**Environmental RTDI Programme 2000–2006**

# Environmental Impacts and Parameters for Inclusion in the Economic Valuation of Road Schemes

# (2000-DS-1-M2)

## Final Report

Prepared for the Environmental Protection Agency

by

Economics for the Environment Consultancy Ltd (eftec)

**Authors:**

**Ece Ozdemiroglu and Craig Bullock**

**ENVIRONMENTAL PROTECTION AGENCY**
An Ghníomhaireacht um Chaomhnú Comhshaoil
PO Box 3000, Johnstown Castle, Co. Wexford, Ireland

Telephone: +353-53-60600 Fax: +353-53-60699
E-mail: info@epa.ie Website: www.epa.ie

## ACKNOWLEDGEMENTS

This report has been prepared as part of the Environmental Research Technological Development and Innovation Programme under the Productive Sector Operational Programme 2000–2006. The programme is financed by the Irish Government under the National Development Plan 2000–2006. It is administered on behalf of the Department of the Environment and Local Government by the Environmental Protection Agency which has the statutory function of co-ordinating and promoting environmental research. The Annexes to this report (available at www.epa.ie) have been co-authored by Ece Ozdemiroglu, Alexandra Howarth, Craig Bullock and Robert Tinch. The authors are grateful to Professor Ian Bateman of University of East Anglia for his comments on an earlier version of the report.

The project was co-funded by the National Roads Authority (NRA).

## DISCLAIMER



**ENVIRONMENTAL RTDI PROGRAMME 2000–2006**

Published by the Environmental Protection Agency, Ireland

ISBN:1-84095-100-1

# Details of Project Partners

Ece Ozdemiroglu and Craig Bullock
Economics for the Environment Consultancy (eftec)
16 Percy Street
London
W1T 1DT
UK

Tel: +44 20 75 80 53 83
Fax: +44 20 75 80 53 85
Email: eftec@eftec.co.uk

# Table of Contents



**The Annexes referred to in this report are available for download from the 'Research and Development' pages of the EPA website (www.epa.ie) and on request from the ERTDI Section, Environmental Protection Agency, Dublin Regional Inspectorate, Richview, Clonskeagh Road, Dublin 14.**

# 1. Environmental Effects and Cost–Benefit Analysis

This section provides an overview of cost–benefit analysis, reasons for including environmental effects in cost–benefit analysis, the difficulties of doing this, and criticisms of cost–benefit analysis in general and the inclusion of environmental effects in particular. In doing this, some conceptual issues are discussed and some examples of international legislation and guidance experience are presented.

## 1.1 Decision-making, economics and environmental effects

All public decision-making involves choice. The necessity of choice arises because public funds are limited. Resources allocated to one purpose cannot be used to fund a different purpose. Money is a measure of resource use. Money spent on, say, education, cannot be spent on health care or the environment. The investments in new roads that reduce the time spent travelling from A to B may change the landscape negatively affecting recreational opportunities. Hence choices, or trade-offs, have to be made. To the economist, the inevitability of making choices is what defines the subject matter of economics. The value of the option that is sacrificed when a particular choice is made is known as the opportunity cost.

Because the subject matter of economics is defined as making choices in the context of finite resources, economists have a lot to say about how to choose between alternative uses of resources. That does not mean that economists alone should give guidance on how to choose. All disciplines have something to offer in terms of this guidance, but it seems fair to say that economic advice is very important precisely because economists have a discipline which is defined by this issue of how to make choices.

To the economist, rational choice means making the 'best' use of available resources. The focus is mainly on a nation's resources, because those are the resources over which national decision-makers have some control. But what is the 'best' use of resources?

'Best' is a value word. That means that what is best depends on what the objective is that we choose to try and achieve. In turn, there can be many different, legitimate objectives of social and environmental policy (which may be conflicting at times): to increase employment, protect the environment, give special attention to the vulnerable groups, stimulate technological change, protect future generations, and so on.

If it was possible to attach a number to each project[1] objective such that a decrease in time spent travelling from A to B of one hour was worth, say, five points, and a 10% decrease in $NO_x$ emissions was worth two points, and so on, we could try to achieve the 'best' result by getting the most points possible. For example, if an investment in a road-widening scheme would result in a decrease in travelling time by one hour but would increase $NO_x$ emissions by 10% (due to increased traffic), then the net effect of the investment would be $+5 - 2 = 3$ points. It would be worth the sacrifice of more air pollution to secure savings of travelling time. While the example is simplistic, this is essentially what cost–benefit analysis (CBA) does. It attaches a score to the change in the indicator associated with each objective and then adds those scores up. If the net change is positive, the project is deemed socially worthwhile. If it is negative it is not worthwhile. This scoring procedure would be an example of rational decision-making provided we have some justification for using a particular scoring procedure. If the five points given to time savings are purely arbitrary, then the procedure cannot be called rational.

CBA adopts a particular rationale for scoring gains and losses. In economics, benefits and costs are defined in terms of individual preferences. An individual receives a benefit whenever s/he receives something in return for which s/he is willing to give up something else that s/he values. To measure how large that benefit is, we measure how much s/he is willing to give up to get it. Conversely, an individual incurs a cost whenever s/he gives up something that s/he would willingly give up only if s/he

1. Throughout the report the terms 'project' and 'scheme' are used interchangeably. The arguments are equally valid for a programme of projects/ schemes and policies.

was given something else that s/he valued as compensation. To measure how large that cost is, we measure how much would compensate him/her for incurring it.

These formulations define benefits and costs in terms of one another. The measure of any benefit is that cost which, in terms of the preferences of the individual who benefits, would exactly offset it. And conversely, the measure of any cost is that benefit which, in the relevant individual's preferences, would exactly offset it. This is not circular. It is in fact what happens every time we purchase goods and services by paying the price charged for them in actual markets. It also reflects a crucial feature of economic valuation: there is no absolute measure of value, there are only equivalencies of value between one thing and another. By not claiming that any particular dimension of human life has absolute value, economic valuation avoids taking any substantive position about what is good for people. It simply uses whatever relative valuations are revealed in people's preferences.

This approach allows all costs and benefits to be measured in a single dimension if, as a matter of convention, we choose one particular type of benefit to use as a standard. We can then express all other benefits and costs in terms of that standard, using the individual's own preference to determine equivalencies of value.

If we are to use the same standard of measure for all individuals, the standard has to be a good that everyone prefers to have more of rather than less of, and that individuals treat as a potential substitute for the array of benefits and costs that we want to measure. Substitute is used here in a subjective sense: with respect to the preferences of a given individual, two goods are substitutes for one another to the extent that the individual is willing to accept a gain of one as compensation for a loss of the other. And it has to be finely divisible. In economics, the usual convention is to use money as the standard of measurement. Money, obviously, is finely divisible. It represents general purchasing power – i.e. the power to buy from the vast range of goods that are sold on markets. Because money can be put to so many different uses, it is a safe generalisation that most people prefer more money rather than less, irrespective of their specific preferences among goods. For the same reason, money is a particularly effective substitute good.

If money is used as the standard, the measure of benefit is willingness to pay (WTP). That is a benefit to any given person is measured by the maximum amount of money that that person would be willing to pay in return for receiving the benefit. Similarly, the measure of cost is willingness to accept compensation (WTA). That is, a cost to any person is measured by the minimum amount of money that that person would be willing to accept as compensation for incurring the cost.

These measures of benefit and cost underlie the concept of economic efficiency. A reallocation of resources increases economic efficiency if the sum of the benefits to those who gain by that reallocation exceeds the sum of the costs to those who lose. In other words, there is an increase in economic efficiency if the sum of WTP for the gainers exceeds the sum of WTA for the losers. Another way of saying this is that there is an increase in economic efficiency, if (in principle) the gainers could compensate the losers without becoming losers themselves. This test is the efficiency criterion (or compensation test). CBA uses this criterion to appraise specific projects. Note that economic efficiency is entirely compatible with there being actual losers, i.e. people who lose from the project and who are not then actually compensated. All that is required for efficiency is that the beneficiaries could compensate the losers without themselves becoming losers.

Those readers who are familiar with CBA will have noticed that the economic efficiency concept outlined above is applied by calculating the net present value, which is the expression of net benefits (benefits minus costs) over time in present value terms. Conventionally, the benefits and costs that are included in this calculation have been those that can be measured in money units by using the data from actual markets (e.g. capital and operating expenses; prices and fees paid, etc.). This is based on the principle that prices in actual markets reflect the maximum willingness to pay of the buyers and minimum willingness to accept compensation of sellers. The concept is simple: buyers would not make a purchase if the price charged was higher than what they are willing

to pay for it. Their WTP must be at least equal to and possibly higher than the market price.

The 'narrow' definition of economic efficiency has been limited to those costs and benefits thought to affect the wealth of individuals, i.e. transactions in actual markets. The 'broad' definition, however, encompasses all factors that impact upon individual well-being. Well-being is defined as the benefits individuals derive from all parts of life including their wealth, their health, concern for others, concern for future generations and concern for the environment in which they live because they make use of it now, or they may want to use it in the future or because they are concerned about the well-being of other species. Further explanation of this concept can be found in Annex 2.

The initial extension of the narrow definition of benefits and costs in the context of the appraisal of road schemes has seen the inclusion of time savings and the cost of accidents. These have been calculated using the value of working and leisure time and the medical costs and productivity losses due to fatal and non-fatal accidents.

Increasing interest in the environmental effects of all public decisions has initially led to their measurement by way of project-specific environmental impact assessment (EIA) and, more recently, by strategic environmental assessment (SEA), which, as the name implies, takes a wider, strategic view of environmental impacts. These are further discussed in Section 2.

Although inclusion of the results of EIA in the decision-making alongside conventional CBA is an improvement compared to the earlier practice of conventional CBA alone, there is a growing view that this is not sufficient. Separate treatment of EIA results risks the perception that environmental effects are of secondary importance compared to the effects included in conventional CBA. In addition, comparison of environmental effects in different units is not possible without a rational standard measure as in the above example of time savings and $NO_x$ emissions.

When implementing CBA, a way of making the environmental and other effects more directly comparable is to use the broad definitions of benefits and costs including environmental effects. Note that this requires at least an initial EIA to have taken place to identify the environmental effects. Also note that the negative environmental effects that are included in CBA are residual effects that cannot be mitigated against.[2] This is not an easy task. Most environmental resources are not traded in actual markets. Therefore, there are no readily available data that can be used to measure individual preferences. In other words, there are no easily identifiable indicators of what individuals are willing to pay for a gain in the quantity and quality of environmental resources and what they are willing to accept as compensation to tolerate a loss. This is why economists have developed the so-called economic valuation techniques that use the available data from actual markets to estimate individual preferences, or they elicit these directly by way of carefully structured surveys. Details of these techniques are presented in the context of their use in Ireland in Section 3 and more generally in Annex 5.

