The Flood Risk Management (Scotland) Act 2009

Flood Protection Schemes – Guidance for Local Authorities

Chapter 5

Project Appraisal: Assessment of economic, environmental and social impacts

The Scottish Government

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The Scottish Government, Edinburgh 2012

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1. Introduction

Scope

1.1 This document provides guidance for Scottish local authorities on the economic, social and environmental aspects of project appraisal for flood protection schemes promoted under the Flood Risk Management (Scotland) Act 2009. It identifies methods for valuing positive and negative impacts in monetary terms and recommends a decision process, based on the principles of sustainable flood risk management (Delivering Sustainable Flood Risk Management – Statutory guidance (reference 1) and Principles of Appraisal: a policy statement (reference 2) and consistent with the HM Treasury Green Book (reference 3). Good practice recommendations are shown in bold text.

1.2 The guidance assumes that the reader has prior knowledge of general cost-benefit analysis techniques, and should be read in conjunction with Chapter 6 (Approaches to Risk). It is not intended to be followed mechanically, or to cover every possible eventuality. Appropriate specialist advice should be sought as necessary for the cost-benefit analyses of all schemes.

1.3 Unless otherwise stated, references in this chapter to economic values, whether in terms of costs, losses or benefits, assume that all components of economic value are taken into account. Such components can include social and environmental values (Annex B).

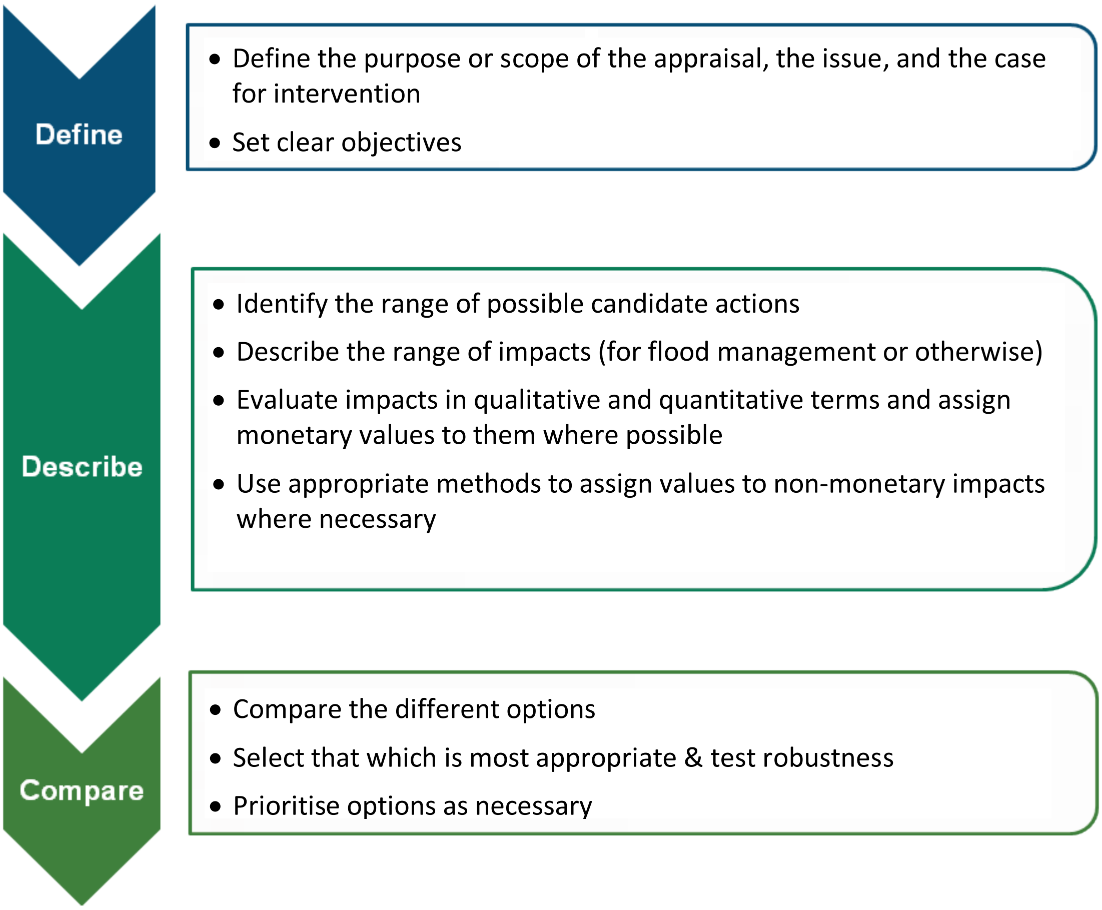
1.4 The document provides guidance that is consistent with the Scottish Government's aims of delivering sustainable flood risk management. It is a revised version of Flood Protection Schemes: Guidance for Local Authorities - Chapter 5: Economic Analysis (published by the Scottish Government in 2005), which has been updated to provide interim guidance for local authorities. The intention is to replace this document in future with guidance on appraisal for the whole of the flood risk management planning process.

Approach

1.5 The recommended approach is appraisal-led design. That is, the whole process of option development, refinement and choice should be carried out within a logical appraisal framework (fig. 1.1). Ideally, this should entail working from strategic assessments through to appraisal of the options for a particular project.

1.6 The key to application of cost-benefit analysis to flood protection schemes is the management of risks. Such schemes reduce the probability or severity of future flood damage, compared to the pre-scheme situation. This change in probability may vary over time; for example, as an embankment erodes. No scheme can eliminate the possibility of flooding, and there can be no certainty about the timing of the next damaging event. Further discussion of issues related to the definition and evaluation of risk can be found in Chapter 6 of the Scottish Government's Flood Protection Schemes: Guidance for Local Authorities.

Figure 1.1 Main stages in investment appraisal



1.7 Cost-benefit analysis is a useful tool for determining the most appropriate strategic approach, deciding whether it is worthwhile to undertake a scheme, and identifying and comparing scheme options. It should not be viewed as a hurdle. The analysis should stimulate the development of alternative solutions by clarifying the consequences of all options. Well-designed, it should ensure that schemes undertaken represent the best value for money, and that uneconomic schemes are identified at an early stage.

1.8 The design process is cyclic and iterative. It involves exploring the problem, generating the 'do something' options, and refining the selection progressively. This approach should also be applied to the cost-benefit analysis, to aid and guide the design towards the best solution.

1.9 It should be emphasised that the aim of cost-benefit analysis is to provide a transparent and inclusive approach to decision-making which, as far as possible, takes all relevant factors into account. It involves comparison of options in terms of a single criterion: economic efficiency. However, the selection of sustainable flood risk management actions will require that the full range of impacts (economic, environmental, social (including human health and cultural heritage) are considered in an equitable manner. Some of these impacts may not be readily valued in monetary terms and others, which for various reasons, may not be given their full weight in the analysis: these impacts should always be described, quantified and brought into the appraisal through appraisal summary tables. Understanding these impacts is critical to selecting sustainable actions and they should not be ignored simply because they are difficult to quantify or value on monetary terms.

Goals

1.10 The goal of investment appraisal is to maximise the total value of interventions in a sustainable manner whilst achieving the objectives set out for the scheme. The appraisal process should aim to achieve the following goals:

- **Best use of public money** - Demands for public funding always exceed the money available. It is therefore necessary to aim for economic efficiency in the investments that are made. This is achieved when the total of all forms of benefit is maximised relative to the resources used. The analysis should not be limited to the consideration of priced benefits and resources. It should, where appropriate, include unpriced benefits, such as the enjoyment gained from walks by a river, as well as the unpriced costs incurred, such as nuisance during construction.

- **Sustainability** - A sustainable scheme will take full account of economic, environmental and social priorities, and protect and enhance our natural and built environment for ourselves and for future generations. The scheme must be developed with consideration of catchment processes and characteristics, making all reasonable and practical efforts to enhance the (urban and rural) landscapes natural ability to slow and store flood water. A sustainable scheme should take account of interactions with other interventions in the catchment, and should avoid as far as possible tying future generations into inflexible and expensive options.

- **Accountability** - A formal process of project appraisal can demonstrate that a wide range of different options has been considered transparently, and that the advantages and disadvantages of each have been properly considered. Appraisals also create an effective audit trail of decision-making.

- **Quality assurance** - Good quality appraisals save time and money by early rejection of unrealistic options; they increase certainty and confidence in the final outcome.

2. The Appraisal Context

2.1 The principles of appraisal for sustainable flood risk management are set out in the Scottish Government's policy statement (reference 2). Additional guidance is provided here on specific issues.

Principles for evaluating costs and benefits

Price basis

2.2 Cost-benefit analysis should be undertaken using real prices; that is, inflation is ignored where 'inflation' has the everyday meaning of the price of a resource increasing without its relative value also increasing. Commonly, the relative prices of the different streams of costs and benefits are assumed to be constant over time; this is generally a conservative practice. In reality, they may change over time.

2.3 Growth factors may be adopted to reflect predicted changes in relative prices or demand. However, if such factors are used for one stream of benefits or costs, they should logically be used for all streams. Since prices are relative, it follows that, over time, some will fall relative to others, in the same way that the real price of many electrical goods has fallen over the last 30 years. Therefore, any use of selective growth factors should be considered carefully.

- **Inflation should be ignored in undertaking the analysis**
- **Real prices should be used for all streams of benefits and costs**

What is a benefit and what is a cost?

Treatment of negative costs and negative benefits

2.4 In deriving a benefit-cost ratio, there is no universally agreed basis for classifying a particular item as either a positive cost, or a negative benefit (disbenefit), or vice versa. While the particular approach adopted will have no effect on the net present value of an option, it can have a significant effect on the benefit-cost ratio. To ensure a consistent approach between options and schemes, it is important to have a common rule. The following conventions should therefore be adopted:

- **Any 'negative costs' should be regarded as benefits**
- **Any 'negative benefits' should be regarded as costs**

2.5 The benefit arising from a flood protection scheme is the net difference between total present value damages with and without the scheme - that is, the damage avoided in comparison with the 'do nothing' option. Any negative benefit, or disbenefit, arising from the project represents a loss to society, and should therefore be treated as a scheme cost. Conversely, resources which become available to society as a result of project implementation should be regarded as a benefit.

2.6 Sales that offset the costs of construction are to be treated as benefits of the scheme. For example, the sale of sand or gravel excavated as part of a channel widening scheme, or charges raised for the incorporation into the scheme of arisings from others, should be treated as a benefit.

2.7 Disbenefits such as noise and disruption caused by project works, and obstructions to views, should be treated as costs. In general, however, they are likely to be better handled as part of the consultation process and environmental appraisal, through which ameliorating actions are likely to be identified and included in scheme costs. If not, the costing of the disbenefits is likely to be disproportionate to their magnitude. The residual impact (the impact that remains following mitigation) will need to be described, quantified and, where appropriate, valued as damages. If mitigation is not possible and actions are required to compensate, then these costs should also be included in the option costs. The value of disbenefits will only require consideration when there are significant differences of impact between different groups or between different options.

2.8 However, there may be additional benefits from the flood protection scheme, particularly environmental and social benefits, that may not have been captured by considering benefits based only on net present value. These benefits might be difficult to value but should still be considered in the appraisal process.

2.9 Note that cost-benefit analysis is only concerned with changes in the total value of benefits and the total cost of the resources used. People will often adjust to a flood loss, and do so in a way that minimises their losses. If flooding closes a factory, production may be increased elsewhere. In such a case, the total national value remains the same. If the alteration simply varies the distribution of benefits and costs across the country, then no economic change occurs. Changes only in the distribution of consumption and resources are termed 'transfer payments' and should be excluded from the cost-benefit analysis (Annex A).

Stocks and flows

2.10 When identifying and valuing the different streams of benefits and costs, it is helpful to think in terms of 'stocks' and 'flows'. It is easy to make the mistake of including the same benefit or cost twice because of a failure to distinguish sufficiently between the stock of some asset and the flow of resources, or consumption, which that stock generates. Typically, stocks give rise to some flow of consumption or resource so that the current capital value of the stock is determined by the discounted value of the future benefits, which flow from it. In some cases the flow diminishes the value of the stock value (e.g. mining coal necessarily diminishes the stock of coal) whereas in other cases it does not (e.g. catching fish at below the rate of replacement).

2.11 An appraisal can include either the stock value of a resource or the sum of all the flows that it yields but not both. However, the market value of a stock might not always fully reflect the value of the flow of services which it provides since these can include unpriced public goods, such as the provision of opportunities for enjoyment of the countryside. In such cases allowance can be made for these additional flow values, suitably discounted.

2.12 In some cases it may be easier to estimate the change in the annual flow of benefits from the stock than the change in the capital value of the stock. For instance, there is no obvious market price for a riverside park that might be destroyed through the construction of a flood protection scheme. An estimate of the value placed by users on visits made to that park might represent a better approach to valuing its loss (paragraphs 5.67-5.72).

A proportionate approach

2.13 The level of detail in a cost-benefit analysis should be proportional to the scale of the project, and to the level of detail needed to chose a preferred option. For projects involving a small amount of expenditure, a detailed cost-benefit analysis may not be economically justified. Similarly, the amount of information required to make a decision will depend on a project, its size and its complexity:

- At the early stages of appraisal, summary data are usually sufficient; as the appraisal proceeds, data are usually refined to become more specific and accurate as needed to support decision making – it is important that the effort applied at each step is proportionate to the time and resources available and that additional data are only collected where they help in identifying a preferred option.

- Less information is needed where the choices between options are clear, whereas more detailed information is likely to be required where there are complex trade-offs between options.

- Once the choices between options are clear, then there is no further justification for the addition of any further detail (for example, where two options have very similar average cost-benefit ratios and it is clear that for all other social and environmental objectives, one option significantly outweighs the other).

2.14 Decisions will therefore be required on the appropriate level of detail, the streams of benefits and costs to be included, and the amount to be spent on the analysis. One of the skills needed for good project appraisal is deciding when enough information has been collected to make a robust and defensible decision. This is usually where collecting more information will not make a significant difference to the decision. In addition, it is essential to demonstrate this clearly and openly to those that may be affected by the decision.

2.15 For example, where appropriate, strategic and prefeasibility studies should be undertaken using readily available data, since the most expensive part of a cost-benefit analysis is data collection and collation. A simplified analysis should not, however, be interpreted as one that lacks economic rigour. This may include the simple technique of value transfer, which involves taking values derived in one context and applying them elsewhere; for example, taking the values of enjoyment for a visit to one river, and using them to estimate the value of visits to another.

2.16 For the more detailed design studies, the cost-benefit analysis should be sufficiently extensive to show with reasonable confidence whether or not it is worth adopting any of the 'do something' options. Ideally, the first streams of benefits and costs to be included should be those contributing the greatest proportion of the total. While it is not always possible to determine in advance which will be the largest, there are 2 areas which should generally be considered first. These are:

- benefits and costs which accrue earliest in the lifetime of the scheme; and
- those which have the highest probability of occurrence.

2.17 The cost of carrying out the appraisal will vary depending on the types of impacts that are appraised and the precision required. For recreational benefits or non-use values, it will cost as much to evaluate these for a small scheme (or area) as a large one, since the costs are largely fixed. The assessment cost also depends on the extent to which standard data can be used, such as the depth-damage data for residential properties. Further, if the flood surface and topography are complex, evaluation costs will increase.

How to determine a proportionate approach

2.18 There are several additional approaches that can be used to identify whether it is proportionate to value certain impacts:

- *Are the impacts significant?* The size of impacts can be considered in relation to property impacts (which can be estimated reasonably quickly) – if monetised impacts are likely to be ~10% or more of property damages they could impact on overall estimated benefits and are likely to be worth spending time on to estimate them in more detail. It is also often worth considering non-residential property damages in detail as they can vary significantly and can account for a large proportion of damages, even if they make up a relatively small proportion of affected properties.

- *Do the impacts differ across the options being appraised?* Detailed assessments should focus on differences between options as it is these differences that will help you decide which are preferred. Where impacts are very similar across all or most options, there is unlikely to be much value to the decision-making in considering these impacts in a lot of detail.

