Department for Transport

Transport Analysis Guidance (TAG)

Unit 3.5.9
The Estimation and Treatment of Scheme Costs

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Contents

1 The Estimation and Treatment of Scheme Costs

1.1 Introduction

1.1.1 This document provides guidance on the estimation and treatment of transport scheme costs within the NATA framework, with the aim of enabling more realistic and accurate scheme costs estimates to be produced. The costs of transport schemes have become a more important part of the scheme appraisal process and for decisions on scheme funding. Unrealistic cost estimates that subsequently rise will adversely affect the affordability and value for money of a scheme and in a number of cases funding has been withdrawn as a result of significant cost increases.

1.1.2 The Department is increasingly taking the view that subsequent cost rises need to be borne by the scheme promoter, rather than through further central Government funding. Therefore ensuring that scheme costs from the start are as robust as possible with realistic assumptions for construction and other cost inflation, and a proper allowance for risks and optimism bias is crucial. The guidance in this unit describes the methodology for estimating scheme costs and the treatment of these costs for use in appraisal, that is, for completing the Transport Economic Efficiency (TEE) and Public Accounts (PA) tables. The derivation of expected outturn costs, which are used for considering affordability and financial sustainability, is described in *Completing the Affordability and Financial Sustainability (AFS) Tables* (TAG Unit 3.8.1). The Department will state its position on the level of funding for schemes in separate advice.

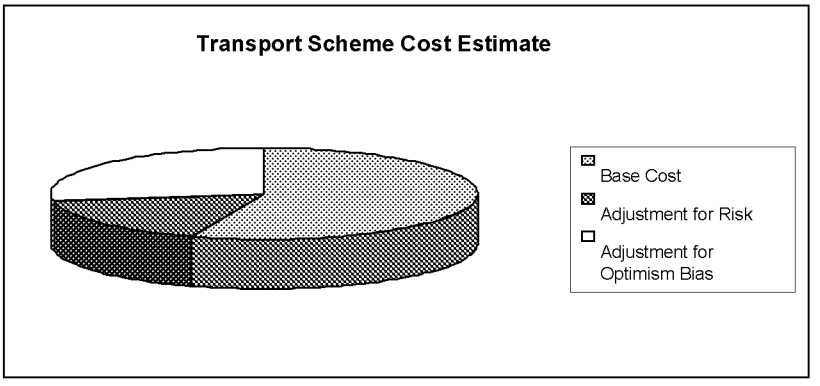
1.1.3 There are three main elements of a scheme cost estimate:

(a) the base cost[1] – the basic costs of a scheme before allowing for risks, though these should incorporate realistic assumptions of changes in real costs over time, e.g. cost increases above RPI growth;
(b) adjustment for risk – which should cover all the risks that can be identified, the majority of which then need to be assessed and quantified through a Quantified Risk Assessment (QRA) and results in the risk-adjusted cost estimate;
(c) and adjustment for optimism bias - to reflect the well established and continuing systematic bias for estimated scheme costs and delivery times to be too low and too short respectively and results in the risk and optimism bias-adjusted cost estimate.

[1] The term base costs may have different meanings elsewhere. In this guidance we refer to these as being the basic costs of a scheme formed in a given price base year, which include realistic assumptions about cost increases between the price base year and the years in which costs are incurred. The base costs do not include any adjustments for risk and optimism bias.

1.1.4 These cost elements are illustrated in the example below.

Figure 1



1.1.5 These cost elements will apply to a given "baseline" which describes the objectives, scope, i.e. the specified output of a given transport scheme, and the overall programme/staging. Hence a significant change in the objectives/scope of a project would be represented by a new baseline and corresponding new base costs, risk assessment and optimism bias adjustment. A change of this magnitude would probably trigger a full reappraisal of the project.

1.1.6 Given the tendency for scheme cost overruns, there is a need to ensure greater accuracy in scheme cost estimates. It is important that scheme promoters take a systematic approach towards identifying and managing risk, so that all risks likely to have a significant impact on scheme costs are considered. In addition, explicit adjustments for optimism bias should be made.

1.1.7 This document provides guidance on estimating each of the three components of the scheme cost estimate for use in appraisal:

(a) **Section 2** explains the concept of base costs and describes the distinction between investment costs and operating costs. This is followed by some guidance on forecasting future operating costs.
(b) **Section 3** focuses on the importance of adjusting base costs to account for risks, and for optimism bias. In particular, the importance of using expected values derived from a Quantified Risk Assessment is explained, and recommended uplifts for optimism bias are provided.
(c) **Section 4** provides guidance on the treatment of cost data for inclusion in the final appraisal documentation, that is, the Public Accounts (PA) and Transport Economic Efficiency (TEE) tables.

1.1.8 The document concludes in **Section 5** with a worked example illustrating the methodology outlined in each part of the guidance. Worked examples are provided throughout the document in order to help demonstrate the calculations described in the text.

2 The Base Cost

2.1 Introduction

2.1.1 The first component of a scheme cost estimate is the base cost. The base cost represents the basic costs of the scheme for a given price base, made up of base investment (or capital costs) and base operating costs (including all maintenance costs). It is a detailed estimate of the cost of the project, which will have also taken into account the amount by which any of the elements of the scheme's cost are expected to increase at a different rate to the general rate of inflation across the economy, i.e. expressed in real prices.

2.1.2 Promoters should take care to form base cost estimates using realistic assumptions about real cost changes, e.g. cost increases above RPI growth. The inflation rates relevant to the delivery of transport schemes are currently (Summer 2006) higher than general inflation rates across the economy. Major costs that are increasing faster than general inflation include wages, power, and many raw materials. This has a bearing on operating and investment costs, and higher costs also have a knock-on impact on value for money. It is difficult to generalise and suggest inflation rates applicable to all schemes. However, recent experience suggests that wage rate inflation is in the region of 4% and construction cost inflation often ranges between 5% and 7%. Most forecasts suggest that inflation rates in construction industries and wage settlements will continue to outstrip general inflation rate across the economy (RPI for example) for the next five years.

2.1.3 Promoters should consider current and forecast inflation from industry sources appropriate for their scheme and present the assumptions and sources of evidence used clearly in the appraisal information submitted to the Department. When forming base costs in a given price base year, different elements of costs should be adjusted by a real cost increase amount, relevant to that particular cost.

2.1.4 The factor by which a given element of cost would be adjusted for the first year after the given price base is represented by:

$$\frac{1 + \%\ forecast\ change\ in\ \text{cost}\ element_{year\ 0 \rightarrow 1}}{1 + \%\ change\ in\ RPI_{year\ 0 \rightarrow 1}}$$

2.1.5 For the years that follow, the factor for each year would be multiplied by the factors from preceding years. Therefore the total real adjustment made in forming the base cost could be a combination of different factors representing real cost changes. For example, in forecasting the base construction cost estimate in a given price base:

- If for the first year after the base cost year the forecast construction cost increase is 6%, and general inflation is 2.5%, then the adjustment factor for that year would be equivalent to 1.06/1.025.

- If this forecast remains the same for the following years, then the total real adjustment factor for n years after the given price base year is $(1.06/1.025)^n$.

- If the forecast changes for the following years, e.g. falls to 5%, in the 5th year after the base year, the total real adjustment for n years after the price base year would be equal to $(1.06/1.025)^4 \times (1.05/1.025)^{n-4}$.

2.2 Investment Costs

2.2.1 Investment costs (often referred to as capital costs) should be distinguished from operating costs. As shown in Table 1, the main components of investment costs may include but not necessarily be limited to construction costs, land and property costs and compensation, and preparation and administration costs and on site supervision and testing. The construction costs should include fees for project management, procurement, design, legal and third party costs. Land and property costs should also include the implicit costs of any resource that is acquired without financial payment such as 'land gift', including that from the local authority.