Box 1.1 illustrates the shift in international practice towards the need to consider environmental and economic costs and benefits together. International experience in the context of road-scheme appraisals is provided in Section 2, with more detailed information presented in Annex 8.

## 1.2 Difficulties of including environmental effects in cost–benefit analysis

Including environmental effects in cost–benefit analysis requires their expression in monetary terms so that they can be measured using the economic concepts of willingness to pay and willingness to accept compensation; and that they are directly comparable to the monetary costs and benefits.

The extent to which this can be done depends on the available environmental and economic (including preferences) data and how much effort can be spent to fill

2. It follows that mitigated environmental effects should not be included as environmental effects. However, the cost of mitigation should be included as part of the scheme costs. Also note that the positive environmental and social impacts of a road are included as benefits within the CBA.

*Box 1.1*

**Inclusion of environmental impacts in CBA: examples from legislation and guidance**

**Article 174 of the Treaty of Europe** states that in preparing its policy on the environment, the Community shall take account of:

- available scientific and technical data;
- environmental conditions in the various regions of the Community;
- the *potential benefits and costs of action or lack of action*; and
- the economic and social development of the Community as a whole and the balanced development of its regions.

The guidance on project appraisal issued by the Treasury in the **United Kingdom** states that "Appraisal is the analysis of the costs and benefits which should underlie the final policy or executive decision. This analysis may range very widely, to include for example, information on subjective environmental impacts, or consistency with declared policy, or the implications of budget constraints. It should always include an examination of the risks and uncertainties. Although a great deal of information can be brought within and presented in terms of a formal framework, this can never do more than inform the final decision. Analysis can show how alternative choices compare in many ways, but there will always be further strategic, or pragmatic issues to which those responsible for final decisions must also give weight. The guidance in this book can therefore never give, without this qualification, 'the right answer'. However, appraisal is an essential input to good decision-making." (HM Treasury, 1997).

The foreword to the project appraisal guidance prepared for the appraisal staff at the **European Investment Bank** (IVM and EFTEC, 1998) states that:

"All projects funded by the European Investment Bank need to be justified in economic, financial, technical and environmental terms. The Bank's Projects Directorate uses appraisal methods that reflect these various concerns. At the same time, we are aware of the rapid strides being taken in the development of environmental appraisal, and in particular the economic valuation of environmental impacts. The general principles and methods of environmental valuation are now widely known and a large body of empirical evidence is being assembled. The current report is intended to make this academic and research literature more accessible for operational appraisal purposes... The whole programme aims to give project staff the analytical tools and data necessary to reflect as fully and accurately as possible the environmental impact of projects funded by the Bank".

Chapter 2 of the **US Environment Protection Agency** guidance on economic appraisal states that "Policy makers need information on the benefits, costs and other effects of alternative options for addressing a particular environmental problem in order to make sound policy decisions. In addition various statutes specifically require economic analyses of policy actions." (USEPA, 2000). One such statute is the Executive Order 12866 "Regulatory Planning and Review" that requires analysis of benefits and costs for all significant regulatory actions. This suggests that benefits should justify costs. Benefits include 'economic, environmental, public health and safety, other advantages, distributive impacts and equity' and may not all be quantified. Some commentators suggest that Executive Order 12866 endorses CBA as an 'accounting framework' rather than an 'optimising tool'.

the gaps in the available data. Section 3 presents the available data in Ireland and evaluates economic valuation techniques in the light of this availability. Whether or not it is worth filling the gaps in available data depends on the scale of the project that is appraised and the scale of the environmental effects. This is discussed in Section 4.

There are three obstacles to the inclusion of all environmental effects into CBA, which are unlikely to be resolved during the appraisal of a given project. These are:

- the underlying physical data do not exist. If, for example, no one has carried out a risk assessment of, say, a given chemical, it will not be possible to say what the economic value (the individual's WTP) of reducing that chemical in the environment is. The absence of basic scientific data is often a reason why environmental effects cannot be expressed in monetary units and hence are not included in CBA;
- the underlying physical data may exist but not in a form suitable for monetary expression. Recall that the monetary values reflect preferences. Now suppose the physical data take the form of 'reduction of X tonnes of biochemical oxygen demand (BOD)' in a river. Individuals do not have measurable preferences for BOD. What they have preferences for is better or worse water quality. The 'object' of preference does not correspond to the physical measure of the environmental change. This is the so-called correspondence problem which can potentially be addressed by expressing the environmental effects in units of impacts that individuals have preferences for (e.g. effect on fish population or the visual appearance of water due to change in BOD levels); and
- the relevant physical data may exist and may correspond to what people value, but the research may simply not have been done. Consider biological diversity. There are numerous studies of willingness to pay to conserve biological resources (e.g. endangered species and habitats) but hardly any that tells us what people's preferences are for diversity *per se*.

Note that we have not listed the 'impossibility' of expressing environmental effects in monetary terms as one of the reasons why they cannot be included in CBA. This is because, in principle, people have preferences for all the changes that are likely to take place in the context of policies and projects. But there will be problems if there are difficulties of perceiving the relevant change. This may be the case with very small risks, for example, or with very small changes.

What should be done if some costs and/or benefits cannot be expressed in monetary terms?[3] Depending on the context, it may still be possible to reach a conclusion about the outcome of the CBA. Consider the matrix below:

| | Non-monetary benefits are deemed to be positive | Non-monetary benefits are deemed to be negative (i.e. there are non-monetary costs) |
|---|---|---|
| Monetary benefits exceed monetary costs | Accept | ? |
| Monetary benefits are less than monetary costs | ? | Reject |

Suppose monetary benefits exceed monetary costs and that non-monetary benefits are positive. Then the project should be accepted even though we do not know the size of non-monetary benefits because the non-monetary benefits will simply be additional to the monetised benefits, which in turn already justify the project. If, on

3. Non-monetary expressions could be in physical units or scores/weights determined by expert judgement or public opinion.

the other hand, monetary benefits exceed monetary costs but non-monetary benefits are negative, i.e. there are non-monetised costs, we will not know whether to accept or reject the project. But we can 'invert' the analysis and ask whether, judgementally, we think the net monetary benefits (benefits minus costs) are sufficient to compensate for the non-monetary costs. At the very least, the procedure forces the decision-maker to list costs and benefits and to ask searching questions about the non-monetised costs. The same procedure can be followed for the final row of the matrix.

What should be avoided is the view that if we cannot monetise everything, nothing should monetised. This view amounts to rejecting valuation information about people's preferences. Further details on the above and alternatives such as multi-criteria analysis are discussed in Annexes 5 and 6.

## 1.3 Criticisms of cost–benefit analysis

There are a number of criticisms of CBA in general and the inclusion of monetary expressions of environmental effects within CBA in particular. These can be classified as those referring to philosophy and content and those referring to process.

***Philosophy and content***

**Credibility –** Credibility rests on several factors: whether the final estimate of net benefits has 'too wide' a range; whether the assumptions made in order to achieve the estimates of net benefits are themselves credible; and whether the estimates have been truly tested for their validity. All are valid sources of concern in decision-making. The range of estimates of WTP for environmental effects tends to represent the underlying uncertainty of socio–economic data. Social science data are not like physical data. While both are subject to uncertainty, social science data are far more probabilistic since they reflect the behaviour and/or preferences of millions of individuals. Therefore, the results of social analyses are considered not to be convergent only if they differ by orders of magnitude. It does not follow that some alternative technique is better. The greater uncertainty of CBA is simply being exchanged for somewhat illusory certainty, illusory because it is achieved by simply ignoring other factors that should bear on how to make decisions. An example is using expert-determined scores instead of monetary expressions of costs and benefits (especially for environmental impacts). The scores are credible and reliable as much as the expert opinions are credible and reliable representations of what affected individuals prefer and as much as there is consensus among the experts whose opinions are sought.

**Morality –** CBA uses money values and there is often a 'moral' hostility to using money as the measuring rod. It is argued that some objectives of projects are absolute and should not be subjected to budgetary constraints. The discussion in Section 1.1 makes it clear that in any decision context, there is an issue of opportunity cost and a trade-off is made. CBA makes this trade-off explicit, and hence the wider the definition of costs and benefits in a CBA, the clearer the trade-offs that have to be made. Decisions taken without using some form of trade-off analysis are still the product of a trade-off, albeit an implicit one. In addition, again as discussed in Section 1.1, measuring people's preferences in monetary units does not equate to measuring the value of, say, an environmental resource *per se* but measuring the trade-off people are willing to make between, say, an environmental cost and money. Thus, it is a relative value rather than an absolute one.

**The efficiency focus –** CBA has economic efficiency as its goal. But governments have multiple objectives; hence CBA appears to be partial and non-comprehensive. One procedure for 'trading off' objectives is multi-criteria analysis (MCA). MCA does not require the monetary expressions of objectives or effects but it does require a rational analysis of what has to be surrendered for what. MCA is further discussed in Annexes 5 and 6. The important feature of MCA is that it embraces objectives that CBA appears not to embrace. For example, it could include a distributional objective (fairness, equity), some assessment of sustainability, and wider national concerns, such as increasing the coverage and quality of an infrastructure network, regional balance, employment, etc.

If MCA is 'wider' than CBA why not recommend MCA rather than CBA? The question is somewhat misleading because CBA is in fact a particular form of MCA. There

is nothing in MCA that says that efficiency is not important and nothing that says that effects should not be expressed in monetary terms, where appropriate. If there is an 'equity' goal this may not be suited to monetary expression, in which case something that is more efficient but less equitable must be traded against something that is less efficient and more equitable. The efficiency status cannot be determined, however, without some form of CBA. Thus, CBA in its broadest possible application can, and should, be an input to MCA.

**The democratic principle –** While it may seem odd to suggest that decision-makers oppose 'democracy', there are concerns about the legitimacy of reflecting preferences in all contexts. Some critics object that, by focussing on the preferences of individuals, economic valuation (and hence CBA which includes it) takes account only of self-interest. In fact, as mentioned in Section 1.1, there are a variety of reasons why individuals have preferences for environmental resources that go beyond their personal use of such resources. These reasons include concern for the well-being of others, future generations and other species. In any case, CBA is not a substitute for the political process; it merely provides information to the actors in that process.

***Process***

**Flexibility –** Some decision-makers may feel that CBA compromises their flexibility of decision-making. Flexibility is a legitimate concern, but it can be preserved whilst still employing CBA. No one technique should appear as providing the 'right' solution. CBA is a tool which at least orders the information available in some logical framework. Thus, information on the likely effects (including environmental) of a decision is the least that should be expected. How far quantification and aggregation of those impacts then take place depends on the context. As the UK guidance quoted in Box 1.1 states, CBA is only an input to the decision-making process.