- *How much uncertainty is there in predictions of risk?* There is very little advantage in spending a lot of time looking at impacts in detail if the approaches that have predicted those impacts are coarse. For example, if a model predicts flood levels of 0.5m ±0.1m, it would not be worthwhile spending time describing differences in impacts that could occur based on 0.4m to 0.6m flood depths. This is because the uncertainty from the model means that the impacts on options with 0.4m and 0.6m flood depth need to be treated as similar.

- *How much time is required to describe, quantify or value the impacts?* It can take a considerable amount of time to estimate the monetary damages of some impacts (for example, disruption to road traffic) where those impacts are relatively small. It is essential to consider how significant the impacts are likely to be before starting to collect data or estimate damages. If the choice of preferred option turns out to be reliant on differences between options in any one category, it is possible to estimate and monetise these impacts later in the appraisal process.

- *Are approaches available to value the impacts?* Not all of the impacts will be easy to value in monetary terms. However, this is not an appropriate reason for excluding impacts. It is important to remember that you are valuing impacts at £0 if you exclude them from the appraisal. If significant impacts cannot be valued in monetary terms, it is important that they are described and quantified so they can be taken into account during decision-making

Consultation

2.19 Consultation is a necessary part of scheme development. It is good practice to consult early in the scheme design, and to continue the process throughout the design work and implementation. This should enable a comprehensive consideration of the appropriate costs and benefits.

The project domain

2.20 In some cases, the form of appraisal will depend on whether the solution is in fact a single scheme, or a series of independent projects. If the latter, a separate cost-benefit analysis should be carried out for each independent element. For example, if separate flood embankments are proposed for several different villages, the protection of each should be justified on its own. Where, however, it is possible to protect all the villages with a single scheme, such as a barrage, or flood storage reservoir, it is still necessary to consider the option of protecting each one individually. In this case, the aggregate costs and benefits of the best worthwhile individual protection schemes should be compared with those of the single scheme.

Multifunctional schemes

2.21 The development of strategic approaches to flood protection may result in the promotion of a multi-functional project. At its simplest, such a project may involve two or more different structures, each with a different purpose, but built together to make savings in total construction costs. In this case, it would be reasonable to apportion these costs, and to appraise the flood defence function of the works separately.

2.22 However, the aim of promoting a multi-functional project will generally be to provide a range of facilities at a lower total cost than if each were provided separately. In this situation, when undertaking the cost-benefit analysis, all benefits and costs should be included and the question of who benefits and who pays can be ignored.

2.23 The question then arises of how to share the costs equitably between funders. Because the overall aim is to make more efficient use of resources, it is reasonable to assume that no party should pay more than the whole-life cost of meeting their specific requirements on a stand alone basis. The contributions should usually be based on the costs of the relevant major sections of the work. However, there may be situations where it will be more equitable to divide costs in the ratio of the major benefits, provided these can be determined on a consistent basis (see also paragraphs 7.9-7.11).

Phasing of a project

2.24 When a single scheme is phased, and there are no independent elements, the cost-benefit analysis should be carried out for the project as a single entity. However, a review of the justification of each stage of the phased works should also be undertaken.

2.25 As a scheme is progressed, the probability of a failure of one part of the scheme will change. It is this change in probability that should be used in the review of each stage of the works. Further, there are likely to be differences in the consequences of a failure, depending upon the particular works already completed.

3. DEFINE: Define issues and objectives

Defining the purpose

3.1 An appraisal should start with a clear statement of the problems to be tackled or the objectives to be achieved. These should be defined without prejudging the solution; for example, it is not acceptable to state that the objective is 'to replace existing flood defences with a 1% annual exceedence probability (AEP) (1 in 100 year return period) design standard flood embankment'. Further, all social, environmental and economic issues should be taken into account, including the effect of climate change. Major constraints affecting the options should also be stated.

3.2 An example of such a statement might be:-

'The town is prone to flooding from the river X with an annual exceedance probability of greater than 5%; the area at risk covers 120 properties including some sheltered housing with a higher expectancy of risk to life. River flood flows are expected to increase by between 15% and 35% by the 2080s. Sections of the river border an SSSI.'

3.3 Deaths from flooding in the UK have fortunately been rare. However, this risk is always present. It is sensible, therefore, to assess whether floods in a particular situation pose an unusually high risk to life. Such a threat might occur with a rapid rise in floodwaters, accompanied by high flow velocities and deep water, particularly where this could result in the structural failure of buildings. Consequently, where structures such as flood embankments fail, or where flooding can occur in very small, steep catchments, special attention should be given to managing the risk.

Setting objectives

3.4 The Scottish Government's policy statement on appraisal sets out principles for setting flood risk management objectives.

Statutory requirements

3.5 Schemes may be affected by legal obligations under national and international law, which may constrain the appraisal process. For example, where the obligations involve requirements that must be met, it would be incorrect to test that position using cost-benefit analysis. Instead, the principles of cost-effectiveness would usually be more appropriate to identify the least costly method of meeting the legal obligations.

3.6 The water environment provides a range of habitats, which supports a wide variety of species and water-related uses. Changes to that environment, both locally for a scheme and in a wider national context, need to be taken into account in the appraisal process, particularly the ability to meet statutory environmental legislation such as the EC Water Framework Directive and the Birds & Habitats Directives. As part of the submission, an Environmental Impact Assessment will need to be prepared under the Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Regulations 2010.

3.7 Boundaries in space and time have to be drawn for any cost-benefit analysis. They should be set taking into account the consequences of the different options. It may not be possible to assess all such consequences, and a reasoned decision must therefore be made as to how far the process should be pursued. Options may have an influence outside the immediate area of the scheme but, in addition, their consequences may depend on factors outside the project boundary. For example, urbanisation of the upstream catchment could affect flood risk. The assumptions made about external conditions should be realistic, not simply convenient. Any significant impacts beyond the project boundary should be included.

Time span of the analysis

3.8 The appraisal period should reflect the physical life (with maintenance) of the longest-lived asset under consideration for a scheme. The presumption is that for most conventional schemes involving major earthworks, concrete or masonry structures, a 100-year timeframe will be appropriate. A 100-year timeframe allows for appropriate comparison of options. Using a shorter timeframe (such as 50 years) would mean that costs or benefits that occur after 50 years are not taken into account and this could affect which option is identified as preferred. For example, short time horizons can bias the economic appraisal against options that cost a lot now but which are less expensive to maintain, which provide significant benefits, and/or may be more sustainable over a longer timeframe. Longer appraisal periods also better allow for more of any environmental or adaptation benefits to be included in appraisals.

3.9 If, exceptionally, a shorter time horizon is used, terminal values may be applied to ensure that different options are evaluated on a comparable basis. These values should equate to the residual values of any assets (the values of the assets minus any depreciation in values that has occurred over the assets' lives to date), normally calculated using straight-line depreciation. It may be beneficial to note down any longer term impacts that are not taken fully into account during the shorter timeframe to ensure these are considered during decision-making. Clearly the costs and benefits of all options should be evaluated over the same period.

4. DESCRIBE: Identifying and short-listing a range of actions

Identifying and short-listing a range of actions

Importance of a good choice of options

4.1 Cost-benefit analysis can only identify the best of those options considered. A good appraisal will, therefore, encompass a wide range of management options, if only to rule out many of these at an early stage. A narrowly defined search may only identify the best of a poor set.

4.2 Options may reduce the likelihood of an event, or reduce the damages when an event occurs. Institutional or behavioural adaptations, such as relocation of some activities, or the temporary closure of roads when flood warnings are in force, may be considered in addition to the construction of works.

4.3 The form of the detailed analysis also depends on the situation and physical aspects of the land, whether or not there is an existing scheme, and whether there are any statutory or other legal constraints affecting the choice of options. The residual life and standard of protection offered by any existing scheme should also be taken into account. These different conditions determine the appropriate 'do nothing' and 'do something' options.

Identifying the 'do nothing' option

4.4 Benefits and costs for all 'do something' options should be compared with those of the 'do nothing' case. The latter provides a convenient common baseline against which the other options can be assessed. Scheme benefits are calculated from the losses avoided by carrying out the proposed works rather than doing nothing.

4.5 Identifying the 'do nothing' option correctly is therefore important to the analysis and needs careful consideration. Where there is no existing scheme, the 'do nothing' option is obvious; there is no intervention in natural processes.

4.6 Where there is an existing scheme, the 'do nothing' option will be to walk away and abandon all associated maintenance and repair, allowing nature to take its course. Simply continuing with maintenance and repair of the existing structure then becomes one of the 'do something' options.

4.7 While it might appear impossible for political or other reasons to abandon the area, this should mean that the advantages of preserving what is there are overwhelming. It should therefore be easy to demonstrate that continuing present practice is better than the 'do nothing' option. If this is not the case, the non-economic reasons for continuing must be carefully considered. For health and safety reasons, it may be necessary to take minimal steps to make any abandoned works safe and these costs should be taken into account.

4.8 In some cases, due to the statutory duty to carry out clearance and repair works to bodies of water (Flood Risk Management (Scotland) Act 2009, section 59), it may be necessary to use the 'do minimum' option as the baseline. Otherwise, this option will only be appropriate when there is interdependence between action on the site and other areas, such that the cost of analysing the 'do nothing' case is disproportionate compared to the size of the project.

4.9 **The 'do nothing' options should be:**

- **where there is an existing scheme, walk away: cease all maintenance, repairs and similar activities immediately;**
- **where there is an existing scheme, and walking away is not permissible for legal or statutory reasons, adopt the 'do minimum' option;**
- **where there is no existing scheme, do nothing; do not intervene in natural processes.**

Identifying the 'do something' options

4.10 In the early stages of analysis, the range of options should be as wide as possible; the process of analysis may itself suggest new options. This guidance does not specify certain design standards. Instead, the approach adopted should be risk-based, linking benefits to costs with the aim of maximising the reduction in overall risk. As described in chapter 5 of 'Delivering Sustainable Flood Risk Management' (reference 1), we expect a variety of protection levels to be included during option development including 0.5%, 1% and if appropriate a lesser level. As an option, we expect actions that protect to a 1% AEP plus allowances for climate change to be include in all appraisals.

4.11 There is always the possibility that a more extreme flood than the design event will occur during the lifetime of a scheme. Consequently, appraisals should consider all events, not just those up to the design standard of protection.

4.12 **An appropriate range of options should be considered. These should normally include:**

- **different standards of protection;**
- **alternative alignments;**
- **different approaches to solution of the problem.**

Short-listing a range of options

4.13 Although it is good practice to start with a wide range of options for several different standards of defence, these can usually be reduced to a smaller range of standards and options for detailed analysis. The shortlist of options should include the ‘do nothing’ and ‘do minimum’ options; other options are then identified using an iterative process to build up solutions to the problem.

4.14 Any options that are technically inappropriate (e.g. an offshore breakwater to deal with fluvial flooding risk) or technically impractical (e.g. a diversion channel over a hill where there are more sensible alternatives) and options that have real constraints should be screened out. Broad costs and impacts (both positive and negative) of options should be identified; options should then be combined and refined options to reduce the negative impacts and including opportunities to increase the positive impacts.

4.15 The process of valuing options will provide important information on the value for money of different options and, in economic terms, the solution with the lowest present-value cost will be the most cost-effective solution for any particular standard. However, sustainability should be a key consideration, and the option which provides the best solution in environmental terms and options that provide sustainable social benefits should not be screened out unless they are clearly and justifiably unviable.

5. DESCRIBE: Assessing and valuing the impacts

5.1 Flood risk management actions alter the risk of flooding, by affecting the likelihood of flooding and/or the consequences. To decide between options, it is therefore necessary to compare the beneficial and adverse impacts of altering flood risk in the appraisal. Impacts should be described, quantified and, where possible, valued.

5.2 This section of the guidance document sets out how to evaluate economic, environmental and social impacts. Section 6 goes on to consider how the evaluation should be used in the context of assessing the benefits from flood protection schemes, compared to the potential losses. Guidance on estimating the financial costs of flood protection schemes is contained in the section 7.

Evaluating impacts

5.3 There is a wide range of different types of impacts that could be caused by flooding. The impacts can be arranged into three categories:

- **Economic impacts** – Property damages, emergency costs, infrastructure, transport, agriculture, land use, indirect impacts;
- **Environmental impacts** – Ecosystem services, landscape, change in status under the Water Framework Directive, changes in condition of protected nature sites;
- **Social impacts** (including human health and cultural heritage) – human health and well-being, way of life, cultural heritage.

5.4 Impacts in all three categories need to be described, quantified and, where appropriate, valued in monetary terms. It is important to properly and clearly record all impacts – one possible way to do this is through the use of 'Appraisal Summary Tables' as recommended by Environment Agency guidance for use in flood protection scheme appraisals in England and Wales (reference 4). Any assumptions used and any uncertainties associated with the description, quantification and valuation of impacts should also be recorded.

Economic impacts

Property

Residential and non-residential properties

5.6 Permanent buildings at risk of total loss from flooding should usually be valued at their current market value, excluding any adjustment in value for the flood risk. For many strategic and preliminary studies, the mid-range of council tax bands, suitably adjusted from their 1991 price datum, can be used to estimate property values. Generally, property will be assumed to be written off if it is flooded on average more than once every three years, unless it is flood resistant or water compatible. This is because there is unlikely to be sufficient time for the property to be repaired and return to full use following the previous flood before the next flood occurs. As a result, repairing the property would be a waste of money. Write-off values are taken as the risk-free market value of an asset. It is important to use risk-free market values because the actual market value of the at-risk property could be lower (where the risk is known, there may be lower demand for the property or higher insurance costs such that the market value is reduced).

5.7 However, market values sometimes need adjustment. For example, for properties such as pubs and restaurants, the market value includes a significant factor for customer goodwill. This 'goodwill' element is a transfer, not an economic loss (Annex A). In other circumstances, if there is an excess supply of, say, some types of commercial property, such property would not be replaced if lost, and no economic loss would be incurred. It is also important to avoid double counting any waterside amenity element of market value. Further, in the case of loss through abandonment, it should be assumed that the contents of the buildings are removed before the building is lost. Consequently, all removable fixtures and fittings should be excluded from the valuation.

5.8 Where a flood has occurred recently, a record of the damages incurred will often be a good starting point for evaluation of losses. However, it is important that the limitations of such data are clearly understood. Actual damages will rarely be available for the required range of events. Where losses are recorded, these will often be in financial rather than economic terms, and values will have to be converted.

5.9 The Flood Hazard Research Centre produces some standard data on the economic losses to be expected for different types of property, according to the type of dwelling, its age and other aspects. Adjustment factors, which take account of the additional losses from saline flooding, are also available. Details on these data and factors can be found in the ‘Multi-Coloured Manual’ and the ‘Multi-Coloured Handbook’ (references 5 and 6). In addition to providing data, the Flood Hazard Research Centre’s manual and handbook also provide further guidance on how to consider, quantify and value property damages.

5.10 For large industrial or commercial properties, or unusual properties such as listed buildings, it will often be necessary to carry out a site survey of the likely losses. A questionnaire can be used for this purpose (reference 5). In times of rapid obsolescence and replacement of many commercial and industrial buildings, effective life should be carefully considered when assessing the value of such properties.

5.11 An alternative to standard data is to commission surveys. However, this is expensive. It is rarely justified unless the properties concerned are atypical and the use of standard data would likely give misleading results.

5.12 **From the foregoing:**

- **land and buildings should be valued in constant real prices in their current use;**
- **any 'goodwill' element in values for commercial premises should be excluded; and**
- **care should be exercised in the derivation of non-standard valuations.**

Temporary and semi-permanent structures

5.13 There are other cases where the real economic value of losses may be very different from current market values. For example, the economic value of a mobile home on a particular site is equivalent to the cost of moving it there and establishing the site, not the value of the unit itself, which could be retained if it were relocated elsewhere. Also, in assessing economic damages, caravans, mobile homes, chalets or other temporary buildings or structures should be considered as depreciating assets worth, on average, only half their replacement cost.