Table 1: Examples of Investment Costs Components

Base Investment Costs	**Roads**	**Railways**	**Public Transport**
Construction Costs	i) Main works contract (including preliminaries, structures, road works general, earthworks, main carriageway, interchanges, side roads, signs, etc.). ii) Ancillary work contracts (including provision of maintenance compounds, lighting, motorway communications, landscaping, noise insulation, etc) iii) Work by other authorities (including Network Rail, local authorities` works, statutory undertakers` works) iv) On site Supervision and Testing	Stations, Route Infrastructure Enabling and Advance Works, Communications, Rolling Stock, Track, Power and Signalling or Passenger facilities. Possession costs for train operators.	For Buses: Providing or upgrading vehicle fleet, New System of Ticketing and Passenger Information, New Stops and shelters, Bus Priority Measures on the highway and passenger information
Land and Property Costs	Acquisition cost, Legal transaction costs, Property management costs, Compensation etc.		
Preparation and Administration Costs	Project Management, Consulting engineers` fees, agent authorities fees, actual costs of pursuing alternative routes (if any) in the early stages of the scheme, Design costs, Public Consultation, Public Inquiry, gaining statutory powers or other licences and consents, compensation, the cost of any surveys carried out during scheme preparation, the costs associated with obtaining statutory orders, and on site Supervision and Testing	Generally as for roads. e.g. the costs associated with obtaining statutory orders	Generally as for roads. e.g. the costs associated with obtaining statutory orders
Traffic Related Maintenance Costs	Reconstruction, resurfacing, surface dressing etc.		

2.2.2 Transport Work Act (TWA) application costs and the costs associated with obtaining statutory orders should also be included in the investment costs. All

costs borne by the private sector should include non-recoverable indirect taxation (e.g. landfill costs, fuel duty and so on).

2.2.3 As the costs considered for a scheme should be those which will be incurred subsequent to economic appraisal and the decision to go ahead. "Sunk" costs, which represent expenditure which is incurred prior to the scheme appraisal *and* which cannot be retrieved, should not be included.

2.2.4 Further information on sunk costs and the treatment of land and property costs can be found in Annex A - *Land and Property Costs.*

Link to Annex A- Land and Property Costs

2.3 Operating Costs

2.3.1 The appraisal should include realistic and comprehensive operating and non-traffic related maintenance cost estimates, identifying the main components. Operating cost and renewals estimates should include an assessment of real growth over time.

2.3.2 It is important to note the distinction between operating costs incurred by transport providers, referred to here, and vehicle operating costs incurred by transport users which are discussed in *Values of Time and Operating Costs* (TAG Unit 3.5.6).

2.3.3 Operating costs may be incurred by private or public sector providers and are recorded in different places in the standard Departmental tables, i.e. TEE and PA tables. Further detail as to how information on costs should be recorded in the appraisal documentation can be found in Section 4 of this guidance. Examples of operating costs are provided in Table 2 below.

Table 2: Examples of Operating Costs Components

Element of Base Cost	Roads	Railways	Public Transport
Operating Costs	Non traffic related maintenance costs (e.g. drainage, street lighting, fencing, grass cutting, repainting lines etc)	Train and station operating costs (e.g. payroll, fuel and traction and track access and station lease charges). Train leasing charges- which normally includes light and heavy maintenance of rolling stock.	Buses: i) Enforcement of bus lane ii) Maintenance of stops; iii) Fuel; iv) Payroll.

2.3.4 Staff costs should include allowances for holidays, sickness, shift working, training and overtime. Note that wage rates may increase faster than GDP growth. Additional costs may include management costs for park and ride sites and rates for premises used as depots. Where possible, operating costs from similar existing systems should be used as a reference before adjustments are made for real cost changes.

2.3.5 Bus-based schemes may include operating costs falling to the highway authority owing to use of the road network, (e.g. maintenance of bus lane) although in general any effects would be expected to be marginal. Bus-based schemes may also include enforcement costs and maintenance of stops.

2.3.6 For public transport schemes it is expected that a whole life cost appraisal is used to establish the total cost of ownership, i.e. the total cost of delivering, operating and maintaining a project. Schemes where the project life can be determined from the limited life of its component assets, i.e. has a finite life will have a planned or contracted life. The total cost of ownership will depend on the quality required over the life of the scheme, for example, constant or increasing patronage, service frequency, and so on, and the trade-off between maintenance and renewal. Residual values can be estimated for projects with finite lives and should be included in the appraisal of projects. Residual values should not however, be included in the appraisal of projects with indefinite lives where the appraisal period should end 60 years after the scheme opening year. For further details see section 5.2 of *Cost Benefit Analysis* (TAG Unit 3.5.4).

2.3.7 Investment in new transport infrastructure may provide savings in replacing existing infrastructure. These avoided renewals can be treated as a maintenance cost saving in the 'with scheme' case. This is the approach recommended by the Department and used within TUBA and COBA.

Forecasting Operating Costs

2.3.8 Operating and maintenance costs must be forecast for the whole of the appraisal period. In forecasting future operating, maintenance and renewal costs, analysts should consider:

- The impact of increasing usage or patronage; and
- The potential for cost increases in excess of general cost inflation.

2.3.9 In order to gauge the profile of operating costs over time and allow the cumulative effects of the scheme to be assessed, it is recommended that estimates should be prepared for three separate forecast years (although this may vary with project type). Analysts will need to use their judgement to

choose the number and timing of years to be considered. Interpolation and extrapolation should then be used to cover the whole appraisal period.

2.3.10 The appraisal period is the period up to 60 years after the scheme opening year. *Cost Benefit Analysis* (TAG Unit 3.5.4) provides further information on the appraisal period. The extension in the appraisal period from 30 years to 60 years requires streams of costs and benefits to be estimated over a longer period than has been the case in the past. In most cases, this can only be achieved by extrapolation and assumption. More detailed analysis for later periods is unlikely to be feasible or worthwhile. However, analysts should take care to ensure that their work is as robust as possible, and based on whatever evidence is available. All assumptions and supporting evidence should be fully documented and submitted to the Department.

2.3.11 For projects with long lives, the extension of the appraisal period from 30 to 60 years after opening may bring additional elements of major structural maintenance and/or renewal within the appraisal period. For example, road pavements and drainage may require renewal, as may rail track and rolling stock. Wherever possible, the timing, cost and duration of these major elements of cost should be estimated explicitly. Where this is not possible, these costs may be included in annual maintenance rates, though care must be taken to avoid underestimation.

2.3.12 For roads, useful information has been developed by the Highways Agency as part of its work on whole life costing methods. Typical maintenance profiles, cost, and durations for new roads are given in the *QUADRO manual* (DfT, 2004). This information for new roads is provided for a 60 year period. For other modes, maintenance profiles, costs and durations should be forecast as discussed above and disaggregated to show the main determinants of cost.

2.3.13 The need for periodic major maintenance and renewal means that the maintenance costs profile over time is likely to be 'spiky' whereas the operating costs profile is more likely to be fairly constant over time.

3 Risk and Optimism Bias

3.1 Introduction

3.1.1 In appraisals there is always likely to be some difference between what is expected and what eventually happens. Several studies have indicated that scheme cost estimates tend to underestimate costs and delivery times and overestimate benefits and revenue streams. As noted by HM Treasury (2003), this is usually due to biases unwittingly inherent in the appraisal, and risks and uncertainties that materialise in the course of the project. As a result, it is important to identify and mitigate risks, and make allowances for "optimism bias".

3.1.2 In the context of cost estimation **Risk** refers to identifiable future situations that could cause an overspend or underspend to occur. Risks that could cause an under-spend to occur are sometimes referred to as opportunities whilst risks that could cause an over-spend to occur are sometimes referred to as 'threats'. In this guidance risks are used to describe situations that could lead to either an over- or under-spend. **Optimism Bias** is defined by the Green Book (2003, p.29) as "a demonstrated systematic, tendency for project appraisers to be overly optimistic", and in effect, results in an underestimation of scheme costs.

3.1.3 The Department requires that the base cost estimate (the derivation of which is described in section 2) should be adjusted to account for risk and optimism bias in order to obtain more accurate cost estimates. The Department recognises that economic appraisal should be based on risk adjusted benefits as well as costs. At present, the Department provides guidance only for cost risk adjustment. Risks associated with patronage or benefits could be dealt with by sensitivity or scenario testing around the central case. However forthcoming guidance on handling uncertainty in forecasting will provide more detailed guidance on handling risks to benefits.

3.1.4 The Department recommends the use of an uplift to reflect optimism bias in the cost estimate. This will follow the adjustment for risk.

3.2 Risk

3.2.1 The Department will expect scheme promoters to provide evidence that they have adopted a systematic approach to cost risk management. Risk management is a structured approach to identifying, assessing, and responding to risks that occur during a project. Its purpose is to support better decision making through improving understanding of the risks inherent in a proposal and their likely impact.

3.2.2 Cost risk management should commence at the initial stage of a project with the initial identification of risks and assessment of risks in terms of their

likelihood and associated cost outcomes. Following the initial identification and assessment of risks scheme promoters should consider how to respond to risks. The risk management process is then a continuous process by which the assumptions included in the risk assessment and decisions relating to responses to risk are kept under review.