**Participation –** CBA is sometimes criticised for being non-participatory. Modern approaches to appraisal rightly stress the need for public participation in the process of appraisal. While participation is often seen as an end in itself, it is also a necessary ingredient for economic efficiency. The reason for this is that lack of participation can easily engender opposition to a project or policy, making it difficult to implement and costly to reverse. Expressing environmental effects in monetary terms can be seen as a form of participation. This is ensured either by observing the behaviour of individuals in actual markets or, more directly, by asking a sample of those affected their opinions and willingness to pay (stated preference techniques – see Section 3). Although this is likely to allow for wider public participation in decision-making than purely expert opinion-based scoring or weighting, economic valuation (and hence CBA) does not intend to replace wide public consultation during design and implementation of projects.

**Capacity –** A final obstacle to the use of CBA is the fact that it requires an input of time in order to understand the underlying rationale and some of the technical details. This is especially the case when the boundaries of conventional CBA are extended to include environmental effects. Involving relatively new techniques, at least at a practical level, this extension does require new capacity building for appraisal practitioners. Whether this capacity is worth building and when it should be used is a context-specific issue. Some guidance is provided in Section 4. Annexes to this report aim to provide the technical guidance for those appraisal experts willing to acquire new skills.

## 1.4 Summary

Cost–benefit analysis is based on the premise that costs and benefits are measured by quantifying individual preferences for the changes that are appraised. Conventionally, only the goods and services that are traded in actual markets have been included in CBA. This is because actual markets generate data on individual preferences. This practice of separate treatment of effects that are conventionally included in CBA and environmental effects by way of, say, EIA can be improved by merging all effects into one, extended CBA. In fact, in principle, CBA should include all effects that impact positively and negatively upon human well-being and hence should include all benefits and costs. The practical difficulty with this is that some of these effects, especially the environmental ones, are not traded in actual markets and hence there are no readily available data for their quantification. To fill this gap in available

data, economists have developed techniques that can quantify individual preferences for environmental effects.

In practice, there are a number of difficulties and criticisms of using CBA both in its conventional form and in its extended form by including environmental effects. Part of these difficulties and criticisms are at a conceptual level and are dealt with within this Section. Others are related to practical concerns and are further discussed in the following Sections.

# 2. Current Practice in Ireland

This section provides the outline of the present Irish approach to including environmental effects in decision-making about road schemes, appraisal of this approach in light of international practice and trends, and appraisal of the present position with respect to legislative requirements. It also recommends steps that can be taken to improve the present approach in Ireland given international practice and developments.

## 2.1 Present Irish approach to including environmental effects

Planning for national road projects takes place in the context of the Government's objectives for investment in road infrastructure as set out in the NDP and the Economic and Social Infrastructure Operational Programme, 2000–2006. The planning and design is progressed by Local Authorities in conjunction with the National Roads Authority (NRA).

***Identification of constraints***

An initial scoping exercise is undertaken in the form of a Constraints Study. Information is gathered on the various constraints that have a potential to affect the design or location of a scheme. Environmental constraints are considered along with physical and legal constraints. In addition, a map of the proposed route corridor options is displayed at public information sessions during which people have an opportunity to comment on the above-mentioned constraints and other aspects of the proposal.

Following this initial public consultation, further surveys are conducted to identify the constraints in more detail and a Constraints Study is submitted to the NRA.

***Evaluation of route corridor options***

Following the Constraints Study, the broad route corridor options are subjected to a technical evaluation under the criteria of engineering, traffic, environment and cost, with the aim of recommending a particular solution. Environmental impacts such as impacts on local communities, archaeology, flora and fauna are identified at this stage, and are evaluated together with other criteria such as impacts on land holdings, severance and financial costings. Particular account is taken of the presence of designated sites under European Directives and national legislation, including Natural Heritage Areas, Special Areas of Conservation and Special Protection Areas. Every effort is made to devise a route that avoids direct impact on such sites.

The various route corridor options are evaluated and a Draft Route Corridor Selection Report is prepared. This usually includes a matrix in respect of routes showing the environmental impacts and other assessment criteria for determination of the most appropriate route corridor option. The Draft Report is submitted to the local authority elected members and made available to the public for comment. The Route Corridor Selection Report is then finalised by the local authority and a specific recommendation is made to the NRA for approval.

***Preliminary design***

Following the Route Corridor Selection Report, a preliminary design is prepared and precise land acquisition requirements are determined. It is only at this stage that a clearer picture emerges of the route and road characteristics such as vertical and horizontal alignments, as well as the specific impacts on individual landowners and residences.

In accordance with the Roads Act, 1993, (as amended by the Planning and Development Act, 2000), prior to the submission of a CPO/Motorway Scheme to An Bord Pleanála, the local authority must inform the public, through notices in newspapers, that a scheme has been prepared, indicating arrangements for public inspection and submission of objections to An Bord Pleanála. In addition, the local authority must notify every landowner and occupier referred to in the scheme.

The preparation of the Environmental Impact Statement (EIS) is carried out in parallel with the preliminary planning and design of the scheme and is submitted to An Bord Pleanála at the same time as the CPO/Motorway Scheme. Although potential impacts will have been considered in the Draft Route Corridor Selection Report, the EIS represents the first detailed examination of

environmental impacts. The EIS will describe the likely effects on the environment of the proposed road in cases, including:

- construction of a motorway;
- the construction of a new road of four or more lanes, or the realignment or widening of an existing road so as to provide four or more lanes, where such new, realigned or widened road would be 8 km or more in length in rural areas, or 500 m or more in length in urban areas;
- the construction of a new bridge or tunnel which would be 100 m or more in length; and
- any road scheme with potential significant environmental effects.

If the road has been the subject of objections, the Board will arrange for an oral hearing to be held. The Board may then approve the proposed road development, with or without modifications, or it may refuse to approve it.

## 2.2 International practice

The European Commission recommends the use of CBA to examine socio–economic costs including environmental effects such as visual impacts (European Commission DGXVI, 1997). For roads, it lists noise and pollution among other impacts both positive and negative.

In practice, use of CBA in transport infrastructure appraisal is widespread, but not universal. The nature of the procedure varies among nations, but there is a trend towards greater inclusion of non-marketed goods and services, and towards reform of the basic techniques used, for example:

- improved integration of the effects of transport on the city, requiring less in terms of the project to be evaluated and more in terms of transport solutions for a given or planned urban configuration;
- improved use of evaluation methodologies in decision-making, including better public consultation and participation. Note that the stated preference techniques outlined in Section 3 and Annex 5 can be especially used as a consultation and participation tool as well as in generating quantitative information about the costs and benefits; and
- combined evaluation of transport policies, development policies, land-use policies and so on.

In all cases, CBA is used as a decision-making tool rather than leading directly to an actual decision. Given the inherent uncertainties and the importance of distributional factors, this is as it should be. Although several countries have arranged their CBA process to facilitate the integration of economic values in particular circumstances, such as where a proposed road is a major investment or is controversial, rather few countries have economic valuation of environmental impacts included in project level CBA on a regular basis (see Annex 8 for further details).

### *Strategic Environmental Assessment*

Although the use of CBA varies from country to country, the methodology is increasingly becoming a component of Strategic Environmental Assessment (SEA). SEA is to become mandatory in Europe under the SEA Directive. This follows from a recognition that major infrastructure investments such as roads can have significant indirect, interactive and cumulative effects. An important rationale for new road construction is to encourage evenly spread regional development. As such, it might be expected that a new road will stimulate economic development, including new settlement patterns and the consequent knock-on infrastructure needs. There will likely be cumulative environmental effects too, although the ultimate significance of these will depend on the extent to which they are foreseen and managed within a co-ordinated planning process.

In practice, detailed assessment of environmental impacts, and many socio–economic impacts too, are only considered at the stage of a (project) EIA, many of which are undertaken for localised stretches of road. Increased coverage by CBA of environmental and social costs and benefits can generate the type of information sought by a SEA with a non-local focus.

For these reasons, several European countries have now begun undertaking SEA. ***Denmark,*** for example, instigated a move towards SEA in 1998 in relation to the

Odense–Svendborg motorway. The need for an SEA became apparent when the EIA for the motorway indicated that improvement of the existing railway was an alternative. The final decision was to proceed with both projects. A systematic SEA for all regional plans was proposed in the 2001 Regional Plan Revision.

Jansson (1999) observes that the trend in transport evaluation in Nordic countries is towards linking assessment ever more closely to sustainability and long-term environmental goals. In this way, ***Sweden*** and ***Finland*** too have introduced methodologies for SEA.

***Germany*** is also pursuing SEA in relation to a commitment to sustainability targets. They have incorporated CBA as a method for linking strategic level planning and project assessment with evaluation carried out only for project alternatives that fit with the optimal policy scenarios in the SEA framework.

***Austria*** and ***France*** have also experimented with SEA using part EU funding. A demonstration project was undertaken on transport options in the Danube corridor. This project aimed, among other things, to clarify links from SEA to project level EIA and CBA, and to investigate ways of encouraging public participation in the process.

### *Project level*

The use of CBA at project level varies from country to country. Some countries, such as ***France***, have a very standardised procedure that allows comparisons to be made between and within various transport modes. The procedure includes the monetary valuation of safety and time gains, and audits of local pollution and greenhouse gases. It has, however, been criticised for allowing 'time cost gains' to dominate the quantification of other impacts. ***Germany***, on the other hand, does not use CBA for roads projects on a regular basis, but instead selects between projects using economic criteria once they have been assessed as being environmentally favourable.

In ***the Netherlands,*** CBA is applied as an iterative process at an early stage to narrow down the number of alternatives, with progressive increases in sophistication until a full CBA is implemented at the final decision stage. Journey time and some environmental effects, such as pollutants, are expressed in monetary terms, but distributional effects and landscape impacts are not.

In the ***UK***, CBA has been used for many years, but has developed over time into a more inclusive form of analysis which incorporates some environmental effects and wider economic impacts beyond the transport sector. Common Appraisal Frameworks are being developed that incorporate environmental, economic, and social equity considerations beyond those that were included in the earlier CBA framework. The New Approach to Appraisal (NATA) guidelines for transport projects (DETR, 1998) represent the current thinking in use at project level. These combine monetary and non-monetary expressions of environmental effects. The key output is an Appraisal Summary Table, which lists on a single page the key impacts evaluated against five criteria, divided into sub-criteria.

Each criterion is evaluated in three columns, a qualitative statement, a quantitative assessment (on a 7-point scale if there is no obvious measure) and a summary assessment of the extent and sign (±) of the effect. Beneath these, quite literally on the bottom line, is the output of the COBA computer programme, which allows consideration of the standard CBA results alongside the non-monetised impacts. There is no attempt to combine all of these criteria into a single figure, making the approach quite similar to multi-criteria analysis (Price, 1999).

In ***Canada,*** extensive use is made of CBA in evaluating infrastructure projects. The approach contains detailed guidance on accident costs based on a review of international studies and practice. The assessment of time savings is also quite detailed. Journeys of less than five minutes are not included so as to reduce the undue influence of time savings in the overall benefit assessment.

