lower values for improvements for coarse fishing as water quality improves, but this is only likely to be significant in specific cases.

K. Impacts on shellfisheries are based on old data. Need updating with modern estimates.

L. Sunman reports that Values based on WTP which are significantly lower (by a factor of up to 10) than WTA. Whether WTA or WTP is appropriate depends on property rights in a clean environment. WTP generally considered more appropriate for assessing discretionary environmental improvement schemes in PR04. But WTA might be more appropriate for prevention of deterioration in F2 and F3 schemes and, looking forwards, to the Water Framework Directive.

4. Way forward and next Steps

The seminar suggested the following actions to improve assessment of environmental benefits:

- Short term actions by August 2003 to improve benefits assessments for PR04
- Concerted long term action to improve benefits assesssment for the implementation of the Water Framework Directive (WFD)

Proposed Short term actions

The short term actions focus on validating and cross checking the valuations in the BAG guidance so as to increase confidence in them and generating additional information that will be useful for sensitivity analyses to aid decisions on the schemes. A first step is to clarify existing information and valuations. A second is to conduct an in-depth analysis of existing studies. This will aim to explain differences in findings and odd results, esp regarding non-use values for water quality improvements. It will focus on the following studies:

- Non-use values for water quality improvements. Need to estimate separately non-use values in Georgiou et al (2000) and then compare these with the non-use values in Willis and Garrod (1995). Need also to compare with those non-use values given by more recent studies for water resource improvements. Need to check how the Willis and Garrod values were derived; they appear to have estimated the total value for the whole country and then divided by the total population and total river length. We need to check if this is appropriate for use in BAG, which uses actual local river lengths and our estimates for beneficiaries (which incorporates a distance decay function).
- Non-use values for water resource improvements. Compare and make consistent users and non-users' non-use values in Mimram (Jacobs Gibbs (2002)), ERM (1997), EFTEC and CSERGE (1998) and Willis and Garrod (1996).

- Bathing waters. Reduced illnesses from bathing. Georgiou et al (2000) and Eftec (2002). Need to clarify differences and determine which is appropriate for our purposes. Need to clarify how the values relate to % point reductions in risks of illness.
- Estimates of non-use beneficiaries, including consideration of Distance effects analysis.

This review will examine and if possible quantify the effects on the values chosen of the following factors:

a) Non-use values for water quality in Willis and Garrod being much lower than Georgiou (2000) – probably even after deducting the use values from Georgiou's estimates. Also their non-use values are lower than those for water resource schemes.
b) Need to clarify just what is included in the values for each study, especially regarding non-use values. This will include Eftec's point about clarifying how these studies have described the complex physical non-use impacts of the water changes for respondents and how respondents then perceived them. Then need to identify those important ecological benefits (see Table 9.2) that are not adequately covered in the non-use values and indicate the importance and value of these omitted benefits.
c) Updating the values from the old studies (e.g. Willis and Garrod (1995) to allow for rising environmental values of at least 0.6 – 0.8% pa with increasing incomes and even more with increasing scarcity of environmental assets such as natural habitats. But current values might be lower due to diminishing marginal utility for environmental improvements and because customers have paid for environmental improvements since then. Need to check how values have been derived in terms of the water quality conditions at that time and validity of applying to current improved conditions today.
d) Effects of income constraints. Compare valuations in BAG's specific studies with Yorkshire Water's more comprehensive study. Need to examine extent to which the income constraints have been taken into account in studies used in the BAG guidance, especially those by of Jacobs Gibbs (Mimram) and Willis Garrod (Darent). Then need to clarify how environmental benefits categories are specified, presented and interpreted in Yorkshire Water's comprehensive study. We need to examine carefully what information was provided on these environmental benefits in the Yorkshire Water survey and how respondents perceived them and how their perceptions relate to full environmental benefit categories of PR04 shown in the BAG guidance and Table 9.2. Need to identify any major gaps of benefits that have been omitted or inadequately covered in the Yorkshire Water study and allow for these gaps (as in (b) above). Also need to examine carefully whether a CE study can handle the complexities of choices where many categories are involved. Need to clarify time, costs and numbers of respondents needed for such surveys.
e) Sequencing effects (see Chapter 5 for scale of possible overestimation by this factor)
f) Perhaps effects of using WTA valuations rather than these WTP based valuations.