5.14 For the 'do nothing' case, it should normally be assumed that any caravan or mobile home could be relocated. The economic loss would then be limited to the cost of removal together with the loss of installed infrastructure, depreciated as appropriate. Where a site is to be protected, the 'do something' damages should be calculated in the normal way, taking into account the seasonal nature of occupation. Similar considerations will apply to other temporary or relatively short-life structures, such as most amusement park rides.

5.15 In specific cases, a caravan park may provide important support to another feature (such as tourism) or the revenue of another operation (such as an associated harbour). Moving the caravan park may not be possible within the local area and may therefore have significant impact on the sustainability of other values in the area. It is important that the overall interaction of features are identified and recorded. While it may not add strongly to the general ‘do something’ argument, it may be very significant in drawing comparison between options.

Emergency costs

5.16 A range of organisations, authorities and bodies may incur emergency costs in tackling flooding and in the recovery process, including police authorities, ambulance services, fire services, local authorities, voluntary services, the armed forces. The Flood Hazard Research Centre produces guidance on how to calculate emergency costs (reference 5).

Infrastructure

5.17 The market value of a property can be expected to include the value of the immediate services; such local services have no economic value once the property is lost. However, separate valuations will usually be appropriate for infrastructure serving a wider area including: trunk sewers; pipelines, cables and pylons; pumping plant and other such facilities; care homes; electricity generating stations (power stations); electricity sub-stations; gas works; hospitals; local authority depots; oil refineries; police, ambulance and fire stations; schools; sewage treatment works; telephone exchanges; village halls; and water treatment works. NB – disruption from and damage to transport infrastructure (notably main road and rail routes) should be considered under the transport impacts section.

5.18 The impacts on both national infrastructure and on infrastructure of local or regional importance should be considered. In accounting for infrastructure losses, the number and type of infrastructure, the area served by the infrastructure, whether existing and alternative structures have spare capacity, whether opportunities exist to divert or redirect services, and whether infrastructure would be lost permanently should all be considered.

5.19 In general, the loss of such infrastructure can be treated as the cost of replacing the facilities elsewhere or rerouting them. Appropriate adjustments should be made for depreciation and obsolescence. The implications of the loss of services provided by the infrastructure should also be considered, as should the potential for impacts to extend beyond the area directly affected by flooding.

5.20 Any knock-on effects from the temporary loss of services, such as health impacts and community disruption, should also be considered. Further guidance on considering impacts on infrastructure is provided by the Flood Hazard Research Centre (reference 5).

5.21 Embankments constructed primarily as flood defences have a functional value only in terms of the protection that they provide. Including a value for such assets is likely to lead to double counting. However, they may also have a use value for recreation, which may be taken into account.

Transport

5.22 Disruption of road and rail networks, can result in significant indirect losses. For road networks, it will not generally be worth evaluating these unless a major through road is closed a flood of at least 0.1% AEP. If flooding is expected with 0.2% (or greater) AEP, and a significant part of the network carrying through traffic is affected, the benefits of reducing disruption can be large, both in total and as a proportion of scheme benefits. Traffic that usually uses the roads will have to divert, and may have to travel further, and/or for longer, incurring both resource and time costs. Since the speed of traffic depends on volume, the normal traffic on the diversion routes will also travel more slowly, again increasing such costs.

5.23 Methods and guidance are available to help calculate the difference in the resource and time costs of using the road network under different flooding conditions, and to address the special problems of calculating the costs of flood-induced traffic disruption. The Flood Hazard Research Centre provides guidance on how to take account of the costs of road traffic disruption (references 5 and 6).

5.24 One problem is that of identifying the diversion routes. Another is that the progressive development of flooding may induce a cascade of traffic diversions as one road after another is closed. Further, standard volume-speed relationships are not intended for highly congested traffic, and their blind application can yield results which are not strictly applicable.

5.25 Where traffic disruption is likely to be severe and extend over a prolonged period, it may be more realistic (and more cost-effective for the appraisal) to equate the economic loss to the cost of reconstructing the road, or making sufficient improvements to alternative routes to avoid the cost of delays. This should be applied only where the present value is likely to be less than that of the long-term costs of disruption.

5.26 Disruption to rail networks can also give rise to substantial economic costs. The Flood Hazard Research centre provides guidance on how the economic costs of rail delays can be calculated (reference 5).

5.27 In addition to road and rail disruption, it is important to note that other types of transport may be also affected by flooding – air transport; and water (sea, estuary, river, canals) transport. In calculating the extent of impacts on these types of transport, the number, length and type of transport affected, and the number of passengers and/or freight carried should be considered, as well as whether there are alternative routes (either by the same transport type or other means).

5.28 Further to transport disruption, flooding may also lead to costly infrastructure losses, which should be considered in an analysis of transport impacts. Analysis should consider the type of infrastructure lost, the relative importance of the infrastructure (whether it is of local or national importance), whether the infrastructure will be affected temporarily or permanently (if infrastructure is affected temporarily, the duration of any affects should be taken into account).

5.29 Impacts on transport from flooding may also give rise to knock-on effects, such as ‘social’ impacts (e.g. health impacts or community disruption). These effects should be considered within appropriate categories. Any effects due to flooding of evacuation routes or infrastructure used in emergencies (e.g. airports or heliports) will also need to be captured.

5.30 Where impacts on transport are likely to be a significant factor in decision-making, appraisers should contact Transport Scotland for further guidance.

Agriculture

5.31 Flooding can impact significantly on agriculture and agricultural production. Defra has produced guidance on how to take account of options' impacts on agriculture (reference 7). The guidance outlines three scenarios typically encountered in flood protection scheme appraisals where land and agricultural output would need to be valued – where land is abandoned or no longer fit for agricultural use for the foreseeable future, where there are occasional losses of output as a result of flooding, and where agricultural output per hectare either falls or rises (a more permanent change in output than the occasional losses in second scenario) – and advises on the valuation approach in each scenario.

5.32 Where land is lost from agriculture, Defra recommends that the loss should be considered as the market value of the land less £600/ha to reflect single farm payment subsidies. Until a definitive measure is available for Scotland, appraisers should use the approach advocated by Defra and should give consideration to varying this assumed value as part of normal sensitivity analysis, to examine the influence of a change in this figure on the NPV and/or the benefit-cost ratio.

5.33 Additional guidance on the appraisal of flood risk management for agriculture is also provided by the Flood Hazard Research Centre (references 5 and 6). As recommended by the FHRC, appraisers should seek further guidance from the Scottish Government when valuing impacts on agricultural land for:

- high level strategic assessments
- large scale schemes of more than 10,000 ha; and
- Measures in agriculturally less favoured areas where there could be significant impacts on vulnerable farming communities and local economies.

Forestry

5.34 There is no readily available method for describing, quantifying or valuing the impact of flooding on production from forestry. Evidence shows that the tolerance of trees to flooding varies according to the nature of the flood event (timing, salinity, duration, velocity, sediment deposition). Newly planted trees and young trees are most likely to be vulnerable.

5.35 Forestry infrastructure (tracks, paths, bridges, culverts) may be damaged by flooding, and costs for repairing this infrastructure (and for clearing up wash-out of bankside trees) could be more significant than the damage to the trees themselves.

5.36 Any potentially significant impacts on forestry may need to be assessed through consultation with the forest managers and/or the Forestry Commission Scotland.

Other land use

5.37 The impact of flooding on land uses other should also be considered – for example, impacts on development, or regeneration land uses.

Land use development

5.38 Any benefits arising from providing flood protection to potential new land use development (including the intensification of existing land uses), should normally be excluded from the appraisal. The primary reason for this exclusion is to preclude Government funding of works which would enable land to be developed for private gain. Where works are proposed for economic regeneration or similar purposes, other sources of funding may be available. Where land has been identified for development though and agreements are in place, or where construction has been commenced, then damage to the proposed development can be taken into account in the appraisal. Brownfield sites should be valued on damages to their current use, except where full planning permission is in place. Whether the future development would increase risks should also be considered.

5.39 Social impacts may occur as knock-on effects from flooding, such as the loss of jobs – these should be considered within the assessment of social impacts. However, it is important to avoid including transfer payments in the assessment (when jobs lost in one area are replaced by jobs in another area)

Indirect impacts

Consumer losses

5.40 If a shop or factory is flooded, the company will lose sales and its customers may be inconvenienced. Potentially, therefore, there are two forms of indirect losses: to the consumer, and to the supplier. In general, the loss to the consumer is the economic loss; that to the supplier is usually financial rather than economic. If consumers can buy the same goods at the same cost from an alternative supplier immediately, there is no loss to them. If they have to make do with inferior goods or incur higher costs, there may then be an economic loss. However, it will only be appropriate to evaluate this in special circumstances; for example, where long-term loss of a rural retail outlet is likely to involve significant extra travel.

Supplier/Business losses

5.41 On the suppliers' side there may be impacts due to businesses being unable to obtain supplies, which affects production, or to distribute finished products, which affects distribution. If these impacts are countered by other shops or factories making up the consumers' purchases, this is simply a transfer unless those other shops or factories incur higher costs (Annex A). The sales lost by one company are gained by another. The only exception is when those purchases are made up by additional imports or lost exports. Indirect losses do not normally arise from disruption to commercial and retail activity because there are typically many alternative outlets offering the same services immediately. This need only be considered in exceptional circumstances, for example when highly specialised products are involved. The Environment Agency has produced multipliers (table 5.1), to be applied to direct damages, that allow indirect effects to be calculated in these cases (reference 8). These multipliers are based on previous research by the Flood Hazard Research Centre

Table 5.1 Indirect Impacts on Business Multipliers

Sector	**Depth of flooding**			
	0.15m	**0.3m**	**0.6m**	**1.0m**
Manufacturing (to the nation)	0.17	0.10	0.11	0.13
Retail	0	0	0	0
Distribution (to the region)	0.67	0.35	0.23	0.11
Leisure	0	0	0	0

Source: Environment Agency Flood and Coastal Erosion Risk Management Appraisal Guidance: Supporting Document for the Appraisal Summary Table (ref. 8)

5.42 There may also be indirect impacts due to closure of businesses. Where a business is expected to close rather than relocate, there may be some knock on effects on trade. It may not be possible to estimate these damages in detail, but any potential significant effects should be recorded.

Socio-economic equity

5.43 A flood protection scheme might have differential impacts on individuals, depending on aspects such as their income. It may therefore be necessary to consider the question of social equity. This can be achieved through a 'Distributional Impacts (DI)' analysis, which examines the distribution of costs or benefits of interventions across different income groups and social classes (reference 3).

5.44 If a decision is made to assess DI, appraisers should be aware of the principle of diminishing marginal utility of additional consumption, whereby the impact of a project on an individual's wellbeing may vary according to his or her income; the rationale being that an extra pound will give more benefit to a person on a low income compared to someone on a high income. In other words, as income rises, its marginal value reduces. Consequently, a loss of £1000 will matter more to someone on a low income. For flood protection schemes, DI analysis can be applied to the evaluated costs of avoided damage to residential property. The subsequent costs arising from the analysis may then be treated in the conventional manner.

5.45 The Treasury Green Book recommends that DI should be applied where it is necessary and practical to do so. Determining if it is 'necessary and practical', depends on a number of circumstances, including (i) whether a community at flood risk can be identified with reliable data and categorised according to their prosperity or social class; (ii) whether the assessment will contribute to an appraisal that demonstrates equity and fairness to people; and (iii) whether the time and effort in undertaking the assessment is proportional to the scale of the overall appraisal, either at a strategic or scheme level.

5.46 In addition, appraisers should consider whether they feel that in not undertaking the assessment, a strategy or scheme will still have an adverse differential impact on a particular group. A decision not to adjust explicitly for distributional impacts will require to be justified.

5.47 The following 2 steps set out the procedure for transposing the guidance on DI into flood protection investment:

> *Step 1* Analyse and understand the level of knowledge on the type, age and number of residential properties; the mix of social class groups and levels of income within an appraisal area. Take account of DI by following Step 2, if necessary and practical. If it is not necessary and practical, ignore Step 2 and use standard depth damage curves that focus on property type and age, only, without accounting for social class mix or income level.
>
> *Step 2* If proven necessary and practical, and good quality information is obtainable, Total Weighting Factors may be applied to social class group as shown in Table 5.2 below. Those for social class groups C1 and C2 will generally have a negligible effect on the DI assessment. Hence, this factor is only recommended where AB or DE social class groups are predominant. The factors may then be applied to adjust the standard depth-damage curves to obtain damages avoided taking account of DI.

In the interest of transparency, both weighted and unweighted results should be routinely presented. Where results are sensitive to any weighting adjustment, a sensitivity analysis should be provided.

5.48 Where the quality of available information permits, appraisers should take account of DI in homogeneous areas or areas with a high proportion of rented accommodation. For the latter, the income level or class of the owner of the property should be used for assessing building damages, and that of the occupier used for the contents damages. The approach in Step 2 is suggested, but again only if a DI assessment is necessary and practical.

Table 5.2 Total Weighted Factors by social class group

Social class group	Total Weighted Factors
AB	0.74
C1	1.12
C2	1.22
DE	1.64

Source: Defra Flood and Coastal Defence Project Appraisal Guidance, *FCDPAG*3 Economic Appraisal, Supplementary Note to Operating Authorities. Revisions to Economic Appraisal on: Reflecting socio-economic equity in appraisal, and Appraisal of human related intangible impacts of flooding (ref. 9)

Environmental Impacts

5.49 Whether valued in monetary terms or not, environmental impacts should always be assessed. While in many cases sensitively designed schemes can make a significant contribution to the environment, there will often be choices to be made. It is probable that all the 'do something' options and the 'do nothing' option will have significant environmental consequences, positive or negative. Consequently, it is important to hold early consultations to establish environmental requirements and, in particular, legislative drivers. In some cases, protecting one site may have consequences for another, and a decision will have to be made on their relative values. In other cases, environmental losses may be unavoidable, for example, in reducing the risk of loss of life. However, an auditable record of the assessment and decision-making process will be required.

5.50 Where such choices have to be made, and in a number of other situations, it may be appropriate to place an explicit economic value on an environmental site or asset, in addition to any associated recreational value. Guidance on assessing environmental impacts of flood risk management actions is available from the Flood Hazard Research Centre (references 5 and 6).

5.51 A proposed flood protection scheme will require an environmental impact assessment (EIA) to:

- assess the environmental implications of the scheme;
- contribute to the design to minimise the adverse effects;
- identify additional measures that may be required to further reduce adverse effects;
- identify opportunities for providing environmental benefits

Note that the baseline for option appraisal is not the same as and should not be confused with baseline information gathered for the purpose of an EIA though some of the information gathered at this stage in project appraisal will be relevant to the EIA process.

Ecosystem services

5.52 An ecosystem services approach allows for multiple and various possible impacts on the environment to be taken into account within a single broad framework, where environmental effects relate to a loss or gain of one, a group, or all of the services of the ecosystems. The ecosystem services approach categorises the various environmental services and goods the people gain from the environment according to four categories – *provisioning* services, *regulating* services, *cultural* services, and *supporting* service. Care must be taken to avoid double counting the services which are part of a suite of primary processes (particularly *supporting* services) (reference 10).

5.53 Eftec have produced a handbook on the Economic Valuation of Environmental Effects for the Environment Agency (reference 11). The handbook provides a framework for the use of the ecosystem services approach to consider the majority of potential environmental impacts. The framework advocates a proportionate approach to assessing environmental impacts, and principally focuses on value transfer as a method to provide monetary estimates of environmental impacts.

5.54 The handbook should be used to highlight the number and range of benefits provided by ecosystems. Advice should be sought from relevant expert bodies (e.g. SEPA, SNH) to determine where there may be negative impacts (for example, due to a change in habitat). The handbook should then be used to determine whether to value changes in services monetarily and whether it is appropriate to follow the ecosystem services framework.

5.55 The ecosystem service approach include the consideration of impacts on landscape. For the context of appraisal of flood protection schemes 'landscape' encompasses all the external environment including cities, towns, villages and the wider countryside. It is a combination of the visual dimension with other factors including geology, topography, soils, cultural heritage, land use, ecology, and architecture which together determine its overall character. It is therefore part of our natural, social, and cultural heritage resource base in both urban and rural areas. Landscape is also dynamic, continually evolving in response to natural or man-induced processes.

