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International Comparison of Transport Appraisal Practice

Annex 1 England Country Report

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Institute for Transport Studies

INTERNATIONAL COMPARISON OF TRANSPORT APPRAISAL PRACTICE

ENGLAND COUNTRY REPORT

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1. Introduction

In 2005-6 a project was undertaken for the EU entitled “Developing Harmonised European Approaches for Transport Costing and Project Assessment” [HEATCO, 2006]. This was a review of the practice of cost-benefit analysis in transport across member and accession states. Deliverable D1 is a review of then current practice in project appraisal across EU member and accession states. D5 is a proposal for harmonised guidelines. Both remain particularly useful as a statement of the position at the time. Subsequently the Department for Transport commissioned a review based on HEATCO as an input to the refresh of the New Approach to Appraisal (Mackie and Kelly, 2007). These reports form the baseline against which subsequent developments can be measured.

There are very different traditions, resources, legal frameworks and states of development across the whole of Europe. One of the purposes of HEATCO was to facilitate information transfer from countries with a stronger tradition and evidence base across Europe.

Within that context, along with the Netherlands and Scandinavia, the UK has been a European leader in the sense of having

- A strong tradition of doing cost-benefit analysis of transport sector projects;
- Guidance Manuals which constitute a clearly defined framework for appraisal which is to be followed at all stages including consultation, public inquiry and decision;
- The framework populated with measures and values of the impacts which are based on evidence which is generated from research studies;
- A policy intention that the results from the appraisal framework should be a significant influence on the case for investment and on prioritisation within programmes.

The question being asked in this study is whether that leading status has been maintained or whether appraisal practice elsewhere has caught up and in some respects overtaken practice here. This question means that there is really little point in looking comprehensively across Europe, nor is there time and budget. Instead we compare developments since 2006 with those in Netherlands, Sweden, Germany, USA, Australia and New Zealand as exemplars of countries with varying but serious track records in this area. We note that the institutional structure is changing so that how other countries handle appraisal in a devolved context to States or city regions is of particular interest.

We have concentrated on the appraisal process. Inevitably there is a cross-over with modelling but we have restricted ourselves in crossing that boundary to places where it is essential for understanding the progress or lack of it in appraisal. We focus on the English appraisal guidance WebTAG while being well aware that the Scottish equivalent STAG differs in a number of respects.

As a basis for the comparison, we

- Set out the English economic appraisal framework and how it has changed, principally as a result of the NATA Refresh
- Describe how the values and measures/weights in the appraisal have changed and also the pipeline of studies which have not yet reached appraisal guidance or been taken forward

Describe developments in the way in which economic appraisal interfaces with the decision-making process, specifically the place of appraisal in the overall Transport Business Case and how this has developed as a result of the coalition commitment to 'reform the way decisions are made'.

2. The Baseline

The HEATCO project undertook a survey of current practice in project appraisal in Europe detailed in Odgaard et al. (2005). The inclusion of elements in appraisal and whether or not they are monetised is summarised in **Error! Reference source not found.** In terms of elements covered, the UK was at that point fairly typical of the North/West group of countries, but had not yet monetised the noise, local pollution and climate change impacts. The provenance of the values will be discussed below.

Table 1: Coverage by country and element in case CBA is used^{1, 2}

		Construction costs	Disruption from construction	Costs for maintenance, operation and administration	Passenger transport time savings	User charges and revenues	Vehicle operating costs	Benefits to goods traffic	Safety	Noise	Air pollution - local/regional	Climate Change	Indirect socio-economic effects
North/West	Austria (*)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Belgium (*+)	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Pink	Pink	Pink
	Denmark (*)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Finland (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Green	Pink
	France (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Green
	Germany (*)	Green	Pink	Green	Green	Pink	Green	Green	Green	Green	Green	Green	Green
	Ireland (*)	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Pink	Pink	Pink
	Netherlands (*)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Sweden (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Switzerland (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	UK (*)	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Pink	Pink	Pink
East	Czech Republic (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Green	Pink
	Estonia (+)	Green	Green	Green	Green	Pink	Green	Green	Green	Pink	Pink	Pink	Pink
	Hungary (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Pink
	Latvia (+)	Green	Pink	Green	Green	Pink	Green	Green	Green	Pink	Pink	Pink	Pink
	Lithuania (*)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
	Poland (+)	Green	Pink	Green	Green	Green	Pink	Green	Green	Green	Pink	Pink	Green
	Slovak Republic (*)	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Pink	Pink	Green
Slovenia (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Green	Green	Green	Pink	
South	Cyprus (+)	Green	Pink	Green	Green	Pink	Green	Green	Green	Pink	Green	Pink	Pink
	Greece (+)	Green	Green	Green	Green	Green	Green	Green	Green	Pink	Green	Pink	Pink
	Italy (+)	Green	Pink	Green	Green	Green	Green	Green	Green	Pink	Green	Green	Pink
	Malta (*)	Green	Green	Green	Green	Pink	Green	Green	Green	Pink	Pink	Pink	Pink
	Portugal (+)	Green	Pink	Green	Green	Pink	Green	Green	Green	Pink	Pink	Pink	Pink
	Spain (*)	Green	Pink	Green	Green	Green	Green	Green	Green	Pink	Pink	Pink	Pink
Colour codes:		green: Included with a money value pink: Measured quantitatively, qualitatively or not included											