Risk Assessment and Adjusting Base Costs

3.2.3 In order to adjust the base cost for the risks associated with the cost of the scheme, the Department **requires** a **Quantified Risk Assessment (QRA)** to be undertaken for transport projects with a cost greater than £5m and encourages a QRA to be carried out for smaller schemes.

3.2.4 The Department requires that promoters undertake a four-step process for all schemes when assessing risk. This process is described in more detail in section 3.3 below. The key features of this approach are:

(i) Risk Identification
(ii) Assessing the Impacts of Risk
(iii) Estimating the Likelihood of the Impacts of Risk
(iv) Deriving the overall distribution and expected value of Risk for the scheme

3.2.5 The identification and assessment of risks performed as part of the risk assessment are key components of the risk management process. The risk assessment can be seen as a snap shot of the risks facing a scheme at a particular stage of development. It should be kept under review throughout the development of a scheme to ensure that it reflects promoter's best judgement as to the risks to the costs of the scheme. In particular the risk assessment that is used to derive the risk adjusted cost estimate used in appraisal should reflect the best available evidence at the time it is submitted to the Department as part of a bid for funding.

3.2.6 The assessment of risk allows an expected value of the cost of the scheme to be calculated. The expected value is defined as the average of all possible outcomes, taking account of the different probabilities of those outcomes occurring. The expected value is equivalent to the "risk-adjusted cost estimate"

3.2.7 For smaller schemes, i.e. those with a capital cost less than £5m, there may be scope for using generalised risk allowances for each cost element to represent the expected costs. However, it is important that a risk assessment process is still undertaken to arrive at the overall range for the cost estimate and the expected cost allowing for risk. In all cases it is important that all

potential risks should be identified and the Department will wish to see the range of costs considered in the risk assessment.

3.2.8 The SRA formerly issued guidance suggesting that a "contingency" addition should be included as well as a risk adjustment. The Department no longer approves of the use of such an uplift to reflect any uncertainties. If a risk can be identified and is likely to be material to the cost of the scheme then it should be included in the Quantified Risk Assessment (QRA), even if the probability distribution or value of that risk is uncertain.

3.2.9 One category of risks that need not be considered as part of the risk assessment is those referred to as catastrophic risks. Catastrophic risks or catastrophe risk relate to events that will be so devastating that all returns from policies, programmes or projects are eliminated or at least radically and unpredictably altered. Examples include natural disasters or major wars. As explained in *The Green Book* (HM Treasury, 2003) catastrophe risk is one of the components making up the real discount rate. Therefore it is not necessary to identify such risks as part of the risk assessment.

3.2.10 The assessment of risk cannot be performed without some costs to the scheme promoter in terms of time and resources. As a general rule, any risk assessment should be commensurate to the size and the stage of development of the project. In addition, the amount of time and resources that are devoted to quantifying risks should relate to how many risks have to be analysed, how difficult that is to do and the materiality of these risks. Scheme promoters should call on professional advice in attempting to identify those risks that are likely to have the most significant impact on scheme costs. The level of detail required may need to be discussed with the Department. As a minimum the Department expects that within the risk assessment the robustness of cost estimates are analysed for the impact of delays and above anticipated cost increases. From past experience, these have been significant factors impacting on scheme costs.

3.2.11 Most risks will be common to conventional public sector procurement and the Private Finance Initiative (PFI). Provisional decisions on the acceptability of major schemes are often taken prior to detailed consideration of the possible procurement routes. The Department expects to see a full assessment of risk for all schemes, irrespective of which procurement route may eventually be chosen. Where there are major risks, promoters will have to demonstrate that such risks are understood and can be actively managed within the public sector or transferred at an appropriate cost to the private sector. The costs should reflect the procurement strategy for the project for example Design and Build (D&B), Design, Build, Finance and Manage (DBFM), Private Finance Initiative (PFI). If a firm strategy does not exist, then the costs should come with a statement on the procurement route assumed for the purposes of the appraisal.

3.2.12 The Office for Government Commerce (OGC) expects Gateway Reviews to be carried out on all government projects. These reviews will seek evidence that risks have been properly considered before the project can move on to the next stage.

Responding to Risk

3.2.13 In addition to performing a risk assessment to derive the expected value of the costs of the scheme, i.e. the risk-adjusted cost estimate the Department will also expect to see evidence that scheme promoters have taken a systematic approach to responding to risks. Broadly speaking responding to risks will involve some combination of the following:

(i) tolerating the risk
(ii) treating the risk
(iii) transferring the risk
(iv) terminating the activity giving rise to the risk

3.2.14 Generally there are two alternative reasons why risks should be tolerated, i.e. no action should be taken to reduce their likelihood or impact. The first is that the cost of taking any action exceeds the potential benefit gained. The second is that there may be no alternative courses of action available.

3.2.15 The purpose of treating risks is to affect either the impact or the likelihood of the risk, or both, whilst continuing with the activity giving rise to the risk. There are a variety of actions that can be taken to treat risks. *The Orange Book* (HM Treasury, 2004) defines four different types of control:

(i) Preventive Controls - designed to limit the likelihood of an adverse risk occurring;
(ii) Corrective Controls - designed to minimise the impact of adverse outcomes should they be realised;
(iii) Directive Controls - designed to ensure that a particular outcome is achieved;
(iv) Detective Controls - designed to identify adverse outcomes once realised in order to minimise their impact.

3.2.16 It is important that any actions that are taken to treat risks are proportional to the risks they are designed to control. Every action has an associated cost and it is important that the action offers value for money in relation to the risk that it is controlling.

3.2.17 Transferring risk can be seen as a form of treating risks. For example, insurance, the conventional approach to transferring risk, can be regarded as

a form of corrective control as it facilitates financial recovery against the realisation of a risk.

3.2.18 Ultimately some risks will only be treatable or containable to acceptable levels by terminating particular activities. This option is particularly important if it becomes clear that undertaking certain activities jeopardises the value for money of the scheme as a whole.

3.2.19 In line with guidance given in *The Green Book* (HM Treasury, 2003), promoters should prepare risk mitigation plans. These will provide the means for minimising the impact of risks. A possible set of options to include in a risk mitigation plan is shown in Table 3 below.

Table 3: Options that could be included in a risk mitigation plan

Active risk mitigation – • Identify risks in advance and plan to reduce or eliminate resulting adverse effects • Include process to monitor risks • Decision making supported by framework of risk analysis
Early consultation – Helps to identify relevant stakeholders and risk mitigation
Avoidance of irreversible decisions – Through understanding causes of delay, through further investigation and improved reliability of project plan
Pilot studies – Acquire more information on risk affecting projects with many unknowns
Design flexibility – Designs adaptable to future changes are less adversely affected by risk than design suited to only one outcome.
Precautionary principle – Precautionary action required to mitigate severe risks
Procurement/contractual – Risk contractually transferred to other parties
Make less use of leading edge technology – Complex untried technologies tends to have greater levels of uncertainty and risk
Reinstate or develop different options – Alternative options may be considered if current options are found to be more risky than initially thought
Abandon proposals – Proposal may be so risky that it is worth abandoning due to adverse risk

Source: SRA (2003) and HM Treasury (2003)

3.2.20 The key objective of responses to risk is ultimately to reduce the risk-adjusted costs of the scheme. It is important that the implications of decisions taken to respond to risks are factored into both the estimates of base costs and the risk assessment that are submitted to the Department.

3.3 Guidance on Performing a Quantified Risk Assessment

3.3.1 The four-step process that the Department requires promoters to undertake when assessing risks is described below.

Step 1: Risk Identification

3.3.2 Promoters should construct a comprehensive Risk Register listing any identified risks that are likely to affect the delivery and operation of the scheme and present this in the business case. A risk register should be updated and reviewed continuously throughout the risk management process, and will therefore list the results of the analysis and evaluation of the identified risks. Information on the status of the risk should also be included. Annex 4 of the *The Green Book* (HM Treasury, 2003) provides further information.

3.3.3 Table 4 highlights examples of the main general types of risk likely to be encountered in a project. Not all of these will be relevant in the context of estimating scheme costs.

Table 4: Examples of Project Risk

Policy Risk	**Legislative risk**	The risk that changes in legislation increase costs. This can be sub-divided into general risks such as changes in corporate tax rates and specific ones which may change the relative costs and benefits of different procurement routes.
	Policy risk	The risk of changes of policy direction not involving legislation.
Risk on delivering the asset	**Construction risk**	The risk that the construction of the physical assets is not completed on time, to budget and to specification. The risk of inflation differing from assumed inflation rates, particularly for any schemes where construction is not expected to start until some years in advance.