This will include meetings with authors of the studies (Willis, Georgiou, Jacobs Gibbs, EFTEC) to seek their views on specific reasons for differences between the values in their studies. We will then ask them to estimate the likely changes in the values if the studies were carried out today using current best practice guidance and the possible direction and if net effect of the possibly counteracting factors in the light of the above and other considerations.

There was a 2-day brainstorming workshop in mid-May with the various authors and academic peer reviewers and water industry expert economists. Aim was to explain

differences between the studies and arrive at a plausible range of appropriate values and to set out research needs for long term for WFD. A report on this workshop will be published shortly.

Long Term Concerted Programme to Improve Valuation of Benefits for the implementation of the Water Framework Directive (WFD)

Table 3.4 in Chapter 3 shows that the full environmental programme proposed in AMP4 would reduce the environmental impacts of water releases and abstractions by about one third. Therefore, there will still remain further major potential environmental benefits, valued at about £1bn – 2bn pa, that could be achieved by further measures under the WFD. There is therefore an important need for a concerted programme to improve valuation of these environmental benefits for the WFD.

This requires a substantial long-term programme (costing about £250k p.a. for 4-5 years) to carry out new valuation studies focused on their use for assisting the implementation of the WFD. This needs to be a concerted collaborative research programme supported by Defra, the Environment Agency, English Nature, SEPA, Scottish Executive, ESRC and the water industry (UKWIR) and other stakeholders. Pearce usefully suggests that there should be a 'blue ribbon' panel of advisers composed of expert economists to advise on the development and implementation of this research programme.

The WFD will specify objectives for various types of water bodies in terms of good ecological status (i.e. the objectives and river classifications will differ between chalk streams and slow flowing rivers). Consequently it will be important that any new valuation studies are linked to these new categories of water status for the various main types of water bodies, which should be specified as part of River Basin Characterisation for the WFD in 2004. Moreover, the WFD adopts a more sensible sequence for analysing the benefits of measures since it first entails assessing the cost-effectiveness of options, which should more appropriately filter out options. This will then focus better on a short list of outstanding contentious options requiring benefits assessment to determine whether or not they are disproportionately expensive. This should help limit the number of contentious schemes to which such valuations need to be applied.

This research programme should include the following steps:

- Develop ex ante a proper BT function focused on key characteristics of particular types or clusters of contentious cases on which better valuation is most needed for specific types of benefits for the WFD. This should apply the existing literature on BT to the needs of the WFD. Defra, the Environment Agency and Ofwat could use the findings of Draft Business Plans at the end of PR04 as surrogates to identify and characterise the sorts of contentious cases likely to require investigation under WFD.
- Do focused new valuation studies to develop and apply this function. These studies need to be carried out systematically in line with best practice guidance and in time to aid decisions needed. Need to select then the appropriate survey methodology (CV or CE) and process to fit context, benefits categories and cases in question.
- Identify how to collect information on determining factors so as to be able to transfer these new values to the key likely cases in question.
- As Eftec suggest, we need to do this economic research in tandem with scientific and technical research to improve the specification and assessment of the effects on key environmental outcomes, which is the key fundamental building block for good valuations of environmental benefits.

New Studies

A key question is how any new valuation survey(s) could overcome the issues raised in S.3 concerning the existing studies and values. We need to bear in mind Eftec's and Professor Pearce's logistical advice on long time and costs required to complete proper valid valuation surveys. Consequently, it is not feasible to do any new surveys in time for PR04. So instead need to log up and characterise the following needs for survey work so that it can be incorporated in a systematic research programme for the WFD.

a) Professor Pearce and Eftec rightly emphasise the importance of the current gaps regarding knowledge of what is included in non-users' valuation of ecological benefits and their motives for these valuations, especially regarding ethical concerns, which might require measures such as Choice Experiment survey techniques to overcome protest votes. Professor Pearce and Eftec suggest therefore that clarifying such non-use values should be a first major research priority before any new surveys are carried out. The Environment Agency and English Nature should therefore carry out in-depth research including focus group discussions with the beneficiaries of selected schemes.
b) Develop distance effects analysis to estimate beneficiaries for the non-use benefits.
c) Property price benefits. Do surveys of estate agents of effects on local property prices of environmental changes from schemes and then analyse economic regeneration effects. Need to enquire with RDAs whether they consider the measures are a priority in their RESs. This will require clear specification of the effects of the WFD schemes on water quality and flow characteristics that householders perceive as affecting property prices. It currently appears that we need to focus on changes in terms of algae, clearness and perhaps colour. We would need to check for the extent that these effects on property prices reflect the informal recreation and fishing use benefits that we estimate separately and for which BAG makes a deduction of up to 50% to allow for any double counting.
d) New survey to value non-use benefits of water quality changes in rural and semi-rural areas. This would also need to address issues of distance effects and should incorporate findings of review in 4b above.
e) The Environment Agency has commissioned Professor Pearce to review material on WTP/WTA to advise on differences between these valuations and which is most appropriate. This might have implications for WFD but probably not for PR04.
f) New valuations for angling and in-stream recreation benefits associated with water quality changes in WFD, if and where these benefits are considered to be significant.