In the ***USA***, the National Environmental Policy Act (1969) requires that any project receiving federal funding or other federal approval, including transportation projects, undergoes an analysis of potential social, economic and environmental effects. Beyond this, there is a requirement for systematic CBA in some cases set out in Executive Order 12893 (January 1994). The

Transportation Equity Act for the Twenty-First Century (TEA-21), although primarily a spending authorisation bill, also expands the set of effects to be incorporated in major transport investment appraisal in an approach quite similar to the NATA used in the UK. TEA-21 sets out seven benefit criteria including economic vitality, safety and the environment.

The Federal Highway Administration publishes Procedural Guidelines for Highway Feasibility Studies (most recent version US Dept. of Transportation – Federal Highway Administration, 1998). Although these are guidelines and not regulations, they must be followed if the study is presented to the Congress. The guidelines specify that monetary benefits should include at least the value of time savings, safety benefits and other non-marketed impacts where possible, and that the alternatives should be assessed from an environmental/ social perspective as well as from a purely economic one.

## 2.3 Appraisal of current Irish situation in relation to international approaches

Although specific details vary considerably amongst countries, there is widespread use of CBA in road transport investment appraisal. Most countries examine time cost savings and accident benefits and costs, and several also price pollution impacts. No country habitually includes monetised estimates of other environmental effects in their CBA, but there is a trend towards greater monetisation of environmental and other effects.

Simultaneously, there is a move to multi-modal focus with integrated transport, economy and environmental planning, rather than a primarily road-based focus or demand-driven approach. The move towards using strategic assessment under the SEA Directive is likely to incorporate more in the way of CBA. At project level too, the effect may be a more rigorous cost–benefit approach to the determination of alternatives for consideration, and potentially the inclusion of shadow values derived from strategic assessment focusing on cumulative and multi-modal aggregate effects.

In Ireland, the Department of Finance has produced guidelines for the appraisal of capital expenditures (DoF, 1994). These, and subsequent reports (e.g. CSF Evaluation Unit, 1999) have recommended the inclusion of non-market effects. A number of well-established economic valuation techniques for quantifying non-market effects are presented in Annex 5.

Road assessment is conducted within a CBA framework. In conformance with Department of Finance guidelines, investment is expected to achieve an Internal Rate of Return of at least 5%. The NRA requires local authorities to use the COBA-10 system when submitting economic assessments so as to facilitate a consistent evaluation. The system includes cost–benefit assessments for time savings, fuel-efficiency savings and accident savings. Accident savings are estimated in relation to Irish statistics and values, an advance on the situation prior to 1999 (Comptroller and Auditor General, 1999) when accident savings were not considered within the economic assessment.

The NRA has been set an objective under the National Development Plan (Government of Ireland, 2000) of delivering Level of Service (LOS) C on the five major inter-urban routes and Level of Service D on the remainder of the network. LOS C equates to an average inter-urban speed of 94 km/h on a dual carriageway and 105 km/h on a motorway. Time savings generally represent around 80% of estimated benefits. The situation is common for other countries, although this has been criticised for biasing the results (Welch and Williams, 1997).

The CBA process does not include any quantification of environmental effects in monetary terms. Instead, the present procedure allows for environmental effects to be considered during the preliminary design phase and at different stages before permission is granted or not by An Bord Pleanála. As well as local public consultation, there is widespread consultation with government bodies, non-governmental organisations and interest groups at national level.

In the EIA, impacts are assessed in terms of criteria that have been broadly determined at EU level and translated into national guidelines by the EPA. Overall, EISs for roads appear to have been of a higher quality than those for many other types of development, most probably because they are sponsored by public authorities rather

than private developers. There is, though, rarely any consideration of the public benefits or costs associated with environmental impacts as they might be perceived by either the local or wider population. Such considerations may surface in the chapters dealing with socio–economics or landscape, but usually only where publicly accessible amenities or tourism assets are concerned. In the main, the public benefit/cost element is not discussed. This omission is, however, common to the UK and other countries (Chadwick, 2002).

Experience shows that there are two options for expressing environmental costs and benefits in a CBA: original valuation studies using the relevant technique(s) from the list presented in Section 3 and Annex 4, or benefits transfer which is a process for adjusting the evidence from the literature to the context of the project in hand.

Benefits transfer is much quicker and cheaper than commissioning original studies. Therefore it is more widely used in routine CBA at project level. It also fits in with the Planning and Development Act 2000, which acknowledged a need to speed up the approval process for infrastructure development. The robustness of benefits transfer depends on how relevant the evidence in the literature is to the context of the project in hand. Considering the significant lack of data on economic valuation of environmental costs and benefits in Ireland, benefits transfer will have to rely on evidence from other countries. The relevance of such evidence to Ireland is likely to be less than desirable, especially for site-specific impacts such as changes in landscape. Nonetheless such evidence can be used to learn about the orders of magnitude of different impacts in terms of their economic values.

For projects that require large investments or lead to significant environmental effects, benefits transfer is unlikely to be sufficient. In these cases, and at strategic assessments, commissioning original valuation studies would be preferable. Although such studies are more costly than benefits transfer, this cost should be seen in light of the overall cost of the road scheme(s) and the scale of the environmental effect. Deciding whether environmental effects should be expressed in monetary terms and included in CBA and how to do this is about striking a balance between the benefits of improved information and the cost of generating this information.

#### *Strategic assessment*

The most recent EU advice on EIA requires that greater consideration be given to cumulative environmental impacts (Council Directive 97/11/EC Annexes III & IV). Although always an element of EIA, cumulative impacts had previously been included as a footnote and given little emphasis in the EPA Advice Notes. As noted above, however, many cumulative impacts can have significant socio–economic and environmental dimensions, and these can have strategic consequences.

In Ireland, major investment needs in relation to strategic transport routes have been broadly identified within the NDP. Only Dublin's transport investment needs have been considered on the basis of an integrated transport strategy. However, the Plan reports that investment needs will be evaluated in relation to sustainable development (as required by the Treaty of Amsterdam) and adds that this criterion will be further addressed by the forthcoming National Spatial Strategy.

Road projects are developed by the local authorities in conjunction with the National Roads Authority in accordance with the procedures set out in the National Roads Project Management Guidelines. An expansion of strategic assessment, reinforced by CBA, could be facilitated by the remit of the NRA which provides for a strategic approach to the improvement of national roads.

## 2.4 Summary

In Ireland, the process by which routes are selected for road schemes includes consideration of the likely environmental effects. There is no quantitative estimate of environmental costs and benefits in the economic assessment of road investment needs, but Ireland is not alone in this respect. Some countries do include an economic assessment of pollution impacts, but no country would appear to have a model system in place that includes all monetary values in all schemes. In addition, in many countries, including Ireland, estimation of time-savings benefits represents a high proportion of the total estimated benefit.

On the other hand, many other countries do possess better baseline environmental information which can be consulted at the stage of route selection. Several countries are also moving in the direction of quantifying environmental effects for the purposes of CBA or MCA. In part, this is in response to an identified need to enhance the sophistication of these methodologies for the purposes of Strategic Environmental Assessment.

Ireland would benefit from a more quantified assessment of environmental benefits and costs in the strategic assessment of transportation alternatives or for the evaluation of major road schemes. At present, there are very few studies from which to gauge the extent of environmental effects such as pollution, noise, landscape or ecological losses in an Irish context. This lack of information is seen both in quantitative data on environmental impacts as well as in individual preferences for choices between transport benefits and environmental costs. The absence of such information reinforces a poor perception of the role of public benefits and costs.

# 3. Assessment of Current Data Provision in Ireland and Necessary Improvements

This section reviews the types of data that are currently available in Ireland and aims to answer the question "Given the data constraints, what environmental effects could be included in current valuations?". It also discusses what steps are necessary to improve existing data to align the present approach better with leading international practice and to include environmental effects in cost–benefit analysis using economic valuation techniques.

## 3.1 Overview of current data availability in Ireland

The EPA Advice Notes on Environmental Impact Assessment (EIA) recommend that the existing environment is described in terms of 'context', 'character', 'significance' and 'sensitivity'. They further recommend that these be followed by an analysis of the impacts with or without any development, i.e. both the 'do nothing' situation and 'predicted impacts'. The latter should include a description of the population affected as well as indirect, secondary and cumulative impacts, together with their interactions, followed by a section on mitigation measures.

A problem in many cases is that there is often very little baseline environmental data to hand and so the EIA often represents the first source of detailed local information. This complicates matters for cost–benefit analysis (CBA) because a reasonable supply of environmental data is required before a thorough economic assessment can take place and, typically, economic assessments take time. Furthermore, some economic data may not be to hand (see Section 1.2 for difficulties with CBA).

Nevertheless, shortage of data, unless severe, does not in itself preclude an economic assessment of environmental impacts. Firstly, if the impacts are expected to be significant, then time and resources should be allocated to ensure that the implications of the development are fully understood. Secondly, a degree of uncertainty can be handled through sensitivity analysis or simply by ensuring that any assumptions made on the basis of the reliability of the data are transparent. Indeed, a CBA can be a very efficient means of organising and interpreting data from different sources.

## 3.2 Overview of economic valuation techniques

Quantification of many effects of road schemes uses data from actual markets. These include the value of time savings and the cost of accidents. The effects on environmental resources, which are not traded in actual markets can be estimated using *revealed preference techniques* (based on data from actual markets that may reflect some of the individual preferences for environmental effects) and *stated preference techniques* (creating hypothetical markets by way of structured surveys that give the respondents the opportunity to state their preferences). Instead of applying these techniques, we can also use the estimates of previous applications by reviewing the literature, selecting the relevant estimates and possibly adjusting these. This process is known as *benefits transfer*. These options are also mentioned in Sections 1 and 2 and explained in detail in Annex 5. Revealed and stated preference techniques are discussed below, and the literature that can be used for benefits transfer is presented in Annex 10.

***Revealed preference techniques***

Revealed preference techniques infer people's valuation of environmental effects based on their behaviour in actual markets. There are three revealed preference techniques differentiated by the type of market data they use: *hedonic property pricing*, *avertive behaviour* and *travel cost*. All these techniques can only be used for a sub-set of environmental effects: those that are reflected in actual markets. Therefore, they can estimate people's willingness to pay (WTP) for using the environmental resources or services. They cannot estimate WTP for other concerns (e.g. for future generations), which are mentioned in Section 1.

*Hedonic property pricing*

The Advice Notes on EIA discourage the inclusion of property price data or projections. This reflects the need to keep the EIA focused on the subject of environmental

effects. Furthermore, where properties are directly affected by a development such as the routing of a new road, this will be reflected in the financial analysis as the property owner has a right to be compensated.