	Planning risk	The risk that the implementation of a project fails to adhere to the terms of planning permission, or that detailed planning cannot be obtained, or, if obtained, can only be implemented at costs greater than in the original budget.
	Residual value risk	The risk relating to the uncertainty of the value of physical assets at the end of the contract.
Risk on operating the asset	**Operational risk**	The risk that operating costs vary from budget, that performance standards slips or that the service cannot be provided.
	Inflation risk	The risk that actual inflation differs from assumed inflation rates.
	Maintenance risk	The risk that the costs of keeping the assets in good condition vary from budget.
Risks on demand and revenue	**Demand risk**	The risk that demands for the service does not match the levels planned, projected or assumed. As the demand for a service may be (partially) controllable by the government, the risk to the public sector may be less than that perceived by the private sector.
	Design risk	The risk that the design cannot deliver the services at the required performance or quality standards
	Availability risk	The risk that the quantum of the service provided is less than required under the contract.
	Volume risk	The risk that actual usage of the service varies from the level forecast.
	Technology risk	The risk that changes in technology result in services being provided using non optimal technology.

Source: Adapted from Technical Note no. 5, Treasury Task Force (1999).

3.3.4 The risk register should include construction risks, such as timescale and cost perspectives, and operational risks such as maintenance risk. The risk of impacts associated with climate change on transport infrastructure being greater or less than has been assumed in calculating base cost should also be considered. This could have important implications for the maintenance profile of costs for a scheme.

3.3.5 Section 2 has emphasised the need to use realistic assumptions about increases in costs above that of general economy-wide inflation when forming base cost estimates. Promoters should consider the impacts of different rates of cost increase from those assumed as part of the risk assessment. Evidence suggests that risks associated with delays in schemes, should also be assessed. In addition appropriate consideration ought to be given to the combined risk of both delays and cost rises that differ from those assumed in estimating the base costs.

3.3.6 The risks associated with changes in scheme design should also be identified and recorded in the risk register. However, the risk of having to make significant design changes, possibly relating to a significant change in scope - where scope is defined as the specified output/objectives of the scheme- should be mitigated prior to submitting the business case to the Department. If any unforeseen changes in scope then do occur, which significantly change costs, the project should be subject to a full reappraisal, including reconsideration of rejected alternatives. Any decisions to proceed will, of course, need to be reconsidered in the light of the results of the reappraisal.

3.3.7 The risk register also needs to identify who owns the identified risk. For example some risks may be transferable through insurance or financial instruments. In all cases the risk register should indicate where risks have been successfully transferred. Where it is thought that a risk has been transferred the promoter should ensure that it is fully transferred. If so the Department will require evidence of this. Moreover the Base cost should include any premiums paid as part of the transfer of the liability for the consequences of any risks.

3.3.8 To identify the main areas of risk and who owns them it can be useful to organise workshops or 'brain-storming' sessions. These should involve experienced people like managers of the project, financial and economic advisers, design, operators and maintainers of the existing infrastructure where there is some, engineering and insurance professionals, professional negotiators, actuaries, and lawyers.

3.3.9 It may also be useful to engage specialist consultants who have relevant expertise in facilitating a risk identification exercise. However the engagement of consultants does not eliminate the need for substantial involvement of the project management team to ensure a searching

examination of project-specific risks. The value of the input by specialist consultants will be directly proportional to the quality of the briefings they receive from client team members who fully understand the project specific risks.

Step 2: Assessing the Impacts of Risk to Determine Possible Outcomes

3.3.10 Having identified risks in step 1, the next step involves assessing the impact of each risk, or combination of risks, should they be realised. This assessment will be in terms of the cost outcomes of the risk. This may be possible through modelled sensitivity analysis or observed outcomes from similar schemes.

3.3.11 The range of outcomes should consider both the upper and lower extremes of the possible range, taking into account any reasonable constraints.

3.3.12 The best methods for quantifying the impact of risk will depend upon the information sources available. As a general rule the best approach should be to use empirical evidence whenever it is available. When it is not, common-sense approximations should be used, rather than aiming for unrealistic or spurious levels of accuracy. What this means in practice, depends on the nature of the risk. The objective is always to obtain an unbiased estimate of the impacts of the risk on the costs of the scheme.

3.3.13 When assessing the consequences of any risk, the analysis should not be restricted to only the direct effects. It is important to extend the analysis as widely as possible to ensure all knock-on effects are included. This requires care, as there could be interaction between different risk events. Some risks will affect the costs of either the construction or operation of the project. For example if a purchase of required land is not available on time, the possible knock-on effects could include:

- Costs associated with looking at alternative sites;
- Lost management time as a result of litigation/seeking Compulsory Purchase Orders;
- Inability to meet contractual commitments
- Increased input costs resulting from cost increases during scheme delay.

Step 3: Estimating the Likelihood of the Outcomes Occurring

3.3.14 Having identified a broad range of risks and having used a systematic approach to assess the potential range of cost outcomes, it is necessary to assess the likelihood of occurrence for each of the possible outcomes.

3.3.15 It is important in assessing the likelihood of an outcome occurring that predictions should be based on experience of past events, taking account of any foreseeable changes or developments, rather than arbitrary estimates. Consultants may have compiled databases of past schemes including details of the reasons for any cost changes. Where available these could be useful in reaching conclusions as to the likely occurrence of different risks.

3.3.16 Estimating probabilities is not an exact science and inevitably assumptions have to be made. There is nothing wrong with this, but it is important that the assumptions in the assessment are reasonable and fully documented, as they are open to question when submitted to the Department.

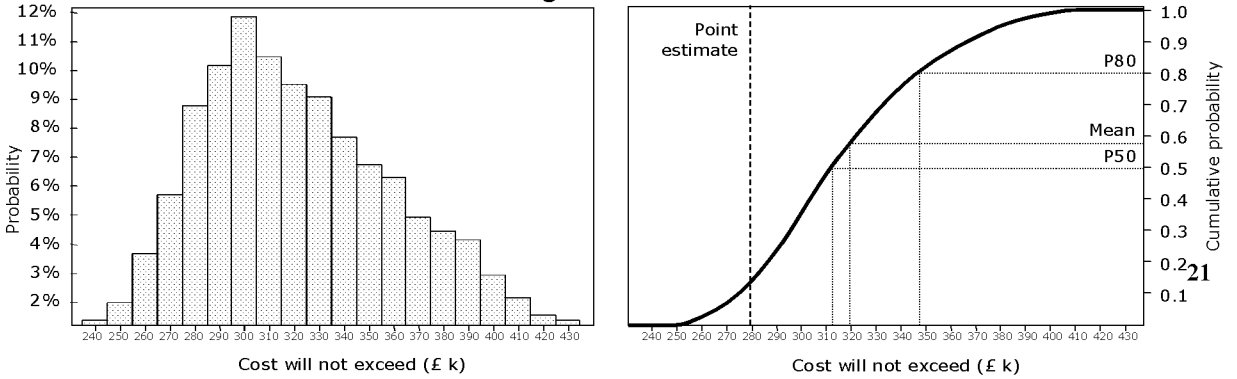
Step 4: Deriving the Probability Distribution for the Costs of the Scheme

3.3.17 A QRA allows a probability distribution around the costs of the scheme to be derived and enables the expected risk-adjusted cost estimate to be obtained. This expected outcome, also known as the *'mean'* or *'unbiased'* outcome is the weighted average of all potential outcomes and associated probabilities. This is the (risk-adjusted) mean estimate of the cost of the scheme, and it is to this that optimism bias will be applied. Operating costs and capital costs should all be based on expected values of the cost of the scheme.

3.3.18 Many risks are linked or correlated, i.e. if one risk occurs another risk is likely to occur. Modelling these relationships is easier with appropriate software, e.g. using Monte Carlo simulation to establish the range of costs. Cost risk relating to time delays is often significant and Monte Carlo simulation can also take account of this.

3.3.19 Several methods can be employed to derive the probability that the total project cost (the sum of all the activities considered in the QRA) will not exceed a particular value. The graph on the left in Figure 5 shows the standard probability distribution. This can provide useful information to derive the cumulative probability distribution or S curve (shown to the right). This gives the probability of the scheme cost estimate being less than or equal to any specified value.