5.56 Guidelines on assessing the landscape and the visual impacts of development projects are available from the Landscape Institute (at a cost): (reference 13). Issues covered by the guidelines include: integration of landscape and visual issues into the development process; the need for a transparent approach to landscape and visual impact assessment; describing the baseline conditions; determining the magnitude and significance of impacts; and reviewing the landscape and visual components of an Environmental Impact Assessment.

5.57 Strong links are needed to the environmental impact assessment when describing impacts on landscape. You should also consider consulting landscape specialists and engaging with local communities when describing impacts on the landscape. There may be significant overlaps with social impacts such as sense of belonging, sense of place.

Greenhouse gas emissions

5.58 The impact of the proposed option on the emission on greenhouse gases should be assessed and valued following the Department of Energy and Climate Change guidance on valuation or energy use and greenhouse gas emissions for appraisal and evaluations (reference 14). The assessment should include the greenhouse gas emissions that are associated with construction and land use change, and those associated with impacts following flooding or coastal erosion through the need for maintenance, repair (both of defences and flooded assets) and emergency management. It is the balance of the two that needs to be considered, particularly when comparing options that would provide different levels of risk management or where options involve significantly different on-going operation and maintenance costs.

Social Impacts

5.59 Flooding can have a wide variety of social impacts (including impacts on human health, community, and cultural heritage) which should be taken into account in project appraisals. A large amount of information on the social impacts of flooding in Scotland can be found in Werritty *et al*. (reference 15).

5.60 The specific social impacts in any community can be determined through include engagement with affected communities to discuss the impacts of options, drawing on their local knowledge to provide insight into the negative and positive impacts (linking to the Stakeholder Engagement Plan as the planning and delivery tool for engagement). Local authority social services, community groups and the voluntary sector may also be able to help describe and quantify the impacts.

Human health and well-being

5.61 Health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity. Disruption to infrastructure and services can have an impact in terms of health, stress and the community. Flooding can lead to loss of life - Defra provide guidance on valuing risk of loss of life from flooding events (reference 16).

5.62 Flooding can also cause disruption to family life which can be significant and last for many months, affecting family relationships. There may also be risks to health and well-being during recovery periods following floods. For example, there may be impacts due to the strain of recovery (for example, heart attacks due to clean-up), and there can be health effects due to exposure to carbon monoxide as a result of the use of equipment for drying out buildings.

5.63 Disruptions to water supplies and/or sewerage systems can also cause health risks – it is important that the need for adequate sanitation to prevent disease/illness be taken into account. Disruption of water supplies or sewerage systems may also cause mental as well as physical health issues (i.e. stress). Similarly, flooding of a care home may have knock-on effects for the nearby hospital and, at the same time, flooding of the hospital could have significant health consequences for residents of the care home. Such impacts need to be considered and described. This may require consultation with operators and owners of infrastructure and such impacts should be considered when describing the economic effects associated with impacts on infrastructure.

5.64 The long-term health impacts of flooding may be significant, especially for vulnerable households. Guidance provided by Defra (reference 9) indicates that the value of avoiding the health impacts of fluvial flooding is of the order of £200 per year per household. This is a weighted average derived from a wide range of responses. Defra also provides a risk reduction matrix which can be used to calculate the value of health related benefits for different standards of scheme protection (table 5.3). For example, the highlighted figure of £188 in the table represents the annual health related damages avoided, and hence the benefit per annum, per household, in moving from a pre-scheme situation with 0.05% AEP to a scheme with 0.01% AEP.

5.65 For areas of uniform flood risk, such as housing on level ground, damages are based on common standards of defence. Having identified the standards of protection before and after an option is implemented, Table 5.3 can be used to derive the annual benefit per household of avoiding health impacts of flooding. This can be applied to the total number of households (or residential properties) in the area to give the overall annual health benefits for a particular option. In areas where the risk varies greatly, such as sloping ground away from a river, damages are based on individual levels of property flood risk. This will require banding of the areas into different levels of existing protection, and the identification of the standards of protection being offered by the scheme to each band area. The table can then be used to evaluate the benefits for the properties within each band.

5.66 The figures in Table 5.3 already take account of distributional impacts. Consequently, a DI analysis should not be applied to the results arising from the appraisal of intangible impacts.

Table 5.3 Intangible benefits associated with flood defence improvements (£ per annum per household) for different standards of protection (SoP)

SoP before scheme: % AEP (return period)	SoP after scheme: **0.007** (150)	**0.008** (125)	**0.010** (100)	**0.013** (75)	**0.020** (50)	**0.033** (30)	**0.05** (20)	**0.1** (10)
1 (1)	£218	£215	£200	£153	£73	£25	£12	£5
0.1 (10)	£214	£210	£195	£148	£68	£21	£8	£0
0.05 (20)	£206	£202	£188	£141	£60	£13	£0	
0.033 (30)	£193	£189	£175	£128	£47	£0		
0.020 (50)	£145	£142	£127	£80	£0			
0.013 (75)	£65	£62	£47	£0				
0.010 (100)	£18	£15	£0					
0.008 (125)	£4	£0						

Source: Defra Flood and Coastal Defence Project Appraisal Guidance, *FCDPAG*3 Economic Appraisal, Supplementary Note to Operating Authorities. Revisions to Economic Appraisal on: Reflecting socio-economic equity in appraisal, and Appraisal of human related intangible impacts of flooding (ref. 9)

Way of life

Recreation

5.67 Flooding can impact greatly on people's way of life – that is, on how people live, work, play and interact with one another on a day-to-day basis. When taking account of impacts on way of life in appraisals, particular focus should be given to impacts on recreation. In addition to the guidance below on taking account of impacts on recreation, further advice on considering such impacts is provided by the Flood Hazard Research Centre (references 5 and 6).

5.68 Flood protection schemes may affect the value of a river or coastal reach for recreational uses, including angling and informal recreation. Any significant associated gains or losses should, as far as possible, be included in the cost-benefit analysis. Where only marginal changes in recreation or amenity are likely, such valuations will seldom be worthwhile. If a scheme relies on a substantial element of recreational benefit for its justification, it should be treated as a multi-functional project (paragraphs 2.21-2.23).

5.69 The benefits of avoiding a loss in recreational value, or an increase in such value, can be calculated by (i) estimating the number of visits made to the site, and (ii) multiplying this by the change in the value of enjoyment per visit.

5.70 Thus, the number of visits made to a site is a primary indicator of the likely magnitude of the benefits. If there are no visitors, there are no benefits.

Therefore, any analysis should start with a preliminary estimate of the number of visits made by adults. For rivers, where the number of visits is small, the estimates given in, for example, the Foundation for Water Research manual on the benefits of surface water quality improvement can be used to estimate the order of magnitude of the recreational benefits (reference 17).

5.71 Where no comparable estimates of the annual number of visits to different types of site have been compiled, the simpler methods shown in Table 5.4 will have to be used. Early thought should be given to accurate estimation of the number of visits. The methods shown in the table are in decreasing order of accuracy.

Table 5.4 Methods of visitor estimation

Method	**Comments**
Long period counts using people counters	A number of infrared, or other automatic, counters are installed at least over the period of March to September in one year. The counters are manually calibrated; interview surveys are conducted to determine statistically how the number of adult visits relates to the number of passages recorded on a given day. An annual growth curve is then used to derive an estimate of the total number of adult visits made in that year.
Short period count	Counts are undertaken by hand over a period of days. An annual growth curve is then used to derive an estimate of the total number of adult visits made in that year.
Inferred estimate	The counted number of visits made to a related site (eg a car park or museum) is used to infer how many visits are made to the site. This requires estimating what proportion of all visitors to the site also visit the site for which counts are available.
Visitor equation	A number of equations have been developed which predict distance-frequency functions so that from census data on the population in different zones, a prediction can be made as to the number of visits generated by a site.
Informed estimate	The estimate of an informed person (eg car park attendant, park ranger) as to the number of adults visiting the site.
Average number of visits to equivalent sites	This benefit transfer approach is only suitable for prefeasibility and strategic studies. The number of adult visits made to the site is estimated as being of the same order as the number of visits made to an equivalent site. However, there are few sites for which good data are available and little research to enable the reliable identification of an 'equivalent' site.

5.72 Where recreational value is a significant part of the total benefits, a contingent valuation study may be necessary to derive a site-specific value of enjoyment. Some of the considerations for such studies are listed in Annex B. However, the difficulties and expense should not be underestimated.

Disruption

5.73 Disruption of way of life may be a significant impact for consideration in appraisal. A partial measure of the disruption resulting from flooding can be given by the cost of renting a home equivalent to the one flooded, together with the cost of accelerating the drying-out process.

5.74 About 50% of households are vacated for an average of 30 days when flooding exceeds 30 centimetres (reference 18). Werritty et al. (reference 15) found that 45% of flooded households were unable to stay in their home for 6 months or more after the event (the depth of flooding for these households is not provided). The use of dehumidifier units is the best method of drying out properties, and hence of enabling repairs and redecoration. The rental of such units reduces the losses that would otherwise occur. The number of dehumidifiers required depends on the size of the property. Rental and electricity rates are used to calculate the costs. On average, two to three dehumidifier units are required for a period of three to four weeks.

Community

5.75 Flooding can impact on the sense of community in the affected area - its cohesion, stability, character, services and facilities. This could include population changes (or predicted population changes) drawing on trends in population that could affect how impacts change over time. If flooding results in properties being lost, this may affect the settlement's ability to support its services. Over time, the services (such as schools, post office, shop, pub and church – which may also be a heritage asset) could be lost which would further affect the community and its activities. This could have knock-on impacts on culture, way of life and future aspirations.

Cultural heritage

5.76 Flooding may impact on cultural heritage, which includes: palaeo-environmental and geo-archaeological remains (as indicators of past climates, vegetational and landscape change); archaeological remains (including wrecks); historic buildings, parks and gardens; and historic landscapes.

5.77 Cultural heritage can be difficult to appraise as it includes not only the heritage assets that can be seen (such as World Heritage Sites, scheduled monuments, listed buildings, Scheduled Monuments and Listed Buildings), but also their context and relationships (for example, Conservation Areas). Cultural heritage also includes those traces of human history that have not yet been discovered (so-called unknown archaeology). While it can be relatively straightforward to assess the impacts on what can be seen, the potential effects on unknown archaeology often have to rely on archaeological potential.

5.78 Appraisal of impacts on cultural heritage should consider: impacts on the physical assets themselves; impacts on their setting; impacts on their inter-relationships with other historical assets; and impacts on areas where there may not be any known physical assets but where there is potential for archaeological finds (including where any works could disrupt or damage hidden archaeology).

5.79 Where monetisation of the impacts is considered appropriate, it is likely to be worthwhile discussing with Historic Scotland (and any other responsible organisations) what they would consider to be the most appropriate approach. This may help with better understanding of the likely uncertainties, which can then be tested in the sensitivity analysis.

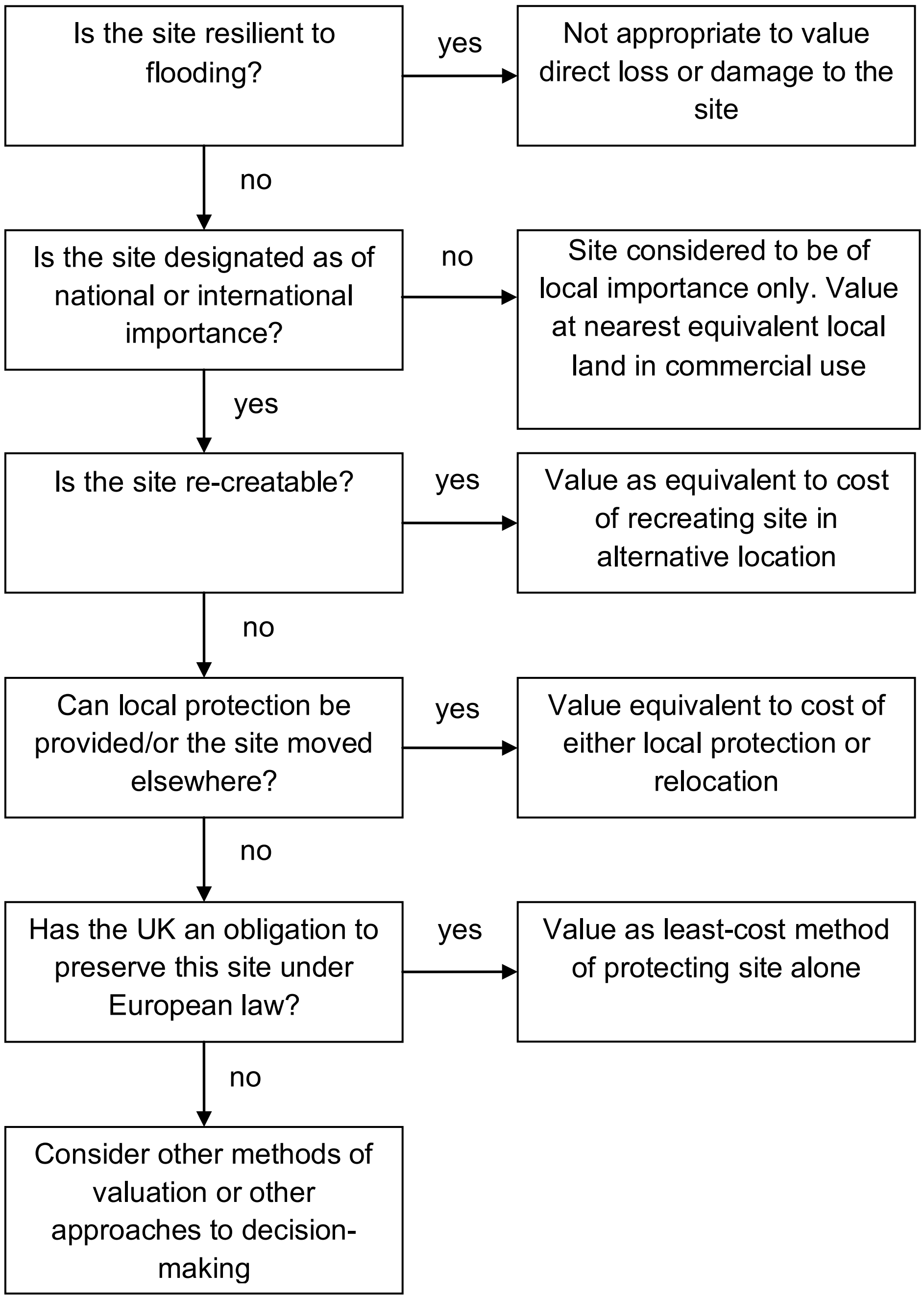
5.80 In general the least contentious and lowest cost method of deriving a proxy for the lower bound economic value of impacts on a heritage asset as a result of a flood or coastal erosion risk management scheme can be taken as the lowest of:

- the cost of relocating a structure to another site (relocation loses the setting of the feature so some negative impacts may remain); or
- the cost of local protection (e.g. a local flood embankment around a heritage asset);
- the costs involved in excavation and recording of an archaeological site; or
- other mitigation measures.

5.81 The use of such proxy values, however, will depend on there being broad agreement that the value of the asset in question is at least equal to the lowest of these figures. You should consult with appropriate specialists if using these approaches. For example, a specialist building surveyor may be able to provide costs associated with rebuilding a historic building. In certain exceptional circumstances, such economic valuations may not be appropriate. For example, an unusually high value may be placed on a feature specifically because of its particular position, and the cost of relocation could omit the particular heritage or cultural value of the feature within its existing context. There may also be some doubt as to whether the heritage value of a structure could really justify the high cost of its relocation. In such cases it may be necessary to obtain a valuation using other monetary based techniques as described in Annex B, or to apply other decision-making techniques. There may also be benefits transfer values available that can be used to monetise impacts on cultural heritage.

5.82 Figure 5.1 shows a decision tree, using the above approach, for the determination of minimum economic values in relation to heritage sites.