Nevertheless, given that roads can have marked impacts on property prices, both positively and negatively, many EISs have not been able to ignore the likely impacts on property prices in the discussion of Material Assets. However, this discussion does not usually extend as far as the cumulative impacts even though these can be even more pronounced.

The temptation to include some discussion of property price impacts follows, partly from the typical absence of any analysis of these impacts at other stages of the project evaluation. This is despite the fact that noise, local congestion or pollution are often among the principal factors behind communities' demands for new roads and bypasses. These factors have an impact on local people's quality of life, part of which can be estimated through any negative effect or positive on property prices.

The ability of property prices to capture people's preferences for environmental quality especially applies to negative impacts such as noise, vibration, visual intrusion, air quality and severance. Indeed, some EISs have acknowledged the human perspective by listing impacts such as noise under the heading 'Human Beings'. The relationship can also apply to landscape, water quality or biodiversity. Some of these impacts can be realised in terms of a premium on property prices. This premium is estimated by a regression analysis in which the variation in property prices over time and space is explained by the structural characteristics of the property (e.g. number of rooms, size of garden); characteristics of the household (e.g. income, number of children) and characteristics of the neighbourhood (e.g. transport links, quality of schools and environmental quality).

Where there is a connection between environmental impacts and property values, the hedonic property pricing can be used to demonstrate the relationship between the two. Studies undertaken in other countries have reported firm relationships between noise and property values, e.g. Bateman *et al.* (1999) on roads in the Scotland, and Laasko (1992) or Forrest *et al.* (1995) on metro systems in Scandinavian countries and England, respectively.

In Ireland, the prospects for time-series hedonic studies are reduced by the absence of any publicly available database of property transactions as well as the confidentiality typically applied by estate agents to sales. First Active and Irish Permanent (Conniffe and Duffy, 1999) began the first series of local house price data, starting from 1996 onwards. However, these data may not be publicly available. Furthermore, the data set is at district level rather than for individual properties and is therefore probably too crude for the purposes of hedonic property pricing.

*Averting behaviour*

This approach assumes that the expenditure people make to avoid an environmental problem is an indication of what they are willing to pay to avoid that problem, e.g. expenditure on double-glazing. This method has the advantage that there are modest data requirements, but there are problems in interpreting the trade-off against an environmental problem where the expenditure has secondary benefits, for example energy savings where double-glazing is concerned. However, even these relatively easily available data are not collected systematically and given the limited applicability of the technique, further effort in collecting these data is not recommended.

*Travel cost*

The travel cost can be used to infer people's preferences for an environmental change (or change in amenity) based on their willingness to incur costs in travelling to and from a particular site, generally for recreation. These costs are comprised of direct travel costs (e.g. petrol, out of pocket expenses, wear and tear) and the opportunity cost of time. The data collected in the course of a travel cost study could also be used to indicate how visitor numbers or expenditure would be affected by increased accessibility.

There have been no detailed travel cost studies undertaken in Ireland, although some crude values were calculated for coastal assets by the SRUNA study (Dublin Regional Authority (DRA), 2001). A weakness of such studies has been the estimate placed on people's

valuation of leisure time in terms of its opportunity cost, i.e. the value of its next preferred use. Transport studies often include an assessment of how much people value the opportunity cost of time, i.e. commuting time, where that time could be spent in paid employment. However, there have been no recent studies in Ireland to indicate how much people value leisure time. There is, though, no reason to suppose that this would vary much from the level for other European countries where the value of leisure time has been estimated as being approximately one-third the wage rate. Although the technique is potentially applicable in Ireland, its application is limited to the effect of road schemes on recreational activities.

### *Stated preference techniques*

Stated preference techniques construct hypothetical markets in public surveys to establish how much people are willing to pay for environmental benefits or to avoid losses. Conversely, people can be asked how much they would be willing to accept in terms of compensation to forgo environmental benefits or to suffer losses. These techniques can potentially be implemented for all environmental effects and can also investigate all different motivations behind an individual's WTP. There are two groups of stated preference techniques: *contingent valuation* and *choice modelling*.

Although both types of stated preference techniques can be implemented before the full EIA is prepared, definition of a road scheme within a contingent valuation questionnaire requires more detail than that in a choice modelling questionnaire. A stated preference survey could therefore be undertaken in advance of a detailed EIA so long as:

- reasonably realistic and easy to understand scenarios of change can be developed, and
- it is realised that the average values estimated reflect people's interpretation of these scenarios.

#### *Contingent valuation*

Contingent valuation questionnaires present, say, a road scheme as a bundle of attributes. These attributes can be travel time, accident risk, noise, change in landscape and so on. The attributes can take both positive and negative values depending on how they are affected by the said road scheme. The technique generates estimates of WTP (or WTA) for the entirety of this bundle. The WTP/WTA question can be asked in an open-ended format (What are you willing to pay for...?); in a dichotomous choice format (Are you willing to pay X?) or by using a payment card design (asking respondents to choose the maximum amount they would be willing to pay from the amounts listed on the card). Also asked are questions about attitudes towards the subject of the questionnaire, here transport and the environment; and socio–economic characteristics of respondents. Therefore the technique creates interesting information beyond WTP or WTA. Only two major contingent valuation studies have been undertaken in Ireland, both in relation to forestry, i.e. Clinch (1999) and Hutchinson *et al*. (1995).

#### *Choice modelling*

If the objective is to estimate how much people value individual attributes of a road scheme then choice modelling is the preferred approach. The technique asks the respondents to choose between different road schemes that have different levels of the chosen attributes. One of the attributes is always cost or price, which enables the analysis to infer WTP/WTA from the choices people make.

In the *choice experiment* format, respondents are asked to choose their most preferred scenario, which can be the current situation (in this context no road scheme).[4] In fact for the design to be compatible with economic theory, current situation must be included as one of the choices. No choice experiment studies have yet been undertaken in Ireland, although the Environmental Institute at UCD is using this approach to value urban open space and a Department of Agriculture study applying this technique to agri-environmental policy is due to commence. In addition, there are also international civil engineering and transport consultancies based in Ireland which have experience of applying choice modelling to evaluation of transportation modes.

4. Other forms of choice modelling are *contingent ranking* and *contingent rating*. Survey respondents are asked to rank or rate a number of alternative scenarios they are presented with instead of choosing their most preferred. Both techniques can be used to value individual impacts in the same way as choice experiment, but are less popular amongst economists because they are not as robustly based on economic theory.

## 3.3 Including environmental effects in cost–benefit analysis in light of currently available data in Ireland

A more detailed review of the availability and appropriateness of data for CBA in relation to specific impacts is provided in Annexes 4 and 7. The following is a summary of the potential for the use of economic valuation techniques introduced above for each environmental effect. Note that the environmental effects refer to residual negative impacts that remain after mitigation or that cannot be mitigated against. The same discussion is also valid for positive environmental impacts.

### *Noise and vibration*

EISs include an analysis of noise impacts where relevant to the development. The better statements include modelled predictions using specialist software. The forthcoming EU Noise Directive will harmonise the methods for the measurement of noise.

The first step of estimating the noise impact is to examine the number of properties affected. In this respect, much road development would be positive as new roads frequently reduce the problem by transferring it to a less populated location. However, noise does negatively affect other public environmental benefits such as recreational sites. Furthermore, there is a cumulative impact in that new roads may induce more local development and more traffic.

Noise could be evaluated within a stated preference study if the measurement indices used are presented to respondents in a way that can be readily understood, for instance by making comparisons with other sources of noises. Vibration would be more challenging to represent in this way, although people would obviously understand the nuisance caused by vibration.

Hedonic property pricing represents an ideal means of placing a partial economic value on noise (or noise mitigation) as it relates to households. Unfortunately, there are no Irish data available at present to implement the hedonic property pricing technique. Benefits transfer using the estimates from hedonic property pricing studies is not always recommended since these estimates are largely affected by the site-specific characteristics of individual property markets. However, there is a large body of international literature that generates very consistent estimates. Thus, it is recommended for benefits transfer in this context.

The structural damage from vibration could be quantified in economic terms. In the US, Ketcham (1991) has attributed 50% of structural maintenance costs for urban buildings to vibration. This he equated to two-thirds of the damage estimated for noise.

### *Pollution*

*Local air pollution*

The principal impacts arise from $NO_x$ and particulates. Low-level ozone is not a serious problem in Ireland. Stated preference techniques could be used to estimate the value that people place on discomfort or health-related impacts due to air pollution. However, these assessments can be biased up or down as people may not be aware of the full effects of air pollution.

Potentially, the health impacts could be assessed directly by using epidemiological functions and data necessary to run them for particular locations. The relationship is imprecise, but could be estimated for a regional or national population and possibly attributed proportionately to a single large scheme. In this way, estimates could be used to demonstrate, for example, the benefits of a bypass. Patrick Goodman of the Dublin Institute of Technology has measured the relationship between particulates and health (Goodman, 1999; Goodman *et al.*, 1998). Data on the costs of medical treatment could also be obtained from the Hospital In-patient Enquiry. However, it would be difficult to link cases of cancer to the emissions of carcinogens given the problems of establishing causality in the face of other factors. More promising would be estimates of the cost of stone cleaning as a partial indication of the costs imposed by dirt and soot. A quicker approach would be benefits transfer, and estimates of local and regional pollutants from the ExternE programme could be used for this purpose (European Commission, 1995).

*Regional air pollution*

One of the main sources of acid rain is the emissions of $NO_x$, the principal source of which is road traffic. The EPA has undertaken modelling to demonstrate the role of domestic and imported sources of acid rain causing pollution. The EPA also publishes annual reports on air-quality monitoring. Although acidification is not yet a serious problem in Ireland, forestry has already suffered from lost production. Sensitive natural environments such as the Burren and the Wicklow Mountains are also being affected. As these locations have a rarity value, the effect could be subjected to an estimation by stated preference techniques. In fact an ongoing EC-funded research project (EMERGE) is doing exactly this for highland lakes in a number of European countries (project run by Professor Ian Bateman at the University of East Anglia).

Benefits transfer is widely used to estimate the economic costs of acidification across Europe. Given that most of the impacts are similar regardless of the location in which they occur, benefits transfer is believed to provide sufficient robustness (European Commission, 1995).

*Global air quality*

The impact of road development on greenhouse-gas (GHG) emissions deserves to be quantified and included within a CBA at the level of strategic environmental assessment. At a local level, the EPA Guidelines on EIA already require consideration of long-term climatic effects and the micro-climate (including cumulative impacts).

As a signatory to the Kyoto Protocol , Ireland was granted a target of 13% increase in its emissions of GHGs. However, between 1990 and 1998 emissions of GHGs rose by 18%. Irish roads carry 90% of freight and 96% of passengers and, as traffic levels have been growing at 5–6% per year, it is predicted that transport will be responsible for 18.9% of GHG emissions by 2010, twice that of 1990.