Figure 5



Source: SRA (2003)

3.3.20 The cumulative probability distribution shows different cost adjusted risk estimates in correspondence to different levels of certainty about the occurrence of cost overrun. For instance, in the example illustrated in Figure 5, the P50 is the budget estimate associated with 50% probability that the project will be delivered within budget. In this example, the P50 estimate is equal to £312k. In a similar way, the P80 estimate represents an 80% likelihood that the project will be delivered within a budget of £348k. The expected value is the mean transport cost estimate, and the value to be used when forming the appraisal cost estimate, is £320k. This suggests that the expected transport scheme estimate lies between the P50 and P80 estimate which is the weighted average of the distribution of costs. It is possible to infer the probability that the scheme is delivered to the base cost. In the case represented above, the base cost point estimate is equal to £280k. The cumulative probability distribution shows that there is only a 12% probability that the scheme stays within the budget of £280k.

3.3.21 For smaller schemes, i.e. those costing less than £5m quantifying the impact of scheme risks can be made easier by banding the risks into a smaller number of categories according to their impact. For example, negligible, slight, severe, catastrophic etc. The amount of time and resources that are devoted to quantifying risks should relate to their likely materiality. It may be acceptable to assess the probability of any one outcome occurring using a simple four-point scale, expanded to more levels if appropriate. This scale would use, at a minimum, very unlikely, moderately unlikely, likely or most likely, where the most likely outcome would normally be the central forecast value. This method (along with the assessment of impacts) can be used to inform 'expected' risk allowances to apply on smaller schemes. However, the exact requirements need to be discussed with the Department on a case-by-case basis.

3.4 Further Information on Managing and Assessing Risk

3.4.1 Further detailed guidance on performing a risk assessment are detailed in *How to Construct a Public Sector Comparator* (Treasury Taskforce, 1999) Technical Note 5. Annex 4 of *The* Green *Book* (HM Treasury, 2003) and the *Quantitative Assessment User Guide* (HM Treasury, 2004) also provide further guidance on quantifying and clarifying risks. *The Orange Book* (HM Treasury, 2004) provides broader guidance on the principles of risk

management that are valid and applicable across all modes. Part 4 of the Highways Agency's *Value for Money Manual*, provides guidance on basic techniques of risk analysis for highway schemes. More specific information on risk analysis in Railways can be found in the WebTAG rail unit.

3.5 Optimism Bias

3.5.1 Optimism Bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters.

3.5.2 Transport projects are inherently risky and subject to uncertainties due to the long planning horizon and complex interfaces. Often the project scope or ambition level will change during project development and implementation due to uncertainty at the earlier project stages. Hence, a certain degree of budget uncertainty exists which will typically be reduced through the project cycle.

3.5.3 Theories on cost overrun suggest that optimism bias could be caused by a combination of how the decision-making process is organised *and* strategic behaviour of stakeholders involved in the planning and decision-making processes. Table 5 provides a brief summary of the two most recent studies on optimism bias. Recent experience of road and public transport schemes has shown that optimism bias is still prevalent in planning and appraisals.

Table 5: Summary of Recent Studies on Optimism Bias

	Major Determinants of Optimism Bias	**Main Features of the study**
Mott MacDonald (2002)	Unforeseen cost overrun due to errors or omissions	Relatively small sample not specifically related to transport infrastructure (50 major public sector projects over £40m). The sample period is quite up to date (1982 -2002).
Flyvbjerg et al. (2002, 2004)	Intentional underestimation of costs due to different motivational factors.	Large sample (total of 258 projects located in 20 countries across 5 continents of which 70% located in Europe) and specifically related to transport infrastructure projects. No information on projects from 1998.

3.5.4 To address the tendency for appraisers to be overly optimistic about key parameters *The Green Book* (HM Treasury, 2003) suggests that appraisers should make explicit, empirically based adjustments to the estimates of a

project's costs, benefits, and duration. The guidance in this section focuses upon making adjustments to costs. Patronage and benefit optimism bias should be examined using sensitivity tests (refer to MSA: Cost Benefit Analysis (TAG Unit 3.9.2) for further information on sensitivity testing and the forthcoming guidance on *Uncertainty in Forecasting* as to how to handle risks to benefits).

3.5.5 The guidance in this section follows the more generic guidance on optimism bias contained in *The Green Book* (HM Treasury, 2003) and in the *Supplementary Green Book Guidance* on Optimism Bias (HM Treasury, 2003). It draws on the available evidence on optimism bias contained in the *Review of Large Procurement in the UK* (Mott MacDonald, 2002) and in the more recently published *Procedures for Dealing with Optimism Bias in Transport Planning* (Bent Flyvbjerg, 2004).

3.6 Relationship between Risk Assessment and Optimism Bias

3.6.1 As a project develops, the Department expects the scheme cost estimate to be refined over time. As it becomes possible to better quantify and value risks, it should be possible to better capture the factors that contribute to appraisal optimism within the risk management process. Therefore, as risk analysis improves as a scheme develops, it is expected that *on average* the risk-adjusted scheme cost estimate will increase while the applicable level of optimism bias will decrease.

3.6.2 It follows that in general, the Department expects that the allowances for optimism bias should be largest at the initial stage of the life of a transport project (e.g. Strategic Outline Business Case). This allowance is expected to be smaller in a more detailed business case (e.g. Outline Business Case) and smaller in the presence of a fully detailed business case (e.g. Full Business Case).

3.6.3 As a scheme progresses, there are techniques for reducing optimism bias uplifts through greater certainty over costs and use of risk mitigation measures, and independent reviews of risk and optimism bias. The promoter will be expected to provide reasoning and justification for any reductions in optimism bias adjustment, from the recommended optimism bias uplifts.

3.7 Guidance on Adjusting (Risk-Adjusted) Investment Costs for Optimism Bias

3.7.1 Adjustments should be empirically based (e.g. using data from past projections or similar projects elsewhere) and adjusted for the unique characteristics of the project in hand. This guidance provides uplifts only for investment costs. The Department's uplifts refer to cost overruns calculated in constant prices and should be applied to investment costs including the allowance for the expected value of risk. They are derived from the evidence provided by *Procedures for Dealing with Optimism Bias in Transport Planning* (Bent Flyvbjerg, 2004) and *Review of Large Procurement in the UK* (Mott MacDonald, 2002).

3.7.2 There is ongoing work by the Department on measures to reduce optimism bias. The Department is in the process of setting up a database to record costs throughout different stages of a project's life. The database will enable better monitoring of costs and provide an empirical evidence base upon which to base future optimism bias uplifts.

3.7.3 There is currently insufficient evidence available for the Department to recommend any specific optimism bias uplifts for operating costs. Despite the lack of strong evidence, the Department expects scheme promoters to consider the sensitivity of their scheme's business case to changes in operating costs from those that have been forecast. Scheme promoters will be expected to justify the level of optimism bias applied to operating costs, and similarly justify a decision not to apply any uplift to operating costs.

3.7.4 The Department requires a 4 step approach to the adjustment for investment costs optimism bias:

- Step 1: Determine the nature of the project
- Step 2: Identify the stage of scheme development
- Step 3: Apply the recommended uplift factors to the risk adjusted transport cost estimate
- Step 4: Provide sensitivity analysis around the central estimate

Step 1: Determine the Nature of the Project

3.7.5 The first step involves categorising the nature of the project according to the typology given in Table 7. *Procedures for Dealing with Optimism Bias in Transport Planning* (Bent Flyvbjerg, 2004) concluded that within each of the categories identified in Table 7, the risk of investment cost overruns can be treated as statistically similar.

Table 7: Project Categories

Category	Types of projects
Roads	Motorway Trunk roads Local roads Bicycle facilities Pedestrian facilities Park and ride Bus lane schemes Guided buses on wheels
Rail	Metro Light rail Guided buses on tracks Conventional rail High speed rail

Fixed links	Bridges and Tunnels
Building projects	Stations and Terminal buildings
IT projects	IT system development

Source: Flyvbjerg (2004)

Step 2: Identify the Stage of Scheme Development

3.7.6 The Department has identified three main stages in the life of a transport project for which default uplift values have been provided, as illustrated in Table 8. Although Table 8 identifies specific stages in the development of different types of scheme, the stages should only be seen as being indicative of the quality of risk assessment and cost estimate typical of schemes at the different stages of scheme development.