Figure 5.1 Decision tree for appraising proxy economic values of heritage sites at risk of loss or damage



6. DESCRIBE: Describing Flood Protection Benefits

6.1 The benefits of flood protection schemes are calculated as the difference between the expected value of flood damage with the option being evaluated, compared with flood damage and losses in the 'do nothing', or where relevant ‘do-minimum’, case. A summary of the procedural steps required is shown in Figure 6.1.

Calculating flood damages

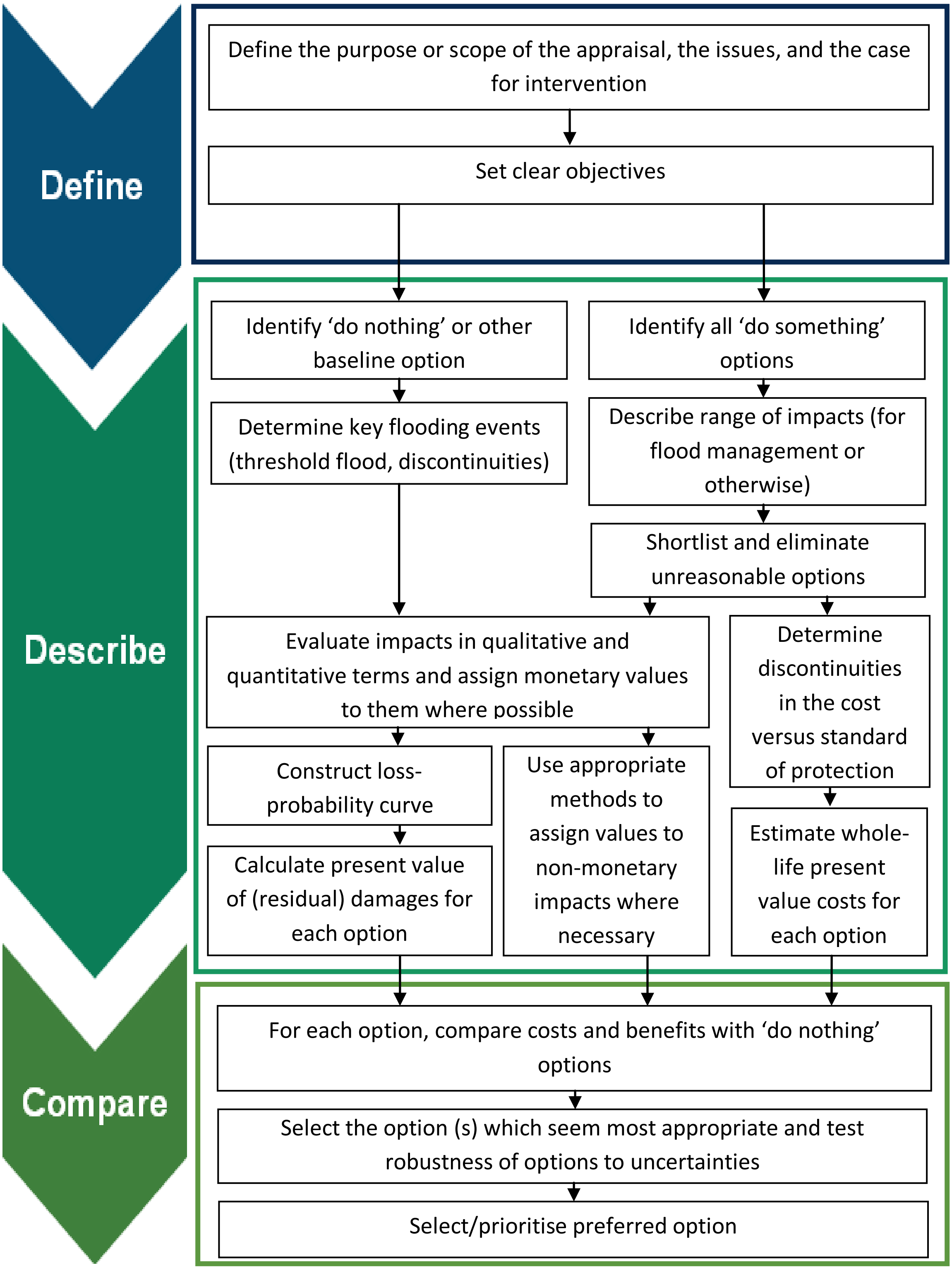
6.2 The damages caused by a flood are a function of its depth, duration, velocity, and its sediment and pollutant loads. In the UK, floods are usually relatively short in duration and involve low velocities. Consequently, the primary determinant of the losses for a particular property is the depth of flooding. However, in steep or flashy catchments, or where protective structures fail, flood velocities can be high. This may result in additional losses from partial or complete structural failure of properties.

6.3 Sediment, debris and sewage borne by a flood may affect the costs of cleaning up after the event. Further, flooding by saltwater generally causes more damage than the equivalent depth of flooding by freshwater.

6.4 When considering the benefits of a flood protection option due to changes in consequences, there are several potential approaches that can be used to capture this information:

- Consider whether the depth of flooding would change;
- Consider whether the timing of flooding would change (this could be due to change in the onset of flooding or erosion);
- Consider whether there are benefits in terms of the duration of impacts (for example, the time over which floodwaters are present on land could be reduced, people may be able to move back into their homes more quickly. This could reduce direct damages, for example, by reducing time for land/habitats to recover or the cost of temporary accommodation and stress due to disruption of family life);
- Consider whether those at risk would change (assess whether more vulnerable people, habitats or higher quality agricultural land would be protected reducing risk to life, biodiversity impacts or impacts on agricultural outputs);
- Consider whether floodwater velocities would be decreased (this, in conjunction with flood depth and rate of onset, could reduce risk to life, risk of scouring of habitats or land with implications for increased recovery).

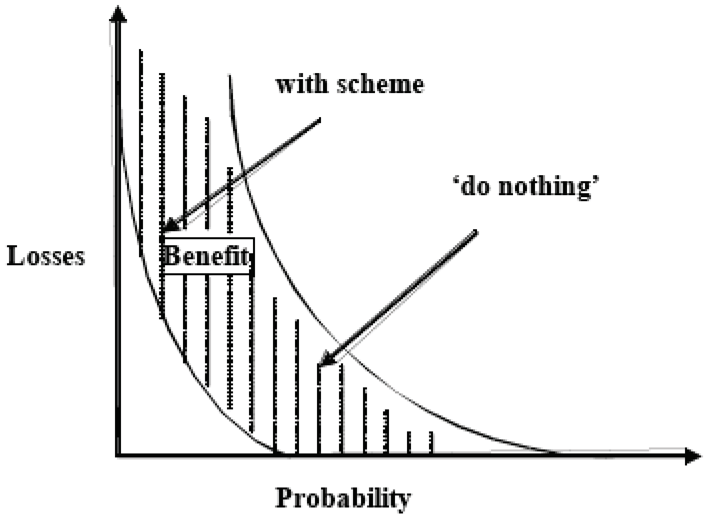
Figure 6.1 Framework flow chart for flood protection appraisal



Loss-probability relationship

6.5 The benefits of flood protection are calculated as the expected value of annual flood losses averted. As floods are assumed to be random events, it is not possible to predict when they will occur. The expected value of annual flood losses is calculated as the probability of a range of events multiplied by the loss that such an event would incur. In practice, the losses are measured by the difference in the areas under loss-probability curves for the 'do nothing' and with scheme options. This difference in area is the expected value of the reduction in flood losses each year over the life of the scheme; the average annual benefits (figure 6.2). These are discounted over the life of the scheme to give the present value of the benefits.

Figure 6.2 Determination of average annual benefits



Changes over time

Identifying the probabilities of failure

6.6 Changes in probability are central to the cost-benefit analysis. For flood protection schemes, the 'do something' options reduce the probability of flooding. Commonly, the probability changes over time; for example, the likelihood that an existing flood embankment will fail may well increase with time. Climate change, development of catchments, and alterations in ground level may also change the probabilities of events of particular magnitudes. Chapter 6 provides guidance on the use of risk assessment in project appraisal, and the derivation of probability functions

6.7 Where changes are anticipated in the expected probabilities of flooding over the life of a scheme, it is necessary to calculate a number of different average annual benefits corresponding to the different conditions. As noted above, such changes could include those associated with climate. For example, physical changes in the catchment could also affect probabilities.

Further, changes over time in the use of the flood plain may alter the losses expected from a flood of a given magnitude. In such cases, average annual benefits should be calculated for appropriate years, and values interpolated for intervening periods.

The upper limit to losses

6.8 Care should be exercised where the total present value of losses exceeds the current write-off value of the asset. In the case of domestic or commercial property, it will usually be prudent to assume that the long-term economic loss cannot exceed the current capital value of the property. In the case of other assets, such as roads, railway lines, pipelines or cables, some very large values can be generated for long-term disruption. It will often then be reasonable to assume that the maximum economic benefit derived from flood defence is equal to the economic cost, depreciated to allow for the age of the existing asset, of reconstructing an equivalent facility at a higher level, or on an alternative alignment, which avoids the flood risk.

Sampling the annual exceedance probabilities

6.9 The loss-probability curve is generally calculated using only a very small sample of the possible AEPs that might be considered. The overall form of the curve, and the area under it, is derived by drawing straight lines between the calculated points. This can, potentially, result in wrong estimates of the area under the curve (figure 6.3). In this illustration, the choice of AEPs, when compared to the 'true' relationship, has resulted in a significant overestimate of the overall losses.

Approximation of loss curves

6.10 Determining how many and which AEPs to include is a sampling problem. The aim is to obtain a reasonably close approximation to the loss-probability curve representing an infinite number of flood exceedence events if these were to be modelled. The ideal AEP events to use are those located at discontinuities on the curve.

High probability events

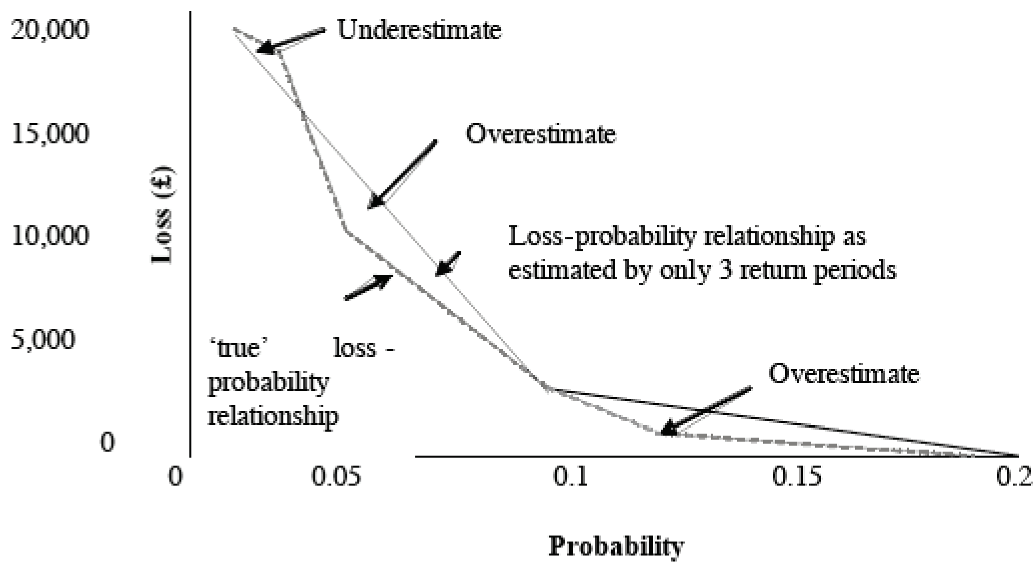
6.11 First, it is important to locate the AEP of the threshold flood event: that is, the most extreme flood that does not cause any damage. Secondly, engineering judgment should be used to assess where the discontinuities are likely to be. For example, they can be expected to occur when an existing natural or man-made structure is overtopped, or a culvert or bridge reaches its capacity. Thirdly, the greatest proportion of benefits generally arises from the greatest probability floods. Consequently, the sampling should usually be biased towards these events. A few judiciously chosen events at appropriate points of discontinuity will generally produce a more realistic result than a larger number at standard intervals.

6.12 If a software package is being used to calculate the flood losses, it is simple to plot a flood-stage/damages curve for a large number of flood stages. Discontinuities on the curve indicate those events that should be included, provided the information that produced the discontinuities is accurately provided in the data input.

6.13 **In terms of good practice:**

- **The benefits should be calculated using a minimum of 3 events (preferably 5) and the choice of those events should be considered carefully;**
- **One of these events should normally be the threshold flood event.**

Figure 6.3 Accuracy of estimation of the loss-probability curve



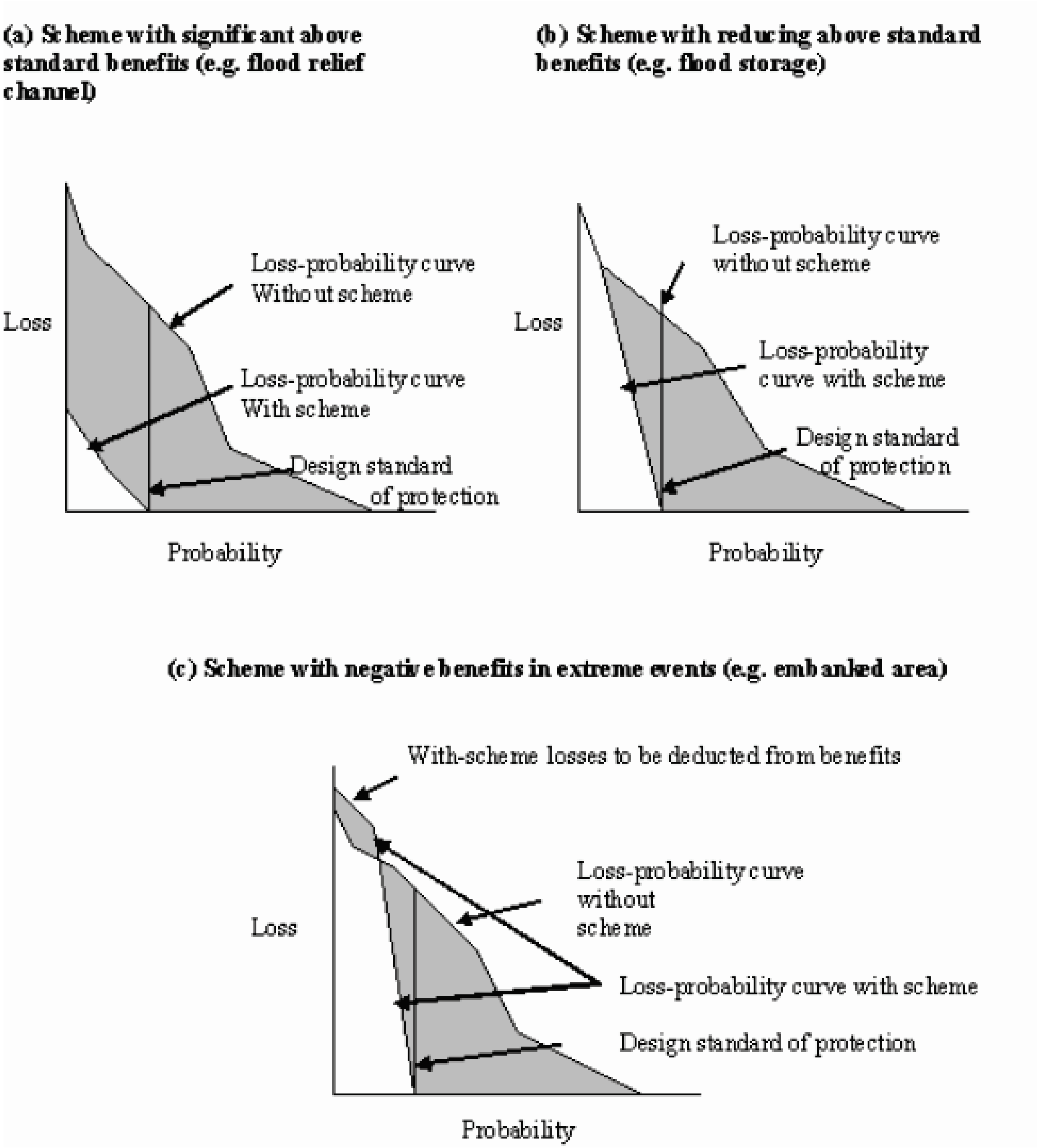
Above-design-standard benefits

6.14 The notional standard of protection (design standard) afforded by a flood protection scheme will usually be defined in terms of the onset of significant losses. However, many such schemes will have some effect on the losses from all floods, even the most extreme, and all of these impacts should be taken into account. While it may not always be practical to model the extent of flooding from all events up to the probable maximum flood, it should be possible to draw logical inferences as to how the scheme will respond to such larger events. From this, the likely shape of the loss-probability curve can be estimated. It is important to ensure that the range of events considered is appropriate for fair comparison of all options.