¹ It appears that all countries include some effects with a money value for inclusion in CBA. Caution should be applied when interpreting this result, as CBA is not a requirement in all countries and as such is only used under some special circumstances. Furthermore, it should be noted that the figure provides a summary for all modes, i.e. it might be that some effects are not included for some modes. (*) - reflects recommended/required approach; (+) - reflects typical approach when CBA is used.

² Since the production of this table some appraisal practice in countries have been updated

Table 2 presents a comparison between the HEATCO guidelines and the UK appraisal conventions as they stood at the time.

Table 2: Overview of general assessment approaches (UK and HEATCO)

	HEATCO	UK
Appraisal Period	Planning and construction + 40 years	60 years
Discount Rate	National Values of risk premium – free rate and sensitivity testing at	3.5% for the first 30 years, 3% for the remaining 30 years
Unit of Account	Factor costs	Market prices
Currency	Euro	GBP
Marginal costs of	MCPF= 1 and use a cut off value of RNPSS = 1.5	MCPF = 1 (all UK) (RNPSS = 1.5 in England only)
Scenario Definition	Reference scenario as “ do minimum”	Reference scenario as “ do minimum”
Decision criteria	NPV, BCR, RNPSS (Ratio of NPV and Public Sector Support)	NPV, BCR
Treatment of future risk and uncertainty	Sensitivity analysis at a minimum, Monte Carlos simulations as a more	UK provides less prescriptive advice and just recommends undertaking a risk analysis
Equity issues (inter-	Winners and losers tables at a minimum, distributional matrices as a more sophisticated	Disaggregation of impacts between stakeholders categories and mode to identify winners and losers
Treatment of indirect socio-economic	Qualitative assessment at a minimum. Use of spatially computable general equilibrium models where possible	Framework approach to appraisal based around the 5 core objectives: environment, safety, economy, integration,
Price base	2002, constant prices + PPP adjusted prices	2002
Treatment of values over time	Adjustment on the basis of national GDP growth rates (elasticity = 1) except for global warming and VTTS (0.7)	GDP growth rates The value of non-working time is assumed to increase with income, with an elasticity of 0.8. Working values of time are assumed to grow in line with income, with an elasticity of 1.

Subsequently to HEATCO, two reports were published by the Danish Transport Research Institute (DTRI, 2002 and Lyk-Jensen, S (2007)) . Table 3 gives a summary of some of the components used in appraisal in the countries reviewed and compares it to the HEATCO recommendation.

Table 3: Summary of Danish 2002 and 2007 reports

	HEATCO	DNK (2007)	SWE (2007)	NOR (2007)	FIN (2007)	DEU (2002)	NLD (2002)	FRA (2002)
Discount Rate (real)	National Values of risk premium – free rate and sensitivity testing at 3%	6%	4%	4.5% (risk free 2%, risk premium 2.5%)	5%	3%	4%	8%(5%)
Unit of Account	factor	market	market	market	factor	factor	factor	market
Marginal costs of public funds	-	20%	30%	20%	-	-	-	-
Decision criteria	NPV, BCR, RNPSS	NPV, BCR, IRR	NPV, BCR	NPV, BCR, FYB, IRR	BCR, NBCR	CBR	NPV	NPV, CBA, FYB, IRR
Local Air pollution – Emissions included	NO _x SO ₂ NMVOC PM _{2.5} / PM ₁₀	Particles NO _x SO ₂ HC, VOCs	Particles NO _x SO ₂ HC, VOCs	Particles NO _x	Particles NO _x SO ₂ CO, HC	Particles NO _x SO ₂ CO HC Carcin- ogens	Particles NO _x SO ₂ CO HC	PM ₁₀ (only emission with monetary value)
Valuation method	DC	DC	DC	SP, DC	DC	-	-	DC
Global air pollution (valued)	yes	yes	yes	yes	yes	yes	yes	yes
Valuation method	DC & AC	AC	AC	AC	DC	AC	AC	Tax
Differentiation of passenger VoT	Purpose - Passenger work and non-work trips	Purpose, type of time,	Mode of transport Purpose. Type of time, distance	Mode, purpose, type of time, distance	Mode, purpose, type of time,	Purpose	Mode, purpose	Mode, purpose, type of time, population groups, comfort, distance
Method	WR/ CSA for work trips	WR, SP	SP, WR	SP, WR	WR	SP	SP	RP, SP, IC, WR
Last study		2006	1995	1997	1999/2000	1991	1998	