The NDP contains plans for expenditure of €6.8 billion to upgrade Irish roads. However, the National Climate Change Strategy (2000) proposes increased fuel efficiency, differential motor and fuel taxes, fuel economy labelling and road pricing. To this end, large amounts are being spent on public transport and transport management (e.g. the Dublin Transport Initiative). In addition, better integration of land use and transport planning is a key feature of the forthcoming National Spatial Strategy and the proposed Greater Dublin Strategic Land Use and Transport Authority. It is proposed that individual road projects should include an assessment of GHGs with a view to reducing these through road design.

There are no known studies that estimate the economic value of changes in GHGs due to road developments. The GHG emissions have too many varied effects on a wide variety of environmental media as well as species and human health for a single economic valuation study to cover. On the basis that the impact of GHGs emitted from Ireland is equivalent to that of other countries, benefits transfer can successfully be applied using one of the available estimates of the marginal damage costs (see Fankhauser, 1995, or Eyre *et al.*, 1997).

***Recreation***

The EPA Guidelines do not specifically refer to recreation, which is occasionally considered under landscape impacts, but more usually under tourism. Therefore, consideration of the public benefits of environmental assets for local amenity depends largely on the quality of the socio–economic assessment.

Bord Fáilte is an obvious source of data on visitor numbers and expenditure. Local tourism agencies, Local Authorities or Chambers of Commerce may also have information. Dúchas possesses a list of Natural Heritage Areas and there is also an existing categorisation of valued Irish landscapes. Tourism amenity is assessed by EISs in terms of tourist numbers and expenditure, usually on a regional basis given the data available. Economic assessments of the benefits of recreation/tourism have been made by Bord Fáilte and the Marine Institute (for water-based leisure). At a local level, the SRUNA project included a modest economic and travel cost appraisal for various sites (DRA, 2001). There have also been estimates of economic benefits where coastal communities are concerned (e.g. the Balbriggan Bypass EIA). The more adverse environmental effects of increased accessibility have not always been considered.

Recreational benefits could be readily estimated by familiar economic methods using tourism expenditure data and included in a CBA. A fuller assessment of the public benefits (especially when recreation is provided for free) could also be estimated through the use of travel cost and stated preference techniques.

***Visual intrusion and landscape***

The EPA Advice Notes discuss the subjects of landscape and visual intrusion together. Visual intrusion is measured in a similar manner to noise using a descriptive matrix or including a discussion of the number of properties affected.

The public benefits of landscape have tended to receive less attention. This may be changing. Firstly, concerns over landscape changes have increased in recent years in response to development pressures. Such concerns have featured prominently in public opposition to road routing options for example around Kilkenny and Enniscorthy. Secondly, local authorities are being required by the Department of the Environment to produce landscape character maps. The Heritage Council has prepared landscape policy guidelines which would assist in this respect.

There is much potential to use stated preference techniques to value the public benefits of landscape impacts. GIS and photomontaging can be used to complement this capability. Generally, these methods would have more success where it is believed that a road will traverse valued landscapes. As such they do not necessarily have to await the completion of a detailed landscape impacts study.

*Biodiversity*

The amended Wildlife Act (2001) is the key national instrument where wildlife is concerned. The Wild Birds and Habitats Directives are also highly influential. There is a network of Natural Heritage Areas (NHAs), Special Protection Areas (SPA) and Special Areas for Conservation (SACs).[5] Dúchas and local organisations such as branches of the Irish Wildlife Trust can provide information on non-designated sites. However, for much of rural Ireland there is still a shortage of detailed ecological data and an EIA is sometimes the first source of such information.

Although EU policy has provided the guiding principles in relation to species or habitat protection, so far there have been no economic estimates of the value of wildlife habitats in Ireland. Nevertheless, biodiversity may have a high economic value based on potential future uses and people's concerns for leaving a diverse natural capital to future generations and their concern for the well-being of non-human species. Stated preference techniques, in particular choice modelling, can be used to provide estimates of public benefits or costs of changes based on best available information. Benefits transfer would probably be inappropriate given that the literature mostly focuses on the recreational value of biodiversity, which tends to be highly site specific.

***Cultural heritage***

The scope of cultural heritage includes archaeology, folklore, architecture, monuments and features. In addition to field research, consultants can collect data from the Sites and Monuments Record, Dúchas, the Heritage Council and local authorities. Cultural heritage could be valued in economic terms in the same manner as environmental effects. For popular sites, actual market techniques could be used and travel cost method is also an option. However, given that people are likely to be willing to pay for the preservation of cultural heritage for reasons other than their own use (e.g. visits to archaeological sites), stated preference techniques would generally be more useful. As is the case for biodiversity, a well-designed questionnaire would ensure that less-familiar or less-visited sites would not be undervalued. In the absence of economic surveys to date, it is unclear whether people would attribute a low value to individual sites given the sheer number of sites (there are 150,000 archaeological sites), or a high value given the awareness of sites' cultural and tourism value. However, the case for valuation in relation to road development is diminished by existing legislation protecting sites of particular importance and requiring that lesser sites be investigated before any construction commences unless cumulative effects are important.

5. The final list of these SACs is still being discussed.

***Water quality, land drainage and flood defence***

Many rural communities are dependent on local surface-water sources for water supply, while angling and boating are major tourism earners. Considerable sums are being spent on mapping aquifers and improving surface- and drinking-water quality under the Water Framework Directive. The Directive also requires strategies to secure the protection of wetland ecosystems.

The principal threat to water quality is from eutrophication, largely by agriculture, and is unrelated to roads. However, there is a risk of pollution from road run-off to which aquatic species would be vulnerable. At a regional or national level, acidification could threaten lakes and wetland habitats.

The threat from flooding is also receiving heightened attention. Following the severe floods of 1999, the Office of Public Works (OPW) has begun a programme of mapping flood risk along the Shannon and is about to commence the same exercise nationally. Under the Arterial Drainage Act of 1945, the OPW must be notified of any road developments that affect river catchments, as must the Electricity Supply Board (ESB) and local authorities in relation to the rivers Shannon, Liffey and Lee. Similarly, Regional Fisheries Boards must be notified of any structures that affect flow.

Cost of flooding is generally estimated using the cost-tangible damage approach, i.e. damage to properties and contents, in the case of a flood. This calculation requires data on the property inventory and representative costings for different types of properties and contents.

Standard economic valuation techniques can be used to estimate some of the amenity value of water and the application of stated preference techniques would be supported by a high awareness of water-pollution issues. As with the cultural heritage, water is not greatly under threat from single road developments and is less threatened by roads than by other economic activity. Nevertheless, estimates of the public benefits of protecting water quality and of providing flood defence could be of particular value at a regional or national consideration of cumulative impacts. More simply, the cost of floods can be estimated using actual market data (e.g. the financial loss due to property damage).

***Community severance***

Severance is usually discussed in EISs in positive terms in relation to existing severance which a new road is expected to ameliorate. Sometimes it is given as increasing or decreasing journey time for pedestrians and cyclists. A good EIS will identify who is affected by severance, but consultants have been discouraged from applying quantitative scorings to severance or socio–economic impacts as these can be a liability at a public inquiry.

Attempts have been made to value the severance effect using stated preference techniques (Soguel, 1994). A simple form of travel cost method can be used to value the benefit of reduced travel time for drivers, but also shortened or lengthened time costs for pedestrians. The EPA Guidance Notes place particular emphasis on the severance of vulnerable groups such as the elderly, disabled, or children. These groups are less likely to place a high monetary value on travel time. As such, severance might be more comprehensively captured by choice modelling methods or multi-criteria analysis, perhaps as part of a wider CBA study. In this case, weightings should be included to account for impacts on vulnerable non-earning groups.

## 3.4 Summary

Benefits transfer is always an option so long as there are relevant estimates in the currently available literature (see Section 2 and Annex 10). This is especially the case for regional, and global air pollution and noise. The more site-specific an impact, the less robust benefits transfer for that impact is likely to be. For more generic impacts, so long as it is assumed that estimates from other countries can be applied to Ireland and with necessary adjustments can reflect the preferences of the Irish population, benefits transfer can be applied with no significant improvements to the currently available data in Ireland.

Revealed preference techniques are valid only for a sub-set of effects that are reflected in actual markets (e.g. noise, visual intrusion, landscape and recreation). Hedonic property pricing requires data on property prices and how these have changed over a reasonably long time frame. Since such data do not exist in Ireland currently,

hedonic property pricing cannot be implemented. Considering it can only be implemented for a small subset of environmental effects and would require systematic collection of necessary data over a long period of time at significant cost, improving the currently available data in Ireland is not seen as a priority.

Travel cost, on the other hand, is not significantly affected by the lack of background data. As a survey-based technique, the necessary data are generated by the technique itself. Therefore, it does not require any improvement to the currently available database but it improves this database by generating new data. It is, however, limited to the environmental effects of road schemes on recreational activities.

If a survey was going to be implemented, it would be more cost-efficient to design a stated preference questionnaire instead of, or in addition to, a travel cost questionnaire. This is because stated preference techniques can potentially estimate individual preferences for all environmental effects and investigate all motivations (as opposed to WTP related to use of resources in revealed preference studies). They can also be used as part of a public consultation exercise. In addition, it does not require any improvement to the currently available database but it improves this database by generating new data with the exception of population data, as mentioned above for travel cost.

# 4. Conclusions and Recommendations

This section summarises the findings of the study and draws different strands together, linking data needs to steps aimed at improving the current practice in Ireland. A summary of recommendations arising from the report is also listed.

The discussion so far will have made clear that standard 'off-the-shelf' monetary values for environmental effects that can be applied to any environmental effect of any road scheme anywhere in Ireland (or for that matter in any other country) do not exist. This is not due to gaps in the literature, although they exist, but is the product of the process of economic valuation. Economic values for environmental effects reflect individual preferences and these preferences differ at the very least according to the characteristics of the individuals, the effect and the cause of the effect. Some of this difference is acceptable given the uncertainties and wide ranges of estimates that are in other parts of a CBA or any other decision-making mechanism. In any case, however, a process of assessment of the relevance of available estimates is necessary before they can be included in a CBA. The annexes to this report provide detailed information on this.

The lack of such 'off-the-shelf' values leads to three alternative approaches:

- benefits transfer;
- original economic valuation studies; and
- the other two failing, a non-economic approach to assessing environmental effects.

Benefits transfer involves finding a relevant monetary value estimate from the available literature and including it in a CBA of a road scheme in Ireland. This process requires relatively little effort and can be implemented for all environmental effects covered in the literature reviewed in Annex 10. It does not require collation of any environmental or economic data that currently do not exist in Ireland except for the data on the affected population mentioned above. The only caveat of benefits transfer is the definition of 'relevant'. Given that the number of economic valuation studies in Ireland is currently so small that they could be judged non-existent, the estimates will have to come from other countries. The degree of relevance of such estimates could be uncertain especially if the attitudes and preferences of the Irish population are thought to differ significantly from, say, other European countries.