6.15 For example, schemes that increase the capacity of a river channel will result in less water flowing out of the bank for all events with the scheme than without. Consequently, the losses from any particular event with the scheme, should never exceed those without the scheme, and will normally be less.

Two examples are illustrated in Figures 6.4(a) and 6.4(b). In both cases the shaded areas represent the total average annual benefits.

Figure 6.4 Estimation of above design standard benefits



6.16 For other schemes, for example those involving walls and embankments that may be overtopped, losses in less probable events can be more severe than if no scheme existed. The duration of flooding may be increased, or the velocities of flow resulting from a failure may be greater than from the natural rate of rise of the flood (Figure 6.4(c)). In this case the negative benefits above the design standard should be subtracted to derive the net average annual benefits.

6.17 For some schemes, above-design-standard benefits can be a significant proportion of total benefits. They will also have an impact on the incremental benefits of different design standard options. For instance, part of the incremental benefits of a nominal 1% AEP scheme may already be realised in the benefits of the 2% AEP scheme. This illustrates the importance of considering the full range of benefits in all decision-making.

Climate change adaptation

6.18 A changing climate poses serious challenges and risks for managing flooding in Scotland. The impacts of climate change include the potential increase in intensity, severity and frequency of rainfall events affecting flooding in fluvial catchments and urban surface water systems. It may also affect sea levels, storm surges and wave actions, with potential associated impacts on flood risk.

6.19 The appraisal process should seek to fully understand risk in a changing climate and should be in accordance with the Scottish Government's guidance on Public Bodies Climate Change Duties (reference 19) and the objectives of the Climate Change Adaptation Framework (reference 20) and accompanying Water Environment and Resources Action Plan (reference 21).

6.20 The likely effects of the changing climate should be consistently taken into account in appraisals using up to date robust evidence. The UK Climate Projections (reference 22) provide projections for precipitation, sea level rise and storm surges for the UK until the 2080s. Modelling will be required to estimate the potential impacts of the projections for a specific flood risk protection scheme. Estimates of changes to peak river flows may be available from other sources– the appraiser should use their judgement to ensure the most up to date robust evidence is used.

6.21 A decision will often need to be made on whether to design now for climate change or to design in a way that allows adaptation at some point in the future. This decision will depend on the nature of the problem. For example, planning led intervention or a 'no-regrets' action might adopt a precautionary approach. If a managed/adaptive approach is aimed for, sensitivity analysis for climate change needs to be undertaken both at the earliest possible screening stages in the appraisal, and after the final options have been short listed. Interventions and approaches that are not sustainable in the long-term should be avoided.

Freeboard

6.22 Freeboard is a factor of safety in flood protection design (usually expressed as height above flood level) and should only be used to take account of uncertainty in scheme performance. The use of indiscriminate standard freeboard allowances can lead to problems, particularly in relation to differential standards of protection. Ideally, defence crest levels should be determined from a risk-based approach (see Chapter 6).

Simplified assessment

6.23 For very small schemes, or preliminary studies, properties can be grouped for the purposes of damage estimation. Estimates can then be used of the likely average depth of flooding in each group of properties. This procedure should be applied for each of a minimum of two flood events above the threshold flood. The average loss for a residential property at each of those depths, multiplied by the number of properties in each group, can then be used to derive the loss-probability curve. For a very basic assessment, it is possible to consider the average benefit of protecting a residential property. The Flood Hazard Research Centre estimate that the annual average damage to an average house with no flood warning and no flood protection is £5,393 (reference 5).

7. DESCRIBE: Estimating the costs

Whole-life costs

7.1 For any economic appraisal, the anticipated benefits of a scheme must be compared with its expected whole-life costs. All relevant surveys, design, capital, maintenance and operation, and mitigation costs must be included. Maintenance estimates should allow for storm damage repairs and, where significant, decommissioning costs. Appraisals should consider both direct and indirect costs required to meet identified objectives of all options.

7.2 Only benefits and costs resulting from implementing each option should be considered. The appraisal should exclude 'sunk' costs, which have already been incurred, such as previous investments in defences and expenditure on feasibility studies. As no illegal operations should have been identified as possibilities, infraction costs (from infraction proceedings, penalties, or fines) should also not be included.

Discontinuities in costs

7.3 In the same way as benefits may vary in a stepped fashion, option costs are also likely to increase in specific increments. For example, this could occur where the form of construction needs to change to accommodate a higher water level for an increased standard of service. The points at which these steps occur should be examined in detail, to assess the range of option standards where benefits may have increased without increased costs.

Residual values

7.4 Some assets may have a lifetime beyond that used in the analysis. The residual values should be taken into account in the estimation of costs and benefits only where this is required to ensure equality of assessment between different options. A straight-line depreciation over the asset life, which presupposes a decision to continue using the asset, will usually be appropriate. For many options, the residual value may be very small (such as where the defence is close to the end of its useful life) unless the defence has a high residual value. In addition, discounting means that residual values will be even smaller. Consider, therefore, whether the residual value is going to be significant in terms of the whole life cost and hence whether it is worthwhile spending time calculating it.

Rates and prices

7.5 Estimates should reflect the nature and scope of the work to be constructed. Aspects to be considered should include site conditions, location, size, complexity, risks, programming and timing constraints, availability of resources, construction methodology, specification and conditions of contract. Wherever possible the estimate should be based on appropriate cost data from recent tenders, completed projects, published articles and estimating price books, estimates and quotations from companies for specialist work, and the estimator's own experience.

7.6 Where less common items constitute a significant part of the overall cost, it is often necessary to make a careful assessment of quotations and estimates obtained from operators with commercial experience in that sector.

Price indices

7.7 The base year used for pricing should always be stated. When data are not available for that particular year, it may be necessary to use appropriate indices to convert historical prices to the same base. At feasibility level, costs and benefits can generally be indexed using the HM Treasury Gross Domestic Product (GDP) deflator series (as this gives an overall picture of the economy and not just prices). For construction costs, the BIS construction price and cost indices is appropriate for most uses.

7.8 Particular components may constitute a large proportion of a project cost, or the cost of those components may be expected to vary in real terms over time. In such cases, sensitivity analysis should be used to explore the implications for option choice.

Contributions from others

7.9 When considering project costs, it may be incorrect to deduct payments from developers, highway authorities or other contributors. Generally, such windfalls only affect the distribution of costs and not the total resources required for the project. If the associated benefits were excluded from the appraisal, it would be reasonable also to exclude the contributions. However, particularly when those contributions come from other budgets of public money, it is preferable to include all benefits and costs. In this way the cost-benefit analysis will demonstrate whether the project as a whole is justified.

7.10 When the contributor is a commercial organisation, it may be prepared to pay on the basis of the financial benefits to that organisation, which may be greater than the economic benefits. For example, the owner of a supermarket might be prepared to contribute an amount which reflects not just the direct losses that would be experienced from flooding, but also the loss of trade where in economic terms the loss is simply a transfer payment. The economic implications of such contributions therefore need careful consideration, having regard to the particular circumstances.

7.11 For example, it may not be correct to take contributions into account where contributions have been used to increase a project’s cost-benefit ratio. A flood protection scheme that is not economically worthwhile (where the benefits are less than the costs) should not be ‘topped up’ with contributions to make it acceptable. This is because there is a risk that more affluent communities who are better able to afford to provide contributions could otherwise provide additional funding that could result in ‘their’ project being prioritised over one for a less affluent area.

Treatment of project risk

7.12 There is a widely recognised, general tendency for appraisers to be overly optimistic in their early assessment of project costs, time-scales and benefits, when these are compared with final outturn values. This is termed "Optimism Bias". Prior to the revision in 2003 of the Treasury Green Book, this bias was taken into account in a generalised way through a percentage premium included within the test discount rate. HM Treasury have *unbundled* the issue from the discount rate, which has been reduced from a flat 6% to a variable 3.5% (reference 3). Consequently, an explicit consideration of Optimism Bias is required through (i) the application of suitable uplift factors to early best estimates of project costs, and (ii) sensitivity analysis of predicted benefits and project time-scales.

7.13 The **best estimate** for any project should be the appraiser's assessment of the most likely outturn costs of the project. These should include, for example, all labour, materials, supervision, land purchase, compensation, access costs and contractors' overheads associated with both temporary and permanent works, and all long-term costs associated with operation and maintenance. Where the estimator judges that additional sums are likely to be required for particular areas of work, for example, for dealing with poor ground conditions, these should be included, but general contingencies should be estimated as part of the process of deriving the optimism bias adjustment. All elements of the estimate should be based on experience of projects of similar character and should recognise the likely difficulties involved in carrying out works in particular circumstances, for example, the high cost of working in confined spaces or within, or adjacent to, private properties in urban areas. Considering these factors will enable associated access, plant, temporary works, transportation and material issues to be considered. This may sometimes show that conventional methods may not be applicable due to some physical, access, environmental or health and safety constraint. The involvement of a contractor or cost consultant at the later stages can be helpful.

Optimism bias

7.14 Sensitivity analysis of **benefits and project time-scales** is an important element of best practice. However, the new approach to optimism bias in **cost estimates** requires a strengthened procedure. Best practice guidance in relation to strategy and scheme costs is set out below. This develops the interim guidance issued by the Scottish Executive to local authorities in 2003 (reference 23).

Strategy costs (initial feasibility stage)

7.15 At this stage it is assumed that no detailed design has been carried out and that, therefore, cost estimates are based on broad assumptions about the scope and nature of the work.

> *Step 1:* For each option, identify best estimates of all capital, operating and maintenance costs given current information.
>
> *Step 2:* Take a **starting** value for optimism bias of **60%** of total Present Value costs (including capital, operating and maintenance costs over the whole life of the option). This percentage reflects the current view of the average cost uplift from strategy/pre-feasibility stage to the final account stage.
>
> *Step 3:* Study Annex C, which sets out the current view of the key components of risk that make up the overall 60% factor. Assess whether the contributions of these components should be higher or lower for the particular situation under consideration. Where demonstrable action has been taken to minimise individual risks, a case can be made to reduce the relevant component(s). Conversely, where the project is considered to be more risky than average in certain areas, perhaps because of innovation, say, the relevant risk component contributions should be increased. In the absence of evidence either way, the default risk component percentages (Annex C values) should be left unchanged.
>
> *Step 4:* Rework the overall Optimism Bias factor based on any revisions to risk components. Apply the revised Optimism Bias factor as a percentage uplift to total Present Value costs (in place of any contingency estimate).As an alternative, where a full "Monte Carlo" type risk evaluation has been undertaken, then the 95% confidence level estimate should be used to derive the optimism bias factor. Where any present value costs are not included in the risk approach these should be adjusted using the above approach and added to the 95% confidence risk based result.

Scheme costs (detailed design stage)

7.16 To reach this stage it is assumed that appropriate site investigations and detailed design of the main works have been carried out, so that major cost items are based on detailed assessments of works required from substantially complete working drawings and specifications.

> Proceed as for strategy costs, but use a starting Optimism Bias factor of **30%** and the relevant risk component guidelines in Annex C.

The alternative Monte Carlo approach

7.17 The Monte Carlo type risk valuation approach requires a more detailed understanding of the risks and mitigation measures but can provide a more informed assessment to the simple optimism bias approach. If the Monte Carlo type has been applied, then the 95% confidence level estimate should be used to derive the optimism bias factor. Where necessary, the approach to applying optimism bias should be used for all present value costs not included in the risk approach, such as long-term maintenance. These adjustments should then be added to the 95% confidence risk-based results.

Discounting and economic efficiency

7.18 To test the economic efficiency of different options on a comparable basis, it is necessary to discount all of the costs and benefits of the scheme, from the time they arise in the future, to their present value. The test discount rates specified in the Treasury Green Book are 3.5% for years 0-30, 3% for years 31-75, and 2.5% thereafter (reference 3).

7.19 The convention that should be adopted is to take all costs and benefits in any given year as accruing at the midpoint of that year, and to discount all these streams back to their present value at mid-year 0. This is the time at which capital expenditure is also to be taken to start to accrue.

7.20 **In terms of good practice:**

- **The test discount rates specified by the Treasury are to be used for all streams of benefits and costs;**
- **Each and every benefit and cost should be taken to accrue in the middle of the year when it occurs;**
- **Present values should be calculated as at the mid-year of year 0.**

7.21 The economic efficiency of options can be assessed by comparing their cost-benefit ratios (i.e. the present value of benefits divided by the present value of costs), and their net present values (i.e. the present value of benefits less the present value of costs).

7.22 Where different options offering different standards of protection are compared, the incremental cost-benefit ratio of the higher standard of protection equals the increase in benefits resulting from that higher standard divided by the additional cost.

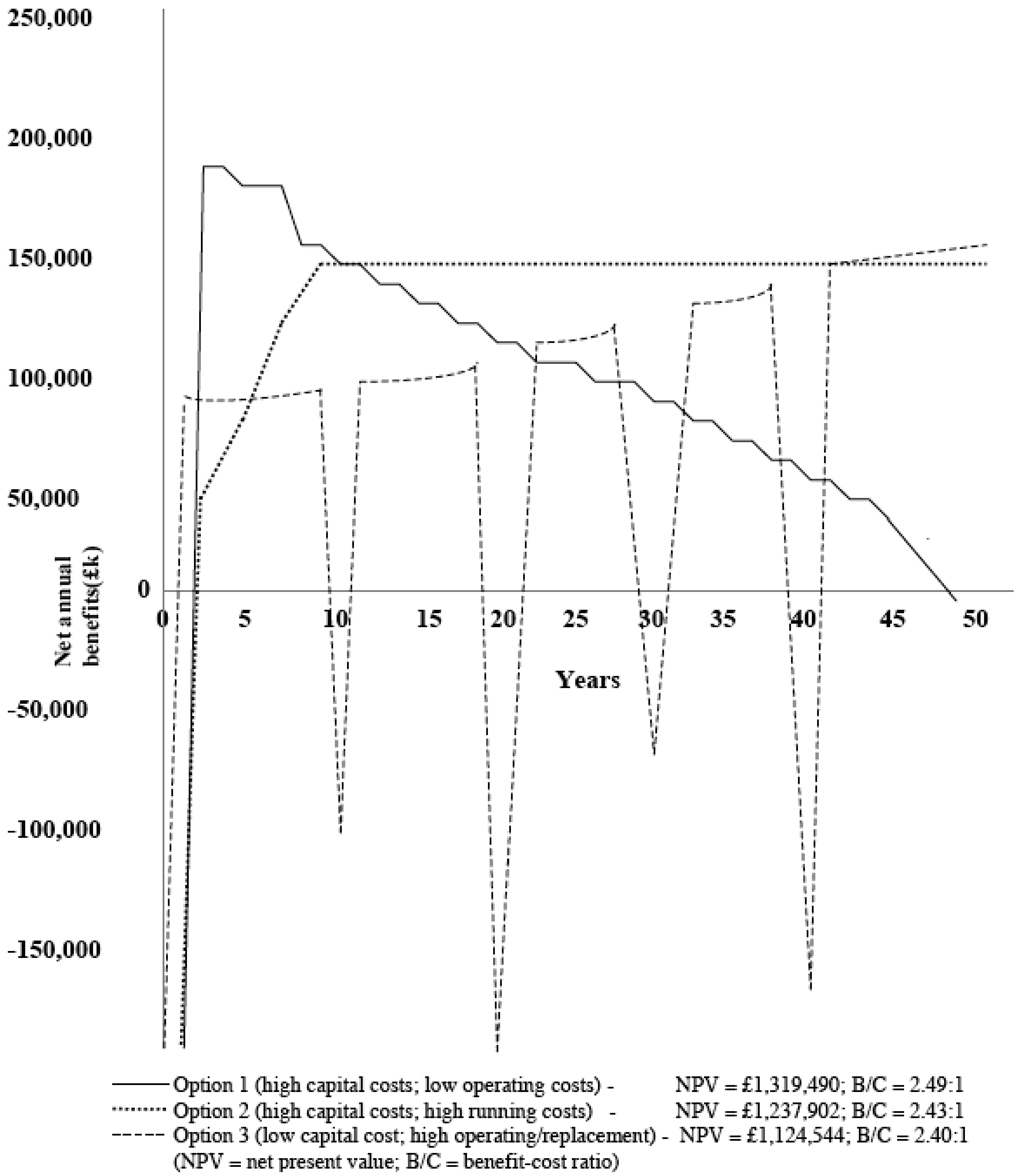
7.23 Because of the limitations inherent in comparing schemes by use of a single indicator, it is good practice to plot the changes in the different streams of benefits and costs over time. Discontinuities are either a sign of a change in conditions or an arithmetic error.