DC = Damage cost, SP = Stated Preference, AC = avoidance costs, WR = wage rate, CSA = Cost saving approach, IC = International Comparisons Source: DMT (2002) and Lyk-Jensen, S (2007)

In 2008 the European Commission released a handbook with estimates of the external costs of transport that was the result of the IMPACT study (Internalisation Measures and Policies for All external Cost of Transport) and produced by INFRAS et al. (2008). Its purpose was to summarise current knowledge on the valuation and internalisation of externalities from transport. It e.g. delivered the basis for the Commission's internalisation strategy and the amendment of the Heavy Goods Vehicle Charging Directive (1999/62/EC). A recent overview of the external costs of transport in EU-27 by CE Delft et al. (2011) built upon the handbook and updated previous UIC funded studies by INFRAS/IWW (1995, 2000, 2004).

3. Generic features of the English appraisal system and developments in economic appraisal

Cost-benefit analysis is a form of social accounting. In the English system, many of the generic characteristics of the CBA Framework as it applies to transport are set out in the Treasury Green Book. Individual departments of state will develop specific methods and evidence for evaluating projects and policies within their remits but the generic features of appraisal should be common. Since the Treasury green Book has not been revised since 2002 (it is currently under revision), it is not surprising that the generic social accounting rules of appraisal are largely unchanged, while the transport sector specific guidance has seen some changes.

Project Life--- assumed as a default to be a 60 year operating life

Discount Rate--- 3.5% for first 30 years from year of appraisal, 3% thereafter

Unit of Account--- market prices (as opposed to factor costs)

Marginal Cost of Public Funds--- a zero shadow price of public funds is assumed (see below re BCRs)

Marginal Cost of Labour--- a zero shadow price of labour of all categories is assumed (see later)

Scenario Definition--- as a minimum, a comparison is required between Do Something and a credible Do-Minimum baseline option. Closure of transport infrastructure is rarely credible.

The above are taken as given by the DfT and have not changed since 2005. However, in some other areas the Green Book gives rather general advice and it has fallen to individual Departments to work out how to implement the advice. The DfT's appraisal guidance is provided in the on line resource WebTAG which is periodically revised and updated as research and policy work develops.

One source of development of economic appraisal was the NATA Refresh conducted in 2007/8, the final report of which was published in April 2009 as NATA Refresh: Appraisal for a Sustainable Transport System (Department for Transport, 2009).

- Whereas the NPV of a project is independent of whether an impact is classed as a negative benefit or a cost, the value of the Benefit Cost Ratio is not. Therefore the numerator and denominator of the BCR require careful definition. Prior to 2009, the denominator was 'The Public Budget' whereas after the NATA Refresh this was redefined as 'The Broad Transport Budget'. The principal effect was to move the indirect tax effects of projects (net revenue to rest of Government) from the denominator of the BCR to the numerator.
- The benefits to transport users are required to be split between employers business, commuting and other rather than employers business and all non work purposes.
- The assumption of a constant unit value of travel time savings is retained but travel time benefits are required to be split into three positive and three negative size bands so small time changes can be separately identified.

More recently the Department has indicated its interest in considering alternatives, including the logsum, to the rule of a half which has underpinned transport CBA. The Department is also supporting studies such as Buses and the Economy and the Social Value of Bus Trips which if

successful will help to extend the reach of economic appraisal guidance. Four other developments are particularly worthy of note since they indicate the way in which appraisal guidance has broadened out in recent years.