This leads us to the second possible approach, which is to implement new economic valuation studies that use either revealed or stated preference techniques. There are two considerations in deciding whether or not to adopt this approach.

The first is the relative limitations and merits of different valuation techniques. For example, hedonic property pricing currently cannot be implemented in Ireland due to the lack of necessary data on house prices and how these have changed over time. Collection of such data would be costly and would take considerable time since the technique requires time-series analysis. In addition, the technique can estimate monetary values for only a sub-set of environmental effects. Thus, collecting the necessary data and implementing hedonic pricing is not recommended as a priority. Travel cost, on the other hand, generates new data and can improve the currently available database in Ireland. It is, however, limited to the impacts of road schemes on recreational activity use. Thus, if an original economic valuation study is going to be commissioned, it would be more cost-efficient to conduct a stated preference (SP) survey. This is explained by the SP technique's ability to estimate monetary values for all environmental impacts and investigate all motivations (i.e. use and non-use values). SP surveys also generate new data and will thus improve the currently available database in Ireland. Furthermore, they can also be included in a wider public consultative exercise.

The second consideration is when to adopt this approach. Should an original valuation study be, say, part of a research programme that covers the relevant environmental effects but is not tied to a particular road scheme? Or could original studies be undertaken within the appraisal of individual road schemes? At least initially there is merit in the first option of a research

programme. Currently there is very little information on what types of environmental effects the population of Ireland has preferences for and against and what is the magnitude of these preferences. Therefore, any addition of such information will be useful not only for the subsequent appraisal of road schemes but also for appraisal of projects or policies in other sectors. Therefore, an inter-agency research programme that addresses the priority environmental effects about which evidence on individual preferences is desired is recommended. The priorities could be determined by analysing the ongoing and anticipated environmental and other policy and project appraisals in Ireland.

Whether or not implementing an original valuation study for the appraisal of a single road scheme or programme of schemes is an efficient option depends on a number of factors. If the road scheme is large enough or if its environmental effects are large in scale and contentious in substance, such a study could be justified. How large is 'large enough' is an empirical issue. Generally, the comparison is made between the investment cost of a scheme, the budget for appraisal and the cost of a valuation study. Therefore, even in absolute terms, the cost of an original valuation study (which can be between €50,000 and €150,000 depending on its scale and complexity) may seem large, relative to large investments it could be deemed worthwhile. In terms of the scale of environmental effects, potentially irreversible effects are likely to be the most contentious. However, there is a timing issue here: once an issue becomes so contentious that it becomes a political one, it may be too late to implement economic valuation techniques. In summary, original valuation studies are more likely to be relevant at the strategic level to identify how the affected populations view and value the environmental effects of road schemes rather than at the level of individual local-scale schemes.

Finally, environmental effects can be assessed using an approach other than the economic one based on individual preferences. This could use scores and weights to appraise environmental effects based on expert or public opinion. Although it simplifies the process, this approach does nothing to improve the current practice of treating economic and environmental costs and benefits of road schemes separately. Therefore, if it is believed that including environmental impacts into CBA will improve the current decision-making process by providing a more structured and directly comparable set of information to the decision-makers, this third approach provides no benefits.

Figure 4.1 summarises the above discussion on how to decide on the level of economic valuation of environmental effects. It looks at this decision in the cases of 'large' and 'small' schemes.

Table 4.1 summarises the suitability of economic valuation to environmental effects at different scales of road schemes. Effects in bold are likely to be those that are more significant. On balance you can see that there are a good number of environmental benefits and costs, even though some such as landscape and biodiversity are usually losers where new road construction is concerned. Note that careful route choice and mitigation measures have the effect of reducing environmental costs (avoiding losses). Thus, only those effects that cannot be mitigated against, or residual effects, are considered for further economic analysis.

Finally, Table 4.2 summarises the discussion of how to express environmental effects in physical units, identifies the most relevant economic valuation techniques for each environmental effect and provides some guidance on how to quantify environmental effects using non-economic valuation approaches.

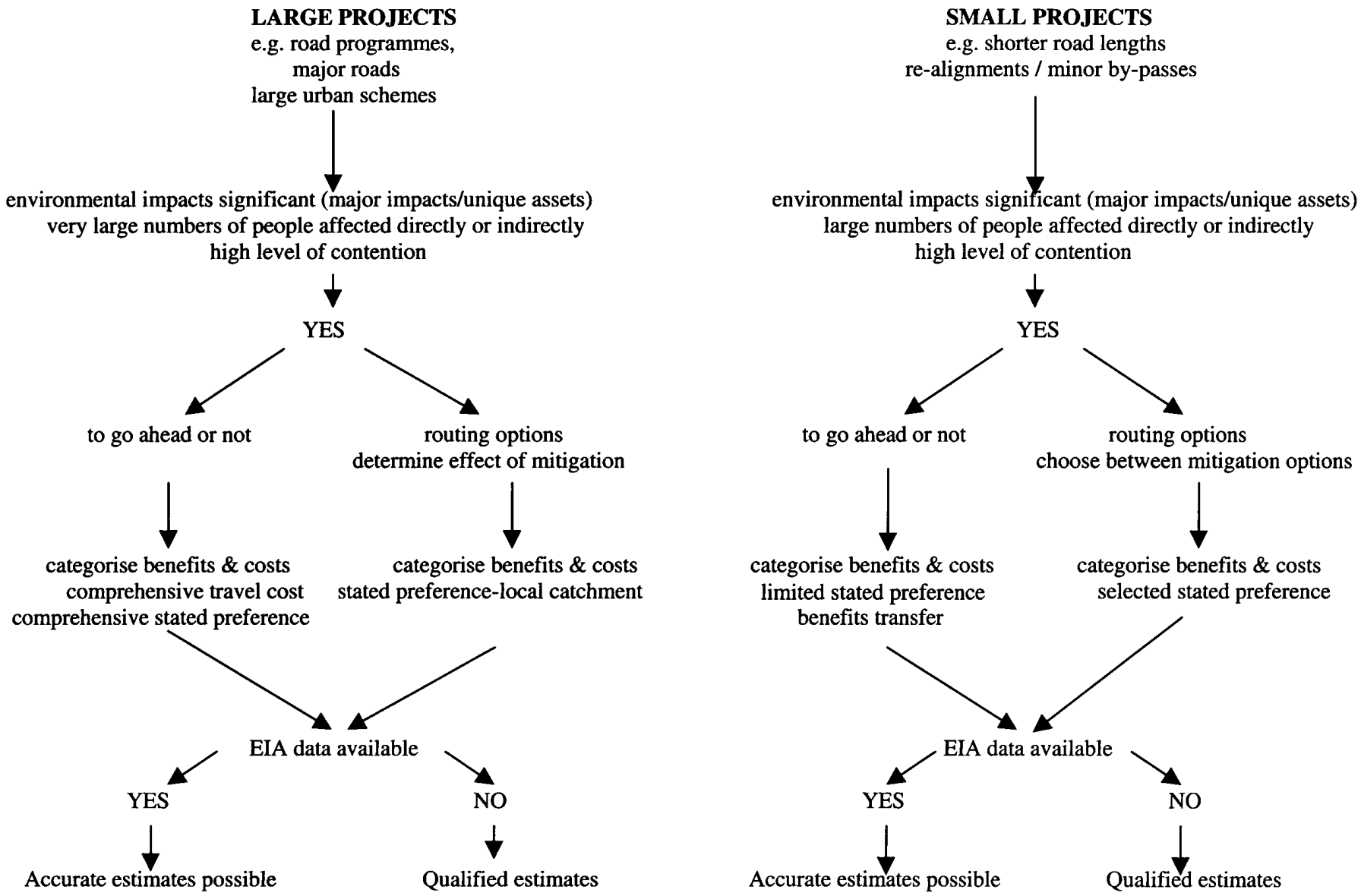


**Figure 4.1. Deciding on approaches to quantifying environmental effects based on the scale of a road scheme.**

**Table 4.1. The potential for economic valuation of environmental effects in the case of road schemes in Ireland.**

| Environmental effect | Environmental benefits/costs | | Potential for economic valuation in the case of roads (Ireland) | | | Recommendations |
|---|---|---|---|---|---|---|
| | **Benefits** | **Costs** | **Programme level** | **Large projects** | **Small projects** | |
| Noise | **Reduced noise** | **Increased noise** | Yes | Yes | Approx. impact on property values | Overall recommendation that there are two approaches to economic valuation of environmental effects applies across the environmental effects and scale of projects:<br>• undertake an original valuation study (using either revealed or stated preference techniques) or<br>• undertake benefits transfer.<br>Potential applicability of different valuation methods for difference is shown in Table 4.2 |
| Vibration | **Reduced vibration** | **Increased vibration** | Yes | Possible | Approx. impact on property values | |
| Local air quality | **Reduced pollution** | Increased pollution | Yes | Possible | Valuation unlikely | |
| Regional air quality | | $SO_x$, $NO_x$, $NH_3$ | Yes | No | No | |
| Global air quality | | GHGs | Yes | No | No | |
| Recreation | Increased access | **Losses of recreational opportunity** | Difficult | Yes | Difficult | |
| Visual intrusion | | **Visual intrusion** | Possible | Yes | Difficult | |
| Biodiversity | | **Loss habitat. Fragmentation** | Yes | Yes | Difficult | |
| Cultural heritage | **Reduced soiling of stonework** | **Direct loss of heritage** | Possible | Yes | Possible | |
| Water quality | | Changes in water quality | Yes | Yes | Possible | |

Effects in bold are likely to be those that are more significant.