Economic sustainability

7.24 The economic sustainability of different options can be examined by plotting the distribution of net annual benefits over time. For example, figure 7.1 shows three options with very different distributions of net annual benefits (ie the difference between expected annual benefits and costs for each year of the scheme life) but very similar cost-benefit ratios and net present values (NPVs). Option 1 has (marginally) both the highest cost-benefit ratio and NPV. However, unlike the other 2 options, the net annual benefits of option 1 are negative in the long run. With option 2 there are some significant initial costs and the benefits are not immediately realised in full, but in the long- term stable benefits are achieved. Option 3, shows increasing benefits over time but also high recurrent costs.

7.25 In such a case it would not be appropriate to attach significant weight to the relatively minor differences in cost-benefit ratio or NPV but rather to examine the wider area of economic sustainability. This might include at least an outline appraisal over a longer time period so that longer-term gains and losses can be taken into account.

Figure 7.1 Comparison of options with different expenditure profiles



8. COMPARE: Choosing the option

Introduction

8.1 A practical way of ensuring best value for money, which may be applied on a project-by-project basis, is to maximise the cost-benefit ratio of those schemes while seeking to achieve an appropriate standard of protection for the type of land in question.

8.2 However, it is important that all impacts (both positive and negative) of an option are taken into account during decision-making. Use of the decision-making process requires these impacts to be considered to help ensure that the best overall solution is identified. It is therefore necessary to weigh up those impacts that have not been valued in monetary terms and consider whether they are of sufficient magnitude, significance and/or duration to change the preferred option from that which would be chosen based on the economic criteria alone. This is a decision that has to be made by the project team, based on the evidence collected and recorded in during the appraisal. All choices and decisions will need to be justified. Where the impacts are considered significant, but have not been monetised, the potential to use tools such as ecosystem services or scoring and weighting to monetise the impacts should be identified.

Standards

8.3 The Scottish Government does not specify design standards for flood protection schemes, although some guidance is given to local authorities on the consideration of design standards in “Delivering Sustainable Flood Risk Management (reference 1) (see also paragraph 4.10).

The decision process

8.4 The decision for funding flood protection schemes lies with the Local Authorities’ Accountable Officers. In making decisions about which flood protection scheme(s) to pursue, there are several criteria which should be borne in mind:

- The extent to which the objectives have been (or could be) achieved;
- Whole life costs of the options (taking account of contributions by subtracting funds from other sources);
- Qualitative and quantitative damages, damages avoided and benefits of each option;
- Average cost-benefit ratio (benefits divided by costs, where the costs include contributions);
- Incremental cost-benefit ratio (the difference between the benefits provided by two options divided by the difference in costs, where the costs include contributions);

- Net present value (benefits minus the costs, where the costs take account of contributions);
- Technical issues;
- Implications of sensitivity analysis.

8.5 It should be emphasised that the decision-making process is not about the manipulation of figures. Rather, what is required is a reasoned interpretation of the information produced from the appraisal.

Sensitivity analysis and robustness testing

8.6 Within economic appraisal, the purpose of sensitivity analysis and robustness testing is to determine whether, within the reasonable bounds of confidence, and for the various assumptions made:

- The scheme is economically worthwhile;
- The economic return is likely to be achieved;
- The option choice is robust.

8.7 It is therefore important to determine those factors that would impact on any investment decision. If, for example, the cost-benefit ratio is highest for an option where there is significant uncertainty, it may be better to pursue an alternative with a lower, but more certain outcome. Chapter 6 incorporates a framework for evaluating such risks.

8.8 Having determined the most important factors, assessments of uncertainty should be made on the basis of experience and judgment. As a general guide, a range of possibilities should be considered for items such as:

- Costs (whole-life capital, maintenance and management) based on the key costs elements and sensitivity to changes in costs of key materials or resources;
- Timing to first failure of deteriorating defences (projects are often sensitive to the timing of impacts, particularly write-off of properties or onset of environmental damages);
- Threshold of flooding (many schemes will be sensitive to assumptions about the level, and hence frequency, at which flood damage commences);
- Calculation of extremes and their probabilities;
- Changes to major beneficiaries (for example, a major business in the benefit area could cease trading or relocate, or where damages to a commercial property account for more than 20% (say) of the benefits, assess how the damages would change if the commercial property changed use such that the damages would be reduced);
- Regeneration potential and development planning.

8.9 Even where it is not possible to quantify the uncertainty associated with each variable, it should be possible to identify a reasonable range of possibilities. All major risks should be considered both singly and in combination.

8.10 The effect of uncertainty may be easier to explore where the benefits (and damages) are valued in money terms, since the impact of changes in assumptions between options can be calculated. Qualitative and quantitative descriptions of impacts should help identify which of the non-monetised impacts have the greatest influence on the choice of option. It is not always necessary to quantify the uncertainties, but it is useful to try and quantify the impacts on the benefits of the options and the average cost-benefit ratio wherever possible. This is particularly important where the scale of the uncertainty is much larger than tangible differences in value between the alternative options. Where it is not possible to quantify the uncertainty associated with each variable, it should be possible to assess the relative scales of the uncertainties compared with the other options. All major risks should be considered both singly and in combination.

8.11 It is important to focus on differences between options, as this will help identify which factors are influencing the choice of one option over another. This information can then be used to help choose between options and to justify the choice of preferred option.

8.12 For major projects it is particularly important to identify switching points where a change in the assumptions would alter the option choice. Informed judgments can then be made of the relative likelihood of the different outcomes, to determine the best option.

Post project evaluation

8.13 Post project evaluations demonstrate whether past investment has been worthwhile and has achieved its objectives. The exercise will be considerably eased if the fully documented original appraisal is readily available to evaluators. For example, it will be possible to compare actual performance against the sensitivity analysis in the cost-benefit appraisal. This will enable a check on the areas of greatest uncertainty, to see whether variations in practice are within predicted limits

8.14 In undertaking cost-benefit analysis as part of post project evaluation of flood protection schemes it can be difficult to identify realised benefits, which are based on the avoidance of losses which would have occurred had the scheme not been implemented. Hence, it is difficult to determine whether the actual benefits are equal to those predicted. It will usually, therefore, be necessary to judge success on the accuracy of related predictions such as the costs of construction and maintenance, rates of environmental enhancement or measures of residual damage.

9. References

1. Scottish Government (2011) Delivering sustainable flood risk management. Guidance document. Scottish Government, Edinburgh. ISBN 978 1 78045 221 0. http://www.scotland.gov.uk/Publications/2011/06/15150211/0

2. Scottish Government (2011) Delivering sustainable flood risk management – Principles of appraisal: a policy statement. Scottish Government, Edinburgh. ISBN 978 1 78045 276 0. http://www.scotland.gov.uk/Publications/2011/07/20125533/6

3. HM Treasury (2003) The Green Book. Appraisal and Evaluation in Central Government. TSO, London. http://www.hm-treasury.gov.uk/data_greenbook_index.htm

4. Environment Agency (2010) Flood and Coastal Erosion Risk Management appraisal guidance. Environment Agency, Bristol. http://www.environment-agency.gov.uk/research/planning/116705.aspx

5. Penning-Rowsell E, Viavattene C, Pardoe J, Chatterton J, Parker D and Morris J (2010) The Benefits of Flood and Coastal Risk Management: A Manual of Assessment Techniques (Multi-Coloured Manual). Flood Hazard Reseach Centre, London. ISBN 978-0-9565567-0-7

6. Penning-Rowsell E, Viavattene C, Pardoe J, Chatterton J, Parker D and Morris J (2010) The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques (Multi-Coloured Handbook). Flood Hazard Research Centre, London.

7. Department for Environment, Food and Rural Affairs (2008) Flood and Coastal Defence Appraisal Guidance: Economic Appraisal – Supplementary note to Operating Authorities: Valuation of Agricultural Land and Output for Appraisal Purposes. Defra, London. http://archive.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/treat-land.pdf

8. Environment Agency (2010) Flood and Coastal Erosion Risk Management appraisal guidance – Supporting Document for the Appraisal Summary Table. http://www.environment-agency.gov.uk/research/planning/116707.aspx

9. Department for Environment, Food and Rural Affairs (2004) *Flood and Coastal Defence Project Appraisal Guidance,* FCDPAG*3 Economic Appraisal, Supplementary Note to Operating Authorities*. Revisions to Economic Appraisal on: Reflecting socio-economic equity in appraisal, and Appraisal of human related intangible impacts of flooding. Defra, London. http://archive.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/fcd3update0704.pdf

10. Mace GM, Bateman I, Albon S, Balmford A, Brown C, Church A, Haines-Young R, Pretty JN, Turner K, Vira B and Winn J (2011) Conceptual Framework and Methodology *In*: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge. http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

11. Eftec (2010) Flood and Coastal Erosion Risk Management: Economic Valuation of Environmental Effects. Eftec, London. http://www.environment-agency.gov.uk/research/planning/116707.aspx

12. Environment Agency (2010) Flood and coastal erosion risk management appraisal guidance. Environment Agency, Bristol. http://www.environment-agency.gov.uk/research/planning/116705.aspx

13. Landscape Institute (2005). Guidelines for Landscape and Visual Impact Assessment, Taylor & Francis. http://www.landscapeinstitute.org/publications/index.php

14. Department of Energy and Climate Change (2011) Valuation of energy use and greenhouse gas emissions for appraisal and evaluations. http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

15. Werritty A, Houston D, Ball T, Tavendale A & Black A (2007). Exploring the social impacts of flooding and flood risk in Scotland. Scottish Executive Social Research, Edinburgh. ISBN 978 0 7559 6590 8. http://www.scotland.gov.uk/Publications/2007/04/02121350/0

16. Department for Environment, Food and Rural Affairs (2008) Flood and Coastal Defence Appraisal Guidance: Social Appraisal – Supplementary note to Operating Authorities: Assessing and Valuing the Risk to Life from Flooding for Use in Appraisal of Risk Management Measures. Defra, London. http://archive.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/risktopeople.pdf

17. Foundation for Water Research (1996) Assessing the Benefits of Surface Water Quality Improvements Manual. FR/CL0005. Marlow, Bucks.

18. MAFF (1999) Flood and Coastal Defence Project Appraisal Guidance, Economic Appraisal - *FCDPAG*3, a Procedural Guide for Operating Authorities. http://archive.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/fcdpag3.pdf

19. Scottish Government (2011) Public Bodies Climate Change Duties: Putting Them Into Practice - Guidance Required by Part 4 of the Climate Change (Scotland) Act 2009. Scottish Government, Edinburgh. ISBN 978 0 7559 9965 1 http://www.scotland.gov.uk/Publications/2011/02/04093254/0

20. Scottish Government (2009) Scotland's Climate Change Adaptation Framework. Scottish Government, Edinburgh. ISBN 978 0 7559 8179 3 http://www.scotland.gov.uk/Publications/2009/12/08130513/0

21. Scottish Government (2011) Scotland's Climate Change Adaptation Framework: Sector Action Plans - Water Environment and Resource. http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/adaptation/AdaptationFramework/SAP/WaterResourceManagement

22. Murphy J, Sexton D, Jenkins G, Boorman P, Booth B, Brown K, Clark R, Collins M, Harris G and Kendon L (2009) Climate change projections. Met Office Hadley Centre. ISBN 978-1-906360-02-3 http://ukclimateprojections.defra.gov.uk/content/view/824/500

23. Scottish Executive (2003) Note on Project Appraisal Guidance.

24. Mitchell RC and Carson RT (1989) Using Surveys to Value Public Goods: the Contingent Valuation Method. Resources for the Future, Washington DC.

25. Louviere JL (1988) Analyzing Decision Making: Metric Conjoint Analysis. Quantitative Applications in the Social Sciences 67. Sage, Newbury Park.

26. Krueger RA (1988) Focus Groups: a Practical Guide for Applied Research. Sage, Beverly Hills.

27. Bateman I and Willis K (eds) (1999) Valuing Environmental Preferences. Oxford University Press, Oxford.

28. Burgess J, Clark J and Harrison CM: 'I Struggled with this Money Business': Respondents to the Wildlife Enhancement Scheme CV Survey Discuss the Validity of Their WTP Figures. School of Geography, University College, London, 1997.

10. Glossary of Terms

Above-design-standard benefits	The benefits from reductions in flood losses from events which exceed the design standard of protection, expressed as an annual average benefit.
Annual Exceedence Probability (AEP)	Probability that an event of specified magnitude will be equalled or exceeded in any year
Appraisal	The process of defining objectives, examining options and weighing up the costs, benefits, risks and uncertainties before a decision is made.
Benefits	Those positive quantifiable and unquantifiable changes that a project will produce.
Cost-benefit ratio	The ratio of the present value of benefits to the present value of the costs.
Contingent valuation method	A valuation methodology which uses questionnaire techniques to elicit valuations using respondents' willingness to pay for an environmental improvement.
Discounting	The procedure used to arrive at the sum of either costs or benefits over the lifetime of a project using a discount rate to scale down future benefits and costs. The effect of using a discount rate is to reduce the value of projected future costs or benefits to their values as seen from the present day.
Economic appraisal	An appraisal that takes into account a wide range of costs and benefits, generally those which can be valued in money terms.
Incremental cost-benefit ratio	The ratio of the additional benefit to the additional cost, when 2 options are compared.
Intangibles	Those costs, benefits and risks that are difficult to quantify but which are nevertheless relevant for the decision making process. Usually applied to non-monetary impacts.