Table 8: Stage of scheme development according to scheme category

Category	Stage 1	Stage 2	Stage 3
Local Authority and Public Transport Schemes	Programme Entry	Conditional Approval	Full Approval
Highways Agency Schemes	TPI entry/ Preferred Route Decision	Order Publication/Works Commitment	Works Commitment
Railways	Grip Stage 1: Pre-feasibility	Grip Stage 3: Option selection	Grip Stage 5: Design development

Step 3: Apply the Recommended Uplift Factors to the Risk Adjusted Costs

3.7.7 Obtain the recommended uplift (appropriate to the stage of development) as given in Table 9 and apply to the risk-adjusted scheme cost estimate.

3.7.8 The Department will expect promoters to apply uplifts at other stages of scheme development as well as those identified. At present we do not have any evidence to suggest suitable uplifts for other stages of scheme

development however the appropriate uplift should generally be higher when the project stage falls before an identified stage in Table 8, whereas when the project stage falls after a specified stage in Table 8 the appropriate uplift should generally be lower. Therefore appraisers are expected to use suitable judgement in deciding applicable uplifts. The promoter's judgement must be supported by clear evidence presented in the business case, as ultimately the Department will decide upon the optimism bias uplift to apply for the purposes of making funding decisions, in consultation with the promoter.

Table 9: Recommended optimism bias uplifts for different projects at different stages of the life of a transport project

Category	Types of projects	Stage 1	Stage 2	Stage 3
Roads	Motorway Trunk roads Local roads Bicycle facilities Pedestrian facilities Park and ride Bus lane schemes Guided buses on wheels	44%*	15%	3%*
Rail	Metro Light rail Guided buses on tracks Conventional rail High speed rail	66%*	40%	6%*
Fixed links	Bridges and Tunnels	66%*	23%	6%*
Building projects	Stations and Terminal buildings	51%*	-	4%*
IT projects	IT system development	200%*	-	10%*

Sources: Flyvbjerg (2004) and Mott MacDonald (2002)*

Note: The DfT is currently undertaking further research into optimism bias in rail schemes. Table 9 will be revised in light of the results of that research. Anyone undertaking a rail appraisal should refer to the forthcoming Guidance on Rail Appraisal (3.13.1).

3.7.9 If the Department is provided with sufficient evidence, it is possible to use uplifts other than those recommended. Uplifts that deviate from the recommended uplifts will reflect both the stage of development of the option, the quality of the risk assessment provided, and the extent to which optimism bias may or may not have been mitigated. The Department does not expect to see uplifts used that are below those given for the next stage of scheme development in Table 9.

3.7.10 The promoter should follow the process outlined above showing clearly why they have reduced optimism bias uplifts. In cases where departmental bodies or agencies have released specific guidance for particular types of transport schemes (e.g. local transport, railways and HA schemes), promoters are invited to refer to these more detailed documents.

3.7.11 Where a project includes significant elements of the different project types identified above, it might be considered a combined project, with the differing elements representing sub-projects. The relative size of each sub-project should be determined and the appropriate uplifts should be identified and applied to that part of the project. After this has been done, the adjusted costs for each sub-project should be aggregated to establish the total cost for the overall project.

Step 4: Perform Sensitivity Analysis

3.7.12 The fourth step requires sensitivity analysis around the uplift used. In addition to the core level of optimism bias determined using the procedures outlined above, it is important to examine the impact of a range of other possible levels of optimism bias on the cost estimates reported in the TEE and PA tables. The Department will expect to see sensitivity analysis performed at every stage of the life of the project.

4 The Preparation of Scheme Costs for Inclusion in the Appraisal Documentation

4.1 Introduction

4.1.1 This part of the guidance focuses on how we expect to see cost estimates recorded, and on the preparation of scheme costs for inclusion in the final appraisal documentation that is, the Transport Economic Efficiency (TEE) and Public Accounts (PA) tables. The preparation of cost data is then illustrated through a worked example for a hypothetical scheme.

4.1.2 The Department strongly recommends that promoters use TUBA or COBA appraisal software. Once investment and operating base cost estimates have been formed, and adjusted for risk and optimism bias, these programs

automatically carry out further adjustments required in deriving the "appraisal" cost estimations for input in the TEE and PA tables.

4.2 Preparing Scheme Costs for Inclusion in the TEE and PA tables

4.2.1 Investment and operating costs appear in the TEE and PA tables. All investment costs which are associated with the option and which are additional to the without scheme case should be included. All costs other than investment costs should be recorded in the 'Operating Costs' rows in the TEE and PA tables. Any funds which have been spent or committed prior to scheme appraisal and which can not be retrieved are "sunk costs" and should not be included in the appraisal.

4.2.2 Once base cost estimates have been adjusted for risk and optimism bias, several adjustments are required in order to obtain the appraisal cost estimates to be included in the TEE and PA tables. Whether these adjustments are carried out manually, or automatically within TUBA and COBA programs, the adjustments include: converting into the Department's standard base year, i.e. 2002 prices; discounting using standard Treasury discount rates; and converting to market prices, as outlined in the methodology below, and in the worked example at the end of this section. The Department's standard base year and discount rates are also given in *Cost Benefit Analysis* (TAG Unit 3.5.4).

4.2.3 Firstly, the risk and optimism bias-adjusted cost estimate -which will have been derived for a chosen price base- should be converted (deflated) into the Department's standard base year (2002) prices, and presented in £m.

$$Cost\ Estimate\ in\ 2002\ prices =$$

$$Risk\ and\ optimism\ bias-adjusted\ Cost\ Estimate\ in\ given\ price\ base \times \left[\frac{RPI_{2002}}{RPI_{given\ price\ base}}\right]$$

4.2.4 Secondly, the (risk and optimism bias-adjusted) cost estimate in 2002 prices should be discounted to the Department's standard base year using the Department's standard discount rates. The discount rate is 3.5% (applicable from 2002) for the first 30 years from the current year the appraisal is taking place in, i.e. years 0-30, and 3% for each year thereafter, i.e. years 31-60.

E.g. for a cost estimate in a given year,

Where m= 0 up to 30 years after the current year the appraisal is taking place in and $m = year - (current\ year + 30)$ thereafter, and $n = year - 2002 - m$:

$$Dicounted\ Cost\ Estimate\ in\ 2002\ prices = \frac{Cost\ Estimate\ in\ 2002\ prices / 1.035^{n}}{1.03^{m}}$$

4.2.5 Finally, all costs incurred by public and private sector providers are perceived in the factor cost unit of account, and so must be converted into the **market price** unit of account by multiplying by the indirect taxation correction factor; t = 1.209. This is required to ensure comparability with scored scheme benefits. The Department's standard base year and discount rates are given in *Cost Benefit Analysis* (TAG Unit 3.5.4).

$$Cost\ Estimate\ in\ 2002\ market\ prices = Discounted\ Cost\ Estimate\ in\ 2002\ prices \times 1.209$$

4.2.6 Where the Affordability and Financial Sustainability (AFS) Table has been completed, the financial Investment Costs should be used to calculate the Investment Cost entries in the PA and TEE tables. The calculations required to translate the financial costs in the AFS table into the Net Present Values required for the PA and TEE tables are outlined in *Completing the Affordability and Financial Sustainability Tables* (TAG Unit 3.8.1).

4.3 Inclusion of the Scheme Costs Estimate in the TEE and PA tables

4.3.1 Investment costs and operating costs incurred by a private sector provider should always be recorded as negative amounts in the appropriate rows of the Transport Economic Efficiency table whilst investment costs and operating costs incurred by a public sector provider should always be recorded as positive amounts in the appropriate rows of the Public Accounts table. In the case of 'land gift' (under land and property costs), if the land belongs to a private sector body these costs should be recorded as a negative in the contribution rows of both the TEE and PA tables. Alternatively if the land belongs to a Local Authority the land gift should be included only as a cost to the Local Authority. Hypothecated developer contributions should always be included as negative amounts in both the Developer Contribution row in the TEE table and in the Developer and Other contributions row in the PA table

4.3.2 The following paragraphs give guidance for each modal grouping of providers on how costs should be separated into the investment and operating cost categories and how they should be recorded in the TEE and PA tables.

- **Buses**. The costs of operating buses in service are borne by the private sector operator. Costs of new investment in bus services falling to the operator might comprise upgrading the vehicle fleet, new systems of ticketing and passenger information. These costs should therefore appear in the TEE table.

- Buses also form part of the general traffic flow, and thereby impose operating costs on the highway authority in the same way as private vehicles. They may also impose costs which other vehicles do not, such as enforcement of bus lanes and maintenance of stops (if these are the responsibility of the highway authority). Changes in these costs should be included in the calculation of public sector provider impacts in the PA table.