Chapter 10

Benefit Assessment: Concluding Remarks

Dieter Helm
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The papers in this volume reflect the considerable effort which the EA has brought to bear on the 2004 periodic review. Progress has been considerable, and reflects a substantial shift in thinking in the EA.

At the 1999 periodic review, there was considerable scepticism about the value of any monetarisation of environmental benefits. The Multi-Attribute Technique (MAT) then employed relied heavily on expert judgements and rankings, and in consequence had little effect on the outcome. In 1999, cuts in the price level represented a victory for Ofwat in reining back the environmental programme, and in the absence of serious quantification of the benefits, the EA did not achieve as much leverage as it could have done.

Recognising that progress has been made should not, however, encourage complacency. The papers present a summary of what can be done with the available information, but they also highlight the extent of our ignorance. Benefits transfer is frequently used because there are so few direct studies. Thus, valuations are carried over from very different locations and points in time. These valuations are also in themselves often limited by budgets, and samples. Like the environment itself, benefit assessment is a scarce resource.

There are a number of conclusions, which follow from these manifest imperfections. The first and most obvious is that it would be a mistake to allow benefit assessment to determine the outcome of the current periodic review. It is one—very important—input. There are other values beyond the utility concepts which underlie benefit assessment and, while attempts to deal with distributional considerations have been debated in the literature, there is still much that is left out. Too many supporters of cost–benefit analysis claim an imperialism which is not justified, confusing means and ends. Fortunately, the final decisions rest with democratically elected politicians and not technical economists.

A second conclusion is that there is enormous scope to do much better. The process of this periodic review has enabled the EA to identify where the most pressing deficiencies in the analyses lie. It can now draw up a research agenda, focused on these priorities. Having done so much with benefit transfers from existing studies, there is a strong case for placing the emphasis on primary data collection.

A third conclusion relates to the wider framework of environmental policy. In this review, the EA argues that much of the capital programme is statutory: that there is no option but to carry out the necessary works, because they are mandated by EU Directives. In many respects, this is correct, although in most cases there are important issues in timing and the forms of compliance. But, of perhaps greater concern, is whether these Directives themselves pass the cost–benefit test. Often environmental quality requirements are laid down with regard to problems of countries with inland waterways and geographical and climate conditions very different from the UK—with its short, fast-flowing rivers and extensive coasts. It is a serious issue that many of these Directives have not been tested against proper cost–benefit assessments; but it is perhaps more serious that there is little account taken of the different

locations. Common European standards of environmental outcomes do not necessitate common approaches to environmental inputs.

Thus, there is a big agenda for the EA to build upon the work done for this periodic review and to bring benefit assessment into the heart of its regulatory and policy work. If the EA is to be congratulated on the major advances made over the 1999 periodic review, it is also to be encouraged to move from the present, rather primitive, base to a more sophisticated analytical one going forward.

Appendix 1: Seminar Programme

Environment Agency Seminar
Economic Appraisal for Environmental Programme in the Periodic Review of the Water Industry (PR04)

Venue: The Ballroom, Randolph Hotel, Oxford
Monday January 13th 2003

PROGRAMME

09.30–10.00	Coffee and Registration
10.00–10.15	**Chairman's Introduction** *Dieter Helm, Director, OXERA* *Martin Griffiths, Head of Water Quality, Environment Agency*
10.15–11.15	**Session One: Context and Overview** PR04 and the Environment Agency's Role in it *Catherine Wright, AMP4 Project Manager, Environment Agency* • Stages and tasks and timetable • Numbers of statutory and non-statutory schemes Environment Agency's Economics Work on Benefits Assessment *Jonathan Fisher, Senior Water Economist, Environment Agency* • Overview of appraisal systems for statutory and non-statutory schemes • Initial high level assessment of benefits of PR04 • Guidance on assessing benefits of non-statutory schemes • Further work for PR04 and beyond Questions/clarification
11.15–12.30	**Session Two: Initial Assessment of Environmental Benefits of PR04** *Hilary Sunman, Environment Agency* • Methodology • Findings • Next steps • Discussion
12.30–13.30	Lunch