Market price	The price for which a good is bought and sold in a market. If restrictive conditions are satisfied, this price may be used to estimate the economic value of the good. Otherwise, the market price may need to be corrected, and a 'shadow price' derived, in order to estimate the economic value of the good.
Net present value (NPV)	The stream of all benefits net of all costs for each year of the project's life discounted back to the present date.
Non-monetary impacts	Used to describe those impacts of flooding on households which do not have direct financial impacts.
Non-use value	The value that people hold for an environmental resource which is not attributable to their direct use of the resource for commercial or recreational purposes. Otherwise known as intrinsic value.
Post project evaluation	A procedure to review the performance of a project with respect to its original objectives and the manner in which the project was carried out.
Present value	The value of a stream of benefits or costs when discounted back to the present time.
Ramsar site	Internationally important wetland, designated under the Convention on Wetlands of International Importance (Ramsar, Iran, 1971).
Return period	The average length of time separating flood events of a similar magnitude: a 100-year flood will occur on average once in every 100 years.
Risk assessment	Consideration of the risks inherent in a project, leading to the development of actions to control them (see Chapter 6).
Special Area of Conservation	An internationally important habitat or species
(SAC)	designated under the EC Habitats Directive.
Sensitivity analysis	Analysis of the effects on an appraisal of varying the projected values of important

	variables.
Special Protection Area (SPA)	Internationally important site designated under the EC Wild Birds Directive.
Sunk costs	A cost incurred in the past and which cannot be recovered whatever decision is taken now. Consequently, sunk costs are omitted in cost-benefit analyses.
Sustainability	The degree to which flood defence solutions avoid tying future generations into inflexible and/or expensive or environmentally damaging options for defence. This will usually include consideration of interrelationships with other defences and likely developments and processes within a catchment. It will also take account of long-term demands for non-renewable materials.
Transfer payment	A payment which has no impact in terms of an economic analysis (see Annex A for a full definition). Examples are most tax payments and general subsidies.
Whole-life costs	The total costs associated with a scheme for its full design and potential residual life span, taking proper account of all aspects of design, construction, maintenance and external impacts. A particularly useful approach in helping to determine economic sustainability when used to compare the relative costs of long-life schemes such as flood defences, and where decisions need to be made between short-term capital costs and long-term maintenance costs.
Willingness to pay	The amount an individual is prepared to pay in order to obtain a given improvement in utility, expressed through the contingent valuation method.

ANNEX A. Transfer Payments

Transfer payments

When does a change result only in a transfer payment?

A1. Cost-benefit analysis is concerned with national economic efficiency where efficiency is, in effect, the ratio of the value of outputs (consumption) to inputs (resources). These inputs are yielded both from stock (eg engineering plant, buildings) and from flows (eg electricity, labour).

A2. A transfer payment occurs when a change simply affects either who gets the consumption or who provides the resources, but there is no change in the national total of either all the consumption, or all the resources required to generate that consumption.

Test for a transfer payment

A3. Will there be any change either or both in the total value of UK consumption, or in the resources required to provide that consumption? If not, then only a transfer payment is involved.

A4. When a physical object is damaged or destroyed by a flood, a transfer payment is not involved since maintaining current levels of consumption will require the replacement of that object. There will be distributional consequences as well (e.g. builders will get more work) but the test is whether there will be a change in the total level of consumption or the resources required, including the need to repair or replace stocks which have been damaged or destroyed.

Examples of a transfer payment

A5. Examples are:

- VAT and excise duties are always transfer payments and must be netted out of the analysis. If less petrol is sold, then the Exchequer will simply find different ways of raising taxes.
- If a hotel or pub were lost, the trade would simply transfer to other outlets, the value of any such 'goodwill' element in the market price must therefore be netted out of the analysis.
- Losses of trade to commercial or retail outlets will be a transfer payment except in the circumstances given below.

Examples of changes which are not a transfer payment

A6. In some cases, a levy is made in respect of negative externalities, a 'green tax', which is intended to reflect a real economic cost, although otherwise it appears identical to other forms of taxation such as VAT. If, for example, a charge were to be levied on aggregates which reflected the real environmental damage caused by aggregate extraction, this would reflect the additional economic loss resulting from mineral workings. Therefore, an increase in aggregate extraction would result in additional economic losses to the country, in addition to the resource costs of extraction and transportation. Landfill taxes are also a 'green tax' and represent a real economic cost. Ideally, where appropriate, these additional economic losses should be quantified and included in the analysis. However, this is unlikely to be practical for most flood protection schemes and it will normally be reasonable to use the tax rates as a surrogate for the real economic loss in any analysis.

A7. Losses of trade to commerce and retail outlets result in real losses if consumers cannot obtain equivalent goods at the same time and at the same cost. If all 3 conditions do not hold, an economic loss is involved. However, the normal expectation is that consumers will be able to obtain equivalent goods at no extra cost and therefore any differences will not be worth evaluating.

A8. The test can also be applied to non-priced goods, such as visits to a riverside park. If consumers can go somewhere else and get the same amount of enjoyment at no extra cost, the change in visiting results in no real economic cost. If they cannot, the net value of the loss in enjoyment, plus any increase in cost to the visitor measures the economic loss.

ANNEX B. Components of Economic Value and Environmental Assets

Introduction

B1. Economic value is determined by individual preferences and, where there is a market in the goods or services in question, can generally be taken as the market price, at least as a first approximation. Many goods and services, however, have no market price, either because they are provided 'freely' by the state, such as defence, law enforcement and street lighting, or are otherwise freely available to all, such as a panoramic view. However, such goods still have an economic value. In the appraisal of flood protection schemes it is the valuation of environmental or recreational assets for which there is no readily available market price that is likely to prove problematic. On top of the economic value deriving from the direct use of an unpriced asset, there are other components of economic value which might arise in some cases. These are:

- a *functional value*, where an asset serves a number of functions and yields benefits other than those deriving from its direct use by 'consumers';
- an *option value* given to maintaining the option of being able to use the asset in the future, although it is not currently used;
- an *existence* (often termed a 'non-use' or 'passive use') value representing a value which people attach to the continued existence of an asset for the benefit of current or future generations, even though they make no direct use of it themselves.

B2. Care always needs to be taken to avoid double counting by estimating total economic value in one way and then adding on some components which have already been implicitly included within the calculation.

The need to derive existence values

B3. In principle, all of these elements should be appraised when valuing changes to an unpriced environmental or other asset which arise as a result of carrying out - or not carrying out - any flood protection scheme. In practice, however, it is likely to be changes in the use and functional value of the asset that will dominate. Three questions should be addressed initially.

(1) Under what circumstances is it necessary to appraise existence values?

(2) How can it be done?

(3) Is it likely to affect the result of the cost-benefit analysis if it is done?

B4. If the answer to the third question is 'No', so that the inclusion of existence value is unlikely to have any bearing on the outcome of the analysis, the first 2 questions become entirely academic. The use of existence values in practical contexts will, moreover, carry a considerable degree of uncertainty. Consequently, any estimates are likely to prove contentious. This is particularly so since those schemes where existence values are likely to have an important bearing on the final choice of option tend themselves to be contentious. Hence, rather than including explicit existence values within the cost-benefit analysis, it may be preferable to adopt the pragmatic approach of attempting to quantify, in non-monetary terms, the relative impact of existence values on the options under consideration, on the basis of consultations with interest groups and the wider public. Consideration can then be given as to how large the implicit monetary values would have to be to affect the choice of scheme, and whether such values are plausible on the basis of the information deriving from the consultation process. With the direct attribution of monetary values to existence values there is a danger of discussions becoming sidetracked into philosophical arguments about whether a monetary value ought to be attached to the environmental asset in question as well as methodological arguments about the adequacy of the particular technique used to derive that value.

B5. The results of any study of existence values will, however, generally be less contentious if there is a consensus that some 'do something' option is preferable to the baseline alternative so that the question essentially reduces to one of deciding whether it is worth spending a particular sum of money.

B6. There are 2 circumstances when it may be necessary to include an assessment of existence value. These are:

(1) Where a proposed scheme protects only an environmental asset from loss or damage;
(2) Where a proposed scheme would protect an environmental asset, amongst other properties, but the readily valued benefits are not sufficient on their own to justify a scheme.

B7. Even here it might be more helpful to look first at alternatives, such as the cost of replacing the asset or of its local protection, before embarking on an appraisal of existence values. Seeking to appraise the existence value of losses or damage to environmental assets, arising as a consequence of one or more of the 'do something' options, however, is unlikely to be helpful in reaching a decision on the best option. If such losses are unavoidable then, through discussion with interested parties, the scope for compensatory works should be explored.

Determining existence values

B8. If it does prove necessary to appraise the existence value of some change in environmental assets, then a methodology such as contingent valuation (Mitchell and Carson, reference 24) or conjoint analysis (Louviere, reference 25) should be used to derive this value. Such a study needs to be carried out by well-qualified practitioners and is liable to be quite expensive (>Â£50,000) taking some time (> 6 months) to complete. Ideally, in advance of the main fieldwork, qualitative studies will be undertaken, for example, using focus groups (Krueger 1988, reference 26). Such studies should seek to explore exactly what it is that the public values, or for which they are prepared to pay, and why they are prepared to pay. It is a useful opportunity to gain an understanding of how the public defines the decision that must be made, and how they believe it ought to be made. Again, in a main contingent valuation or conjoint analysis study itself, emphasis should be put on gaining an understanding of how different members of the public approach the choice. Additionally, it will be helpful to discuss the formulation of the study with interested parties, including the statutory consultees.

B9. One of the major issues in studies of existence value has been whether a value for the particular site is being obtained or something rather more ill-defined, such as a preparedness to pay for environmental protection as a whole. Care therefore needs to be taken that the values elicited from any study are specific to the asset in question, and do not relate to that type of asset in a more generic sense. For example, if an existence value for a SSSI is being sought, the interview schedule should be designed so that a clear distinction can be made between a preparedness to pay to preserve the specific SSSI and SSSIs in general.

B10. Another major issue in appraising existence value is the specification of the appropriate population. What are the geographical boundaries defining the population that is deemed to place an existence value on the asset and, by implication, which population is prepared to pay for it? It clearly makes a profound difference to the calculation of the existence benefit of protecting a site if an average existence value (the sample mean amount for individual preparedness to pay) of Â£1.60 a year relates to the population of the entire country, or only the population living within 5 kilometres of the site in question. The identification of the appropriate population is often neglected so that a relatively small monetary value (mean individual preparedness to pay), ends up being multiplied by a very large but essentially arbitrary population figure.

B11. This question can first be explored through the qualitative studies; for instance, by selecting the samples for the studies from populations living at various distances from the site in question. Secondly, the population to which the mean preparedness to pay is applied should not be wider than the population that was sampled in the quantitative study. Thus, if only people living within 10 kilometres of the site were interviewed, then it is a conservative assumption that people living further away are not prepared to pay to protect the site. Within the sample, it may be worthwhile exploring whether there is any relationship between the distance individuals live from the site and either the likelihood that they are prepared to pay at all, or the total amount they are prepared to pay. Where there is such a relationship, the population mean should be calculated by the appropriate weighting by distance.

B12. The individual figures found in the study will be intended to reflect the total economic value, both use and existence, of the site to the particular individual. Usually, they will contribute some use value to some individuals that will have been valued by other means. If so, this element must be removed from the sample estimates, to leave only existence value, and hence avoid double- counting of use values within the cost-benefit analysis. If it is assumed that the only difference between 'users' and 'non-users' is that one group uses the site and the others do not, users should be expected to be more likely to be prepared to pay, and to pay more, than non-users. This difference should be equal to the use value of the site to those users. Therefore, on this argument, the mean sample preparedness to pay of non-users can be used as the basis for generalising to the relevant population. However, the argument depends on the validity of the assumed sole difference between users and non-users, which must be checked. It is also necessary to determine whether there is a statistically significant difference between the preparedness to pay of the two groups.

Guidance for contingent valuation and other studies

B13. In general, both the contingent valuation and conjoint analysis techniques should be treated as experimental methods rather than routine tools. Consequently, it is necessary to establish the validity of the results, particularly that individual differences in preparedness to pay reflect those differences which are expected theoretically. Equally, because they are experimental techniques, it would be undesirable to set such restrictive rules as to inhibit innovation and the development of improved methodologies. Therefore, other than the adoption of social survey good practice, the rules below define what should be achieved, rather than prescribe the means to achieve those ends.

B14. The minimum requirements for a contingent valuation or conjoint analysis study are:-

- Sample size should be a minimum of 500 individuals.
- This shall be a random sample of the population to which it is intended to generalise the results.
- Professional quality fieldwork is required, complying with the Interviewer Quality Control Scheme and the Code of Conduct of the Association of Market Survey Organisations. This fieldwork should normally be undertaken by a specialist fieldwork organisation.
- Personal interviews with respondents are required rather than postal surveys or telephone interviews.
- The results may not be generalised to a wider geographical population than that included in the sample.
- The effects of distance on both the probability that an individual is prepared to pay and the amount that an individual is prepared to pay shall be analysed.
- The 'use value' component of preparedness to pay shall be removed from preparedness to pay when estimating existence value.

- The likelihood that an individual is prepared to pay, and the amount that an individual is prepared to pay, shall be reported separately.
- Since theory predicts that both the likelihood an individual is prepared to pay and the amount that such an individual is prepared to pay depend upon a number of factors, notably income, the extent to which the results are consistent with theory shall be reported.
- A report of the reasons why the values obtained can be treated as specific to the site in question is required.

Further reading

B15. There are many books and publications available on this topic but references 24 to 28 provide a selection of texts, including those referenced in this Annex. Bateman and Willis (reference 27) provide a good review of the state of the art in theory and methodology and Burgess, Clark and Harrison (reference 28) give a critical examination of how people actually respond in a contingent valuation study seeking to derive an existence value for a specific site.

ANNEX C. Optimism Bias Data for Flood Protection Costs

C1. The following data and other details have been abstracted from the note issued by Defra to operating authorities in March 2003 (reference 23).

Starting (upper bound) Optimism Bias factor for **Strategy** costs (pre-feasibility stage):	**60%**
Starting (upper bound) Optimism Bias factor for **Scheme** costs (detailed design stage):	**30%**

C2. The risk components contributing to the above factors are detailed in tables C1 and C2. The risk components (except for those described "Other") may be reduced for individual strategies or schemes if demonstrable action to minimise risks has been taken, or other evidence is provided that risks are not applicable to the degree indicated. In which case, the revised sum of risk components should be divided by 100 and multiplied by either 60 or 30 to obtain the new Optimism Bias factor

Example of Optimism Bias approach: After an assessment of risk components, the "environmental impact" component for a strategy plan is halved (ie reduced by 6.5). The new optimism bias factor equals:

(100-6.5)/100 x 60 = 56

So the best estimate of Present Value strategy costs is increased by 56%, with this adjustment applying to operating and maintenance expenditure as well as capital expenditure.

Table C1. Risk components contributing to optimism bias factors

Risk components contributing to optimism bias factors (see table C2)		**Average % for flood defence projects**
Procurement	Late contractor involvement in design	1
	Dispute and claims occurred	11
	Other	1
Project specific	Design complexity	4
	Degree of innovation	4
	Environmental impact	13
	Other	9
Client specific	Inadequacy of the Business Case	23
	Funding availability	2

	Project management team	1
	Poor project intelligence	8
Environment	Public relations	5
	Site characteristics	4
External influences	Economic	5
	Legislation/regulations	4
	Technology	4
	Other	1

Table C2. Definitions of risk components

Procurement	Late contractor involvement in design	Late involvement of the contractor in the design leads to redesign or problems during construction.
	Dispute and claims occurred	Disputes and claims occur where no mechanisms exist to manage effectively adversarial relationships between project stakeholders.
	Other	Other factors that relate to procurement which affect the final project cost.
Project specific	Design complexity	The complexity of design (including requirements, specifications and detailed design) requires significant management, impacting on final project costs.
	Degree of innovation	The degree of innovation required due to the nature of the project requires unproven methods to be used.
	Environmental impact	The project has a major impact on its adjacent area leading to objection from neighbours and the general public.
	Other	Other project specific factors which affect the final project cost.
Client specific	Inadequacy of Business Case	The project scope changes as a result of the poor quality of requirement specifications and inadequate project scope definition.
	Funding availability	Project delays or changes in scope occur as a result of the availability of funding.
	Project management	The project management team's

	team	capabilities and/or experience impact on final project costs.
	Poor project intelligence	The quality of initial project intelligence (eg preliminary site investigation, user requirements surveys etc) impacts on the occurrence of unforeseen problems and costs.
Environment	Public relations	A high level of effort is required to address public concern about the project, which impacts on the final project cost.
	Site characteristics	The characteristics of the proposed environment for the project are highly sensitive to the project's environmental impacts (eg greenfield site with badger setts, or contaminated brownfield site).
External influences	Economic	The project costs are sensitive to economic influences such as higher-than-expected construction cost inflation, oil price shocks etc.
	Legislation/regulations	The project costs are sensitive to legislation and regulation changes, eg health and safety and building regulations.
	Technology	The project costs are sensitive to technological advancements, eg the effects of obsolescence.
	Other	Other external influencing factors which affect the final project cost.

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