- Costs of new investment in the bus network might comprise new stops and shelters, bus priority measures on the highway, and passenger information. Some of these costs would fall to the highway authority and some to the PTE in metropolitan areas. All should be included in the calculation of public sector provider impacts in the PA table.

- **Rail**. Studies should attempt to distinguish between rail investment and operating costs. All capital investment in heavy rail is considered as an investment cost, whether it is concerned with rolling stock, track, power and signalling, or passenger facilities. Operating costs should include train and station operating costs such as payroll, fuel and traction. These costs should also include both light and heavy maintenance of rolling stock and network infrastructure, such as track, power supply and signalling. These costs fall to the private sector Train Operating Companies and Network Rail and should therefore appear in the TEE table.

- **Road**. New or improved roads and car parks are normally provided by public sector bodies (although private companies may also be involved) and their costs of provision form part of public sector providers' investment costs recorded in the PA table. These costs should include due allowances for land and property purchase, construction, and design, preparation and supervision costs.

- Where new road capacity is to be provided, provision must be made for the non traffic related maintenance costs of the additional infrastructure. Costs per km per year are given in Table 9/1 of the *COBA User Manual,* (DfT, 2006). Where tolls or congestion charges are considered, there may be significant ongoing or recurrent operating and other costs. Where options (including tolling and congestion charging) include significant changes in the level of enforcement, these should be taken into account. All these costs should be included in estimates of public sector providers' operating costs in the PA table.
- **Parking**. Costs incurred by the parking authority comprise ongoing operation and maintenance of car parks, and enforcement. These may be excluded from the appraisal if changes are likely to be insignificant.

4.3.3 It is important that all costs are correctly allocated. For example, private sector costs should be allocated to the private sector even if some or all of these costs are met with a grant from the public sector. Where a grant is paid by the public sector to the private sector, a positive amount should be recorded in the PA table, with a corresponding positive impact for the private sector provider in the TEE table. This includes counting European Restructuring and Development Funds (ERDF) or equivalent grants. It is important to be aware of such transfers and this can also provide a clearer

picture of operating revenues and costs. Further advice on the allocation of particular costs and benefits between the public and private sectors is given in *The Public Accounts Sub-Objective* (TAG Unit 3.5.1), *The Transport Economic Efficiency Sub- Objective* (TAG Unit 3.5.2) and *Completing the Affordability and Financial Sustainability (AFS) Tables* (TAG Unit 3.8.1).

4.4 Reporting Requirements

4.4.1 The Department requires scheme promoters to detail the key steps in the calculation of the costs reported in the TEE and PA tables. When recording the process in forming cost estimates the Department recommends following the presentational layout of the cost proforma. Following this layout promoters are expected to record the cost estimates for each year they are expected to be incurred.

Link to Cost Proforma

4.4.2 Where COBA and TUBA programs are not used, the columns that fall after the risk and optimism bias adjusted estimates in the appraisal costs breakdown sheet, represent the adjustments (re-basing, discounting and conversion to market prices) required in obtaining the appraisal cost estimate for each year. The steps involved in making these adjustments manually can be found in the following section.

4.4.3 Where the COBA program is to be used, modellers have the option of having these adjustments performed automatically within the program. Where the TUBA program is to be used, all of these adjustments will be made automatically within the program. Hence where TUBA and COBA programs are to be used, the column displaying the risk and optimism bias adjusted cost estimates for each year can be taken as a basis for what is required for input into the COBA and TUBA programs. Further information on preparing cost inputs for COBA and TUBA can be found in the *TUBA User Manual* (Mott MacDonald, 2006) and the *COBA User Manual,* (DfT, 2006).

5 Preparing Scheme Costs for Inclusion in the TEE and PA tables - A Worked Example

5.1 Overview

5.1.1 As described in Sections 2 and 3 of this guidance, the steps in deriving transport scheme costs involve:

- calculating base costs; and
- deriving the risk-adjusted cost estimate and adjusting for optimism bias.

5.1.2 In addition, as illustrated in section 4, the transport scheme costs should be:

- converted into the Department's standard base year prices;
- discounted using standard discount rates; and finally
- converted into market prices.

5.1.3 The example that follows illustrates the outlined methodology in deriving the appraisal scheme cost estimate.

5.2 Derivation of the Base Costs

5.2.1 Table 10 provides an example of the components of the initial estimate of investment costs for a hypothetical road scheme **in 2004 prices**. The opening year of this hypothetical scheme is 2011, and the current year of appraisal is 2006. For simplicity, it is assumed that no investment costs are incurred after the opening year, i.e. there are no traffic related maintenance costs.

Table 10: Components of Investment Costs (All in £m)

Calendar Year	*Construction Costs*	*Land Costs*	*Other Costs*	*Total*
2008	***7.9***	***5***	***1.5***	***14.4***
2009	***6.7***	***0***	***2.5***	***9.2***

5.2.2 The first step in cost estimation is the determination of base costs. This should be done in accordance with Section 2 for a given price base, distinguishing between investment costs and operating costs components.

5.2.3 As explained in section 2 it is necessary to consider whether any of the components of base cost need to include an adjustment for cost increases being above that of general inflation across the economy. In this worked example, it is assumed that only construction costs are expected to increase faster than the general rate of inflation. In practice, promoters should consider current and forecast inflation from industry sources appropriate for their scheme in deciding which components of investment and operating costs need to be adjusted.

5.2.4 In estimating the base construction cost estimate for the 2004 price base, it has been forecast that construction cost increases remain constant at 6% for 4 years between 2004 and 2008 and then increase by 7% in 2009. Therefore,

For 2008: From Table 10, the initial construction cost estimate in 2004 is £7.9m
Forecast annual construction cost increase between 2004 and 2008 is 6%
General inflation is 2.5%
Then the real adjustment factor = $(1.06/1.025)^4$
Hence base construction cost estimate = £7.9m x $(1.06/1.025)^4$ = £9m
Contribution due to real cost increases is (£9m - £7.9m) = £1.1m

For 2009: From Table 10, the initial construction cost estimate in 2004 is £6.7m
Forecast annual construction cost increase between 2004 and 2008 is 6%
Forecast annual construction cost increase between 2008 and 2009 is 7%
General inflation is 2.5%
Then the real adjustment factor = $(1.06/1.025)^4$ x $(1.07/1.025)^1$
So base construction cost estimate = £6.7m x $(1.06/1.025)^4$ x (1.07/1.025)= £8m
Contribution due to real cost increases is (£8m - £6.7m) = £1.3m

5.2.5 Table 11 illustrates the estimation of the base cost scheme profile for this example, including both investment and operating costs. Operating costs are essentially due to **non-traffic** related maintenance costs and are realised with a frequency of approximately 10 years starting from 2020. It has been assumed for simplicity that no adjustments were required to operating costs for increases in costs above the general rate across the economy.

Table 11: Base Cost Scheme Profile (all in £m)

Calendar Year	Cost excluding real cost increases and risk		Contribution due to real cost increases		Cost inc. real cost increases (Base Cost)	
	Investment	*Operating*	*from Investment*	*from Operating*	*Investment*	*Operating*
2008	14.4	0	1.1		**15.5**	
2009	9.2	0	1.3		**10.5**	
2020	0	2		0		**2**
2030	0	2		0		**2**
2040	0	5		0		**5**
2050	0	2		0		**2**
2060	0	2		0		**2**
2070	0	5		0		**5**
TOTAL					**26**	**18**

5.2.6 The base cost estimate is the sum of the base investment and operating costs in 2004 prices and, in this example, it is **£44m**. It is important to note that the base cost estimate is for appraisal purposes only and it is not to be used for bidding purposes.

5.3 Adjusting the Base Costs for Risk and Optimism Bias

5.3.1 As shown in Section 3 of this document, both the investment and operating components of base cost should be adjusted to take account of risk, whilst generally only the investment cost component need necessarily be adjusted for optimism bias.

5.3.2 The risk-adjusted cost estimates for both investment cost and operating cost is derived from the Quantified Risk Assessment (QRA). Table 12 shows how to derive the risk-adjusted base costs using the same road scheme example highlighted previously. The second and third columns represent the base costs estimated for each year as calculated in Table 11. The fourth and fifth column then represent the quantified risk contribution for investment and operating costs derived from the QRA. In this example, the risk adjusted cost estimate is equal to £45.71m - the sum of the total risk adjusted investment and operating costs.