13.30–14.30 **Session Three: Guidance on Benefits Assessment for all Non-statutory Schemes**

Meg Postle, Director, RPA
Teresa Fenn, RPA

- Types of non-statutory schemes
- Impacts covered
- Approach using BT for determining values and population estimates
- How apply and present findings
- Worked illustrative example

Discussants:
Professor Ken Willis, Centre for Research in Environmental Appraisal and Management, University of Newcastle upon Tyne
Ian Dickie, Economist, RSPB

14.30–15.00 Coffee

15.00–16.30 **Session Four: Rapporteur's Summary of Seminar Discussions and Next Steps: Way Forward for Benefit Assessment for PR04 and Beyond**

Jonathan Fisher, Senior Water Economist, Environment Agency

- Timetable for PR04 (need results by August 03 or at latest Nov 03)
- Need also to look beyond PR04 and pave way forward in time for WFD/PR09
- Priority needs for valuations (values and population estimates)
- What able to complete by August 03?
  - In-depth explanatory analyses of existing studies
  - New valuation surveys
    - A national survey or a set of scheme surveys?
    - How to develop a BT function to fill these needs?
    - Methodology to apply for new stated preference valuation studies
      - How ensure covering reflecting and reporting key concerns (focus group sessions)?
      - CV or CE?
    - What rigorous new studies able to complete by August 03?

Discussants:
Professor David Pearce, UCL
Ece Ozdemiroglu, Director, EFTEC

16.30 Chairmen's conclusions

Appendix 2: Delegate List

Environment Agency Seminar
Economic Appraisal for Environmental Programme in the Periodic Review of the Water Industry

Monday January 13th 2003
Venue: The Ballroom, Randolph Hotel, Oxford

Name	Title	Company
Paul Hickey	Principal Scientist	Anglian Water
Kathryn Darke	Environmental Strategy Scientist	Anglian Water
Ken Willis	Director	Centre for Research in Environmental Appraisal and Management
Diane Burgess	Senior Research Associate	CSERGE
Anita Payne	Assistant Economist	Defra
Laura Fellowes	Environment Protection Economics	Defra
Judith Harris	Water Quality Division	Defra
Joanne Gigg	Inspector	DWI
Ece Ozdemiroglu	Director	EFTEC
Sheila Sowerby	Water Quality Process Technical Advisor	Environment Agency
Paul Bryson	National Centre	Environment Agency
Martin Griffiths	Head of Water Quality	Environment Agency
Graeme Peirson	Fisheries Scientist	Environment Agency

Name	Title	Company
Jonathan Fisher	Senior Economist, Water	Environment Agency
Bruce Horton	Economic Analyst	Environment Agency
Dave Martin	Policy Advisor (Water Quality Planner)	Environment Agency
Catherine Wright	AMP4 Project Manager	Environment Agency
Tim Webb	Water Resources Manger	Environment Agency
Brian Arkell	Principal Water Resources Planner	Environment Agency
Colin Green	Flood Hazard Research Centre	University of Middlesex
David Newsome	Consultant	Foundation for Water Research
John Sparrow	Environment, Food and Rural Affairs Team	HM Treasury
Giordano Colarullo	Economist	Ofwat
Rowena Tye	Head of Quality Enhancements	Ofwat
Dieter Helm	Director	OXERA
Janet Wright	Managing Consultant, Head of OXERA Water	OXERA
Robin Smale	Managing Consultant	OXERA
Meg Postle	Director	RPA
Teresa Fenn	Consultant	RPA

Name	Title	Company
Ian Dickie	Environmental Economist	RSPB
Hilary Sunman	Economic Consultant	SCL – Economics Environment Development
Bob Breach	Principal Advisor, Quality and Environmental Services	Severn Trent Water
Ian McGuffog	Business Strategist	South West Water
Yvette de Garis	Environmental Assessment Manager	Thames Water
Mark Abbott	Price Review Manager	United Utilities
David Pearce	Professor of Economics	University College London
Robert Weeden	Economic Regulation Adviser	Water UK
Deryck Hall	PR04 Coordinator	Water Voice
Ian Banks	Economic Advice (Agriculture, Environment)	Welsh Assembly
Melinda Acutt	Economic Policy Manager	Yorkshire Water

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