Treatment of Social and Distributional Impacts (SDI)

This area covered in WebTAG units 2.13 and 3.17 is one that has seen most development in guidance in recent years. The guidance is very ambitious, covering not only interventions targeted on social change but also the more common case where social and distributive impacts happen and require assessment as a by-product. The approach is relatively instrumental, thus

‘ This TAG unit sets out a robust approach to the identification of issues and impacts for different groups of people which will help in working towards greater equality and fairness but also contribute to better safety, security and health’.

Social Impacts include effects on communities such as cohesion, stability and services, on people’s way of life, health and well being and sense of security. **Distributional Impacts** refer to the pattern of variation in impact across different groups in society, for example by spatial impact and across income groups.

Based on Atkins and MVA (forthcoming), the guidance asks for consideration of eight impacts in SDI terms. These are User Benefits; Noise; Air Quality; Accidents; Personal Security; Severance; Accessibility; Personal Affordability. The approaches chosen may be more qualitative or quantitative according to proportionality principles. The SDI appraisal is to be fully integrated with the rest of the appraisal work, although no guidance is provided about how to balance SDI impacts, whether positive or negative, against the rest of the appraisal.

The scale of effort required to respond to the guidance properly can be judged from the Mott Macdonald (2011) study of the SDI of the Bexhill to Hastings Link Road (65pp plus Appendices). At the time of writing, the guidance on SDIs is under review in the direction of simplification rather than fundamental change.

Aviation

A different kind of development is the new (Aug 2012) guidance on aviation appraisal (WebTAG unit 3.18). This sets out principles relevant to strategy assessment, policy analysis, regulation and planning applications, demonstrating the intended reach of WebTAG both in terms of policy instruments and modal coverage. A few specific points covered in the guidance are worthy of note:

- The special tax regime for air travel is considered
- The treatment of time savings for foreign residents where despite the Green Book guidance to exclude such benefits, a number of reasons are given (cogent in the authors’ view) why ‘we might want to treat the benefits of UK residents and non-UK residents the same in the appraisal of aviation interventions’. In our view these reasons apply equally to land modes.
- For noise, no air transport specific values are given in the guidance.
- For CO₂, since emissions are included in the EU Emissions Trading Scheme, the cost of emissions is internalised through the inclusion of the traded price in airline costs. However,

since the traded price is currently less than a third of the non-traded price and only equals the non-traded price from 2030 onward, this has a slightly peculiar effect.

Walking and cycling and physical fitness

One of the key changes in the UK has been the inclusion of specific guidance on the appraisal of walking and cycling schemes (WebTAG 3.14.1), which was first introduced in 2010. A few specific points covered in the guidance are worthy of note:

- It promotes proportionality –“It is accepted that the amount of effort devoted to the analysis of such schemes should either be proportional to the scale of the project or the scale of impact on cycling and walking modes” (p4). Therefore, a full scale appraisal is not always required.
- Details are provided on minimum monitoring requirements for evaluating walking and cycling interventions and the key impacts that need to be included.
- The guidance provides monetary values for key parameters that are important specifically to investment in walking and cycling facilities (others such as travel time savings and accidents are covered elsewhere in WebTAG) including:
 - **Journey Ambience Benefits:** Journey ambience includes a large number of potential impacts from concerns about accidents and safety when cycling and walking to the quality of the environment and the walking/cycling infrastructure. The guidance provides the methodology and values for estimating the journey ambience effects from investment in walking and cycling infrastructure.
 - **Health Benefits:** The guidance provides a methodology for evaluating the health benefits of new cycling and walking facilities based on the World Health Organisation, HEAT Tool (WHO, 2011). The Swedish Road Administration has also adopted this methodology.
 - **Absenteeism Benefits:** The guidance provides methodology for estimating the absenteeism benefits of new cycling and walking facilities.

This methodology has now been applied to a range of schemes.

The 2006 methodology for the appraisal of impacts on physical fitness (WebTAG unit 3.3.12) was based on a quantitative measurement of the number of pedestrians and cyclists involved in activities with more or less than 30 min/day. This has been extended by guidance introduced in 2009 to include changes in mortalities and resulting numbers of deaths and a monetisation of these. The health benefits are quantified using the WHO HEAT tool, as described above.

Proportionate Appraisal

Recent versions of WebTAG unit 2.1 have placed emphasis on the need for proportionality in appraisal. This recognises that the cost of acquiring appraisal information should not exceed the marginal benefit as it relates to

- Estimating the scale and severity of impacts
- Assessing the level of uncertainty about estimated impacts
- The focus of the local objectives

Appraisal effort should be focussed on 'larger' impacts, those where there is uncertainty about the scale of benefit/cost and those which could make a difference to the BCR or VFM categorisation. Based on this, it is acceptable where appropriate for impacts to be 'assumed neutral' or 'assumed slight positive or negative'. The appraisal should be orientated in effort towards the intended or expected impact – for example a safety scheme might have a full scale safety model and appraisal but not warrant a full scale regeneration assessment. Thus a degree of professional judgement of appraisal requirement and materiality in shaping the appraisal within the guidance is encouraged.