Table 12: Risk-Adjusted Base Cost (£m)

Calendar Year	Cost inc. real cost increases (Base Cost)		Quantified risk contribution QRA P(mean)		Risk adjusted cost using QRA P(mean)	
	Investment	*Operating*	*Investment*	*Operating*	*Investment*	*Operating*
2008	15.5		0.75		**16.25**	
2009	10.5		0.5		**11**	
2020		2		0.05		**2.05**
2030		2		0.07		**2.07**
2040		5		0.09		**5.09**
2050		2		0.07		**2.07**
2060		2		0.1		**2.1**
2070		5		0.08		**5.08**
TOTAL	26	18			**27.25**	**18.46**

5.3.3 In order to account for optimism bias, uplifts should be applied to the risk-adjusted base cost estimate. In this example, only the investment cost associated with the scheme will be uplifted. Table 13 summarises the application of the four-step approach to adjusting for Optimism Bias recommended by the Department to the hypothetical road scheme being considered in this worked example.

Table 13: Summary of the recommended methodology for optimism bias adjustment

Steps	Description	Example
Step 1	Determine the nature of the project	Local Authority road scheme
Step 2	Identify the stage of development of the scheme	Stage 2 - Conditional Approval
Step 3	Apply the recommended up lift factors	Apply 15% uplift to investment costs
Step 4	Provide sensitivity analysis around the central estimate	O% -15% - 44%

5.3.4 Table 14 shows how a risk-adjusted base cost estimate should be further adjusted to account for optimism bias on capital costs. Following the road scheme example, the second and third columns show the risk-adjusted base costs as derived in Table 12. Optimism bias is accounted for with the application of a 15% uplift (in this case) on the risk-adjusted investment cost only. The final two columns in Table 14 show the risk and optimism bias-adjusted cost estimates. It is worth noting that these values should be used as the basis for the costs input into TUBA and COBA.

Table 14: Adjustment for Optimism Bias

Calendar Year	Risk adjusted cost using QRA P(mean)		Total contribution of optimism bias to costs for the year		Risk and Optimism Bias adjusted cost	
	Investment	*Operating*	*from investment*	*from operating*	*Investment*	*Operating*
2008	16.25	0	2.44	N/A	**18.69**	
2009	11	0	1.65	N/A	**12.65**	
2020	0	2.05	0	N/A		**2.05**
2030	0	2.07	0	N/A		**2.07**
2040	0	5.09	0	N/A		**5.09**
2050	0	2.07	0	N/A		**2.07**
2060	0	2.1	0	N/A		**2.1**
2070	0	5.08	0	N/A		**5.08**
TOTAL	27.25	18.46	4.09	0	**31.34**	**18.46**

5.3.5 Table 15 shows the sensitivity analysis performed around the central case as required in the guidance. Note that in this instance optimism bias uplifts are only applied to investment costs, therefore the analysis is provided around total investment costs, which in the current example are the total costs in 2008-2009. The Department will expect promoters to illustrate the implications of performing the sensitivity analysis around the optimism bias uplift factor in terms of the cost estimates input into the TEE/PA tables.

Table 15: Adjustment for Optimism Bias and Sensitivity Analysis

	2008	2009	Total Costs 2008-2009		
Risk-adjusted Investment Costs part of Base Cost (2004 prices)	16.25	11	**27.25**		
Adjustment for OB (i.e. 15% of the risk adjusted investment cost)	2.44	1.65	**4.09**		
Sensitivity Analysis			Lower Bound (OB=0)	Central Case (OB=15%)	Upper Bound (OB=30%)
Adjustment for OB			0	4.09	8.17
Risk and Optimism Bias-adjusted Investment Cost Estimate (2004 prices)			27.25	**31.34**	35.42
Risk- adjusted Operating Cost part of Base Cost (2004 prices)	N/A				
			Total costs 2008-2068		
Risk- adjusted Operating Cost part of Base Cost (2004 prices)			**18.46**		
Risk and Optimism Bias-adjusted Cost Estimate in 2004 prices.			45.71	**49.8**	53.88

5.4 Preparation of Scheme Costs for Inclusion in PA and TEE tables

5.4.1 In order to obtain the cost estimates to be included in the PA and TEE tables, the Risk and Optimism Bias-adjusted cost estimates derived above need to undergo several adjustments, following the steps outlined in Section 4.

5.4.2 The Department strongly recommends that promoters use TUBA or COBA appraisal software for these calculations as the programs carry out the adjustments (rebasing, discounting and converting into market prices) applied to different cost element components automatically. For example TUBA only requires that the price base in which cost estimates have been formed is defined, along with the assumed Retail Price Index (RPI), and the proportions of different elements of base cost expected to be incurred in each year. Please see the COBA User Manual (DfT, 2006) and TUBA User Manual (Mott MacDonald, 2006) for further details.

5.4.3 For schemes where neither TUBA nor COBA is used, appraisal cost estimates will need to be calculated following the steps below (and illustrated in Table 16) using a spreadsheet or other means.

a) Convert to standard base year prices:

As an illustration, the deflator in this example is equal to RPI_{2002} / RPI_{2004} = 176.2/186.7 = **0.944**. Therefore,

$$2009\ \textit{Risk and OB adjusted Cost Estimate in}\ 2002\ \textit{prices} = 12.65 \times 0.944 = 11.94$$

$$2050\ \textit{Risk and OB adjusted Cost Estimate in}\ 2002\ \textit{prices} = 2.07 \times 0.944 = 1.95$$

***b) Discount using standard discount rates**:*

As an illustration, in our current example, for 2009, m=0 and n=7 (where m and n have been defined in 4.2.4),

$$\textit{Dicounted Cost Estimate in}\ 2002\ \textit{prices} = \frac{11.94/1.035^{7}}{1.03^{0}} = 9.38$$

For 2050, m=14 and n=34, hence.

$$\textit{Dicounted Cost Estimate in}\ 2002\ \textit{prices} = \frac{1.95/1.035^{34}}{1.03^{14}} = 0.40$$

c) Convert into market prices:

Now converting the discounted investment costs for 2009 into the market price unit of account by multiplying by the indirect taxation correction factor; t = 1.209:

$$2009\ \textit{Discounted Cost Estimate in}\ 2002\ \textit{market prices} = 9.38 \times 1.209 = 11.34$$

5.4.4 These adjustments need to be applied to each year in which costs are incurred and for operating and investment costs separately. Table 16 presents the results of applying these adjustments in the context of the hypothetical road scheme used in this example. The totals in the final column of Table 16 represent the investment and operating cost estimates that are input into the TEE or PA tables. In this example, the investment costs estimate that should be used is £28.69m, whilst the estimate of operating costs is equal to £5.24m.

Table 16: Transport Scheme Cost Estimate to be included in the TEE/PA Table

Calendar Year	Risk and optimism bias adjusted cost		Risk and optimism bias adjusted cost in 2002 prices		Discounted Risk and optimism bias adjusted cost in 2002 prices		Discounted Risk and optimism bias adjusted cost in 2002 market prices	
	Investment	*Operating*	*Investment*	*Operating*	*Investment*	*Operating*	*Investment*	*Operating*
2008	18.69		17.64		14.35		17.35	
2009	12.65		**11.94**		**9.38**		**11.34**	
2020		2.05		1.93		1.04		1.26
2030		2.07		1.95		0.75		0.90
2040		5.09		4.8		1.30		1.57
2050		2.07		**1.95**		**0.40**		0.48
2060		2.1		1.98		0.30		0.37
2070		5.08		4.79		0.54		0.66
TOTAL	31.34	18.46	29.88	17.4	23.73	4.33	**28.69**	**5.24**

6 Further Information

The following documents provide information that follows on directly from the key topics covered in this Unit.

For information on:	*See:*	*TAG Unit number:*
Completing the Public Accounts table	*The Public Accounts Sub-Objective*	*TAG Unit 3.5.1*
Completing the Transport Economic Efficiency Table	*Transport Economic Efficiency Sub-Objective*	*TAG Unit 3.5.2*
Residual Values *Interpolation and Extrapolation*	*Cost Benefit Analysis*	*TAG Unit 3.5.4*
An overview of the appraisal process	*The Appraisal Process*	*TAG Unit 2.5*
An overview of cost benefit analysis for Major Schemes	*MSA: Cost Benefit Analysis*	*TAG Unit 3.9.2*
Operating Costs	*Values of Time and Operating Costs*	*TAG Unit 3.5.6*
Retail Price Index	*http://www.statistics.gov.uk/cci/nugget.asp?id=21*	
Risk Register - Office of Government Commerce	*http://www.ogc.gov.uk/sdtoolkit/reference/documentation/p15_risklog.html*	

7 References

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8 Document provenance

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