**Table 4.2. Environmental effects and approaches to quantification.**

| Environmental effect | Qualitative assessment | Quantitative assessment | Monetary valuation | Non-monetary valuation | Potential for monetary valuation in Ireland |
|---|---|---|---|---|---|
| Noise | • Record magnitude, intensity, duration and certainty of impact<br>• Identify sensitive receptors, e.g. households, fauna, the location, number and sensitivity of receptors | • dB(A), or Leq<br>• No. of households exposed to road traffic noise by d(B)A bands, i.e. 51–55, 56–60dB(A), etc. | • Hedonic property pricing study<br>• SP techniques<br>• Benefits transfer | • Number of properties exposed to noise ± a benchmark level could be used as an assessment criterion | • SP techniques<br>• benefits transfer |
| Vibration | • As for noise | • Information on traffic flows, e.g. frequency of disturbance, duration of disturbance | • As for noise | • As for noise | Probably best to combine a study for vibration with one for noise.<br>• SP study<br>• Benefits transfer |
| Local air quality | • Record type of pollutants, emissions and dispersion which generates concentration and/or deposition data as relevant | • Emissions data for local air pollutants<br>• Changes in ozone concentrations<br>• No. of premature mortality/morbidity cases due to local air pollution | • Hedonic property pricing study<br>• SP techniques<br>• Benefits transfer | • No. of properties in distance bands from the roadside, that receive emissions of chosen pollutants. ± a benchmark level could be used as an assessment criterion | Benefits transfer |
| Regional air quality | • Record type of pollutants, emissions and dispersion which generates concentration and/or deposition data as relevant | • Tonnes of SOx, NOx and $NH_3$ | • SP techniques<br>• Benefits transfer | • Deposition maps of the regional air pollutants can identify the population exposed to increases in emissions. ± a benchmark of acceptable increases for different pollutants can be used as an assessment criterion | It is unlikely that acidification due to new road developments will have a great impact on Ireland; however, if valuation is required:<br>• benefits transfer |
| Global air quality | • Net change in level of greenhouse gases due to new road development | • Tonnes of greenhouse gases | • Benefits transfer | • Consideration of long-term climatic effects and the micro-climate<br>• Net change in $CO_2$ levels due to new road development | • Benefits transfer |

**Table 4.2.** ***contd***

| Environmental effect | Qualitative assessment | Quantitative assessment | Monetary valuation | Non-monetary valuation | Potential for monetary valuation in Ireland |
|---|---|---|---|---|---|
| Recreation (related to 'landscape' impacts) | • Consideration of size, quality, importance, rarity, mitigation and substitution opportunities for recreational sites<br>• The effect of the road scheme on the recreation experience | • No. of visitors<br>• Purpose for recreation to identify the effect of the road scheme on the recreation experience<br>• Travel costs | • SP techniques<br>• Travel cost method | • Recreational effects can be assessed using the landscape categories of large, moderate, slight beneficial/adverse effects and neutral effect based on how suitable the road scheme is for the existing landscape | • Benefits transfer<br>But for site-specific impacts:<br>• SP techniques<br>• Travel cost method |
| Visual intrusion (related to 'landscape' impacts) | • Consideration of the receptor points and the impact of the road scheme on those points | • Population affected: local, visitors, non-use population may also be affected if unique landscapes are affected | • SP techniques<br>• Hedonic property pricing study | • Landscape effects can be assessed using the categories of large, moderate, slight beneficial/adverse effects and neutral effect based on how suitable the road scheme is for the existing landscape | • SP techniques |
| Biodiversity | • Consideration of the ecosystem/habitat area under threat, i.e. presence of protected individual species threatened by road scheme | • Area of natural environment/designation under threat<br>• Species under threat<br>• No. of visitors if related to recreation<br>• Potential non-user population | • SP techniques<br>• Travel cost method (if change affects recreational behaviour)<br>• Benefits transfer (mainly for recreation, not for biodiversity *per se*) | • An impact assessment scale can be set, based on the severity of the biodiversity impact on selected sites of importance such as Natura 2000 sites | Changes to biodiversity are likely to be site specific, thus benefits transfer may not be suitable.<br>• SP techniques<br>• Travel cost method |
| Cultural heritage | • Description of the heritage site under threat such as national/international, condition, period, group value, rarity, situation, multi-period nature, and fragility | • No. of visitors<br>• Potential non-user population | • SP techniques<br>• Travel cost method (if change affects recreational behaviour)<br>• Benefits transfer | • A scale of large, moderate, slight beneficial or adverse effects and neutral effect can be set based on the physical and aesthetic effect of the road scheme on the cultural heritage site and whether the site is of regional, national or international importance | Although there is a growing body of literature looking at the economic value of cultural heritage, such values are specific to the heritage assets and hence benefits transfer can only provide orders of magnitude.<br>• SP techniques<br>• Travel cost method |

**Table 4.2.** ***contd***

| Environmental effect | Qualitative assessment | Quantitative assessment | Monetary valuation | Non-monetary valuation | Potential for monetary valuation in Ireland |
|---|---|---|---|---|---|
| Water quality | • Consideration of the water body under threat and ecological and recreational services it provides | • Changes in water quality, e.g. appearance, fish catch, etc.<br>• Changes in water quantity, e.g. flow<br>• Affects type and scale of recreational use<br>• Non-user population if relevant | • SP techniques<br>• Travel cost method (if change affects recreational behaviour)<br>• Benefits transfer | • A qualitative impact scale can be devised based on the type and scale of the impact (e.g. chemical discharge, reduction in water quantity), the type of water body (e.g. groundwater, surface water) affected and the uses of the water body (e.g. drinking, fisheries, recreation) | • SP techniques<br>• Travel cost method<br>• Benefits transfer |
| Land drainage and flooding (related to 'water' impacts) | • Consideration of land types: for example, soil, rock composition, etc. and effect of the road scheme on the risk of flooding and interference with the drainage system<br>• | • Increase in risk of flooding due to road schemes<br>• No. of properties and ecosystems potentially at risk from flooding | • SP techniques<br>• Avertive behaviour is relevant only if avertive action is taken to avoid flooding or to mitigate the flooding impacts of the road scheme | • A qualitative impact scale could be devised based on changes to flood risk: e.g. large, moderate, slight beneficial or adverse effects and neutral effect due to the road scheme | • SP techniques |
| Community severance | • Consideration given to vulnerable groups affected, e.g. elderly, children, disabled, given the location of community facilities and the frequency with which they are used | • Pedestrian/cyclist journey time (±)<br>• Change in accident levels; distance travelled and speed | • SP techniques<br>• Travel cost method (if change affects recreational behaviour or affects the travel time for other journeys) | • An impact scale can be devised based on the severity of the impact and the number of people affected | • Opportunities for benefits transfer are limited due to the limited literature on the economic cost of community severance effects<br>• SP techniques |

**The Annexes referred to in this report are available for download from the 'Research and Development' pages of the EPA website (www.epa.ie) and on request from the ERTDI Section, Environmental Protection Agency, Dublin Regional Inspectorate, Richview, Clonskeagh Road, Dublin 14.**

## References


Bateman, I., Day, B., Lake, I. and Lovett, A. (1999) *The Effect of Road Traffic on Residential Property Values: A Literature Review*, UEA, ESRC and UCL. The Centre for Social and Economic Research on the Global Environment, University of East Anglia and University College London.

Chadwick, A. (2002) *Socio-economic Impacts: Are they Still the Poor Relations in UK Environmental Statements? Journal of Environmental Planning and Management*, **45(1),** 3–24.

Clinch, J.P. (1999) *Economics of Irish Forestry.* COFORD, Dublin.

Comptroller & Auditor General Office (1999) *Development of the National Road Network (Report on Value for Money Examination)*, Report No. 29. Government of Ireland, March 1999.

Conniffe, D. and Duffy, D (1999) *Irish House Price Indices – Methodological Issues.* Economic and Social Research Institute, working paper 110. ESRI, 4 Burlington Road, Dublin 4, Ireland.

CSF Evaluation Unit (1999) *Proposed Working Rules for Cost-Benefit Analysis.* CSF Evaluation Unit, Dublin, Ireland.

DETR (Department of the Environment, Transport and the Regions, UK) (1998) *Guidance on the New Approach to Appraisal*. DETR, London (available at www.dtlr.gov.uk).

DoELG (Department of the Environment and Local Government, Ireland) (2000) *National Climate Change Strategy.* Stationery Office, Dublin, Ireland.

DoF (Department of Finance, Ireland) (1994) *Guidelines for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector.* Stationery Office, Dublin, Ireland.

DRA (Dublin Regional Authority) (2001) *Planning for Sustainability – A New Planning Method.* (Information Pack) www.dra.ie/sruna/consultants.

European Commission DGXVI (Regional Policy & Cohesion) (1997) Guide to Cost-Benefit Analysis of Major Projects in the Context of EC Regional Policy. Series: Evaluation & Documents No.3.

European Commission (1995) *'ExternE' Project*: Externalities of Fuel Cycles, European Commission, Directorate-General XII, Science, Research and Development, Brussels.

Eyre, N., Downing, T., Hoekstra, R., Rennings, K. and Tol, R., (1997) *Global Warming Damages*, Final Report of the ExternE Global Warming Sub-Task, DGXII, European Commission, Brussels.

Fankhauser, S. (1995) *Valuing Climate Change: the Economics of the Greenhouse*, Earthscan, London.

Forrest, D., Glenn, J., Grime, K. and Ward, R. (1995) *House Price Changes in Greater Manchester 1990–1993 and the Impact of Metro Link*, Working Paper 16, Dept of Geography, University of Salford, Salford, UK.

Goodman, P.L. (1999) *Particulate Air Pollution and Mortality in Dublin 1980–1996.* Ph.D. thesis, Department of Health Sciences, Trinity College, Dublin 2, Ireland.

Goodman, P. et al. (1998) Particulate air pollution and acute mortality in Dublin – a study over 14 years. *European Respiratory Journal* **12:S28:** 376s.

Government of Ireland (2000) *Ireland – National Development Plan 2000–200*6, Stationery Office, Dublin.

HM Treasury (1997) *Appraisal and Valuation in Central Government*, HM Treasury, London (the 'Green Book').

Hutchinson, W.G., Davis, J. and Chilton, S.M. (1995) Theoretical and Spatial Limits to the Value of Rural Environmental Benefits: Evidence from the Forestry Sector. *Journal of Rural Studies* **11(4),** 397–404.

IVM (Institute for Environmental Studies, Free University of Amsterdam) and EFTEC (Economics for the Environment Consultancy) (1998) *External Economic Benefits and Costs in Water and Solid Waste Investments: methodology, guidelines and case studies*, IVM, Amsterdam.

Jansson, A. (1999) *Transport SEA: A Nordic Perspective.* Paper presented to OECD/ECMT Conference on Strategic Environmental Assessment for Transport, Warsaw, 14–15 October.

Ketcham, B. (1991) *Making Transportation Choices Based on Real Costs.* paper presented at Transportation 2000 conference, Making Transportation a National Priority, Snowmass, Colorado.

Laasko, S. (1992) Public Transport Investment and Residential

Property Values in Helsinki. *Scandinavian Housing & Planning Research* **9,** 217–229.

Price, A. (1999) The New Approach to the Appraisal of Road Projects in England. *Journal of Transport Economics and Policy* **33,** 2.

Soguel, N. (1994) *Évaluation Monétaire des Atteintes à l'Environnement: une Étude Hedoniste et Contingente sur l'Impact des Transports*, University of Neuchâtel, Switzerland.

US Department of Transportation – Federal Highway Administration, September 1998, *Procedural Guidelines for Highway Feasibility Studies*.

USEPA (US Environmental Protection Agency) (2000) *Guidelines for Preparing Economic Analyses*, Office of the Administrator, USEPA, Washington DC, USA.

Welch, M. and Williams, H. (1997) The sensitivity of transport investment benefits to the evaluation of small travel-time savings. *Journal of Transport Economics and Policy* **31(3)**, 231–254.

Wildlife Act (2001) Wildlife Act: Act 38/2001. Stationery Office, Dublin, Ireland.