4. Specific Impacts within the economic appraisal

4.1. Economy Impacts

4.1.1. Values of Travel Time Savings (WebTAG 3.5.6)

In English practice, a basic distinction is made between values of travel time savings in the course of employers business, or 'working time' savings and the valuation of non-working time savings which are travel time savings on all purposes other than employers business.

Ever since the early days of CBA in England, the cost saving approach (CSA) has been used to value travel time savings during the course of work. The resource cost of labour is taken to be the wage gross of tax plus the employer national insurance, pensions and other on costs which on average add 21.2% to the wage. Since CBA in the UK is conducted in market prices, the value of the marginal product of labour needs to be uprated by $(1 + t)$ where t is the average rate of indirect taxation currently 19%. So labour with a cost of 1 produces goods with a value of 1.19 at market prices. The values are at 2010 prices and values and have been uplifted using the Treasury GDP deflator. A unit income elasticity of the value of business travel time savings is assumed and real GDP per head forecasts are provided.

The CSA has been reviewed on several occasions during its long life including by ACTRA (1978), MVA/ITS/TSU (1987), ITS (2003) and Batley, Mackie and Wardman (2011).

Despite its intuitive appeal, the CSA has always been regarded as a simplified method which depends on various assumptions being acceptable approximations when viewed in toto

- The value of the marginal product of labour equals the gross cost of employing labour
- Travel time savings convert unproductive travel time into productive labour time
- Travel time on EB displaces work not leisure
- There are no indivisibilities or constraints ; work time is of equal productive value at the margin in all locations at all times
- The employer is indifferent between types of travel time; a minute is a minute.
- The employee is indifferent between working and travelling.

Aspects of this, and the proposition that they add up to the CSA result are controversial particularly in the context of (a) rail travel and (b) the mobile office and flexitime revolution in working practices. This led to the commissioning of the SPURT report (Mott MacDonald et al 2009) and to a further scoping study of options for change which are under consideration by the Department.

Unlike employers' business purpose, guidance for values of non-working time is based on evidence from willingness to pay methods. Revealed Preference and Stated Preference evidence shows that people are willing to pay something for a reduction in in-vehicle journey time and will pay more per minute for reductions in walking and waiting time. Wait time is valued at 2.5 x in-vehicle time and walk time at 2 x in-vehicle time.

In the UK, a policy decision was made many years ago that for non-working time, standard values per minute would be used across incomes, modes and regions. Therefore, practice is to use behavioural information for modelling but standard values for appraisal. National value of time studies have been used to obtain behavioural information from which to compute average mileage weighted values of travel time savings which are then applied in appraisal.

Research has found that, after correcting for income differences, values of commuting time savings are around 10% higher than for other non-work purposes and this difference is included in the guidance. There is a fair amount of evidence that VTTS is higher for long distance journeys than for short distance for a combination of reasons:

- Longer journeys tend to be made by higher income people
- Tedium and fatigue set in on longer distance trips
- The length of time taken to make a long distance trip can cut into the time available at the destination.

In adjusting from behavioural to standard values, it would be appropriate to take account of the second and third of these factors. So far the evidence base has not been considered sufficiently secure to do this robustly, so VTTS is not taken to vary with journey length in appraisal.

Another controversial question is the treatment of small time savings and gains versus losses. It is often asserted that small time changes are of lower or no unit value and/or that gains and losses from some base point are valued differently. The main stated preference experiment in the AHCG report of 1994 published 1999 certainly pointed in that direction. However the reanalysis of that data by ITS (2003) led to the conclusion that 'there is no sound basis for differentiating [unit] values of travel time savings in terms of their sign or size either for car or public transport applications.' The Department's guidance values were taken from the 2003 report and have subsequently been converted to 2010 values and prices using the GDP deflator together with an elasticity to GDP per head of 0.8 recommended by ITS (2003). These are shown in Table 4. Standard growth rates of the values are available as are values per car using vehicle occupancy data.

Table 4: Values of Travel Time per person

(£ per hour, 2010 prices and values)

	Resource Cost	Perceived Cost	Market Price
Working time – Average of all working persons	28.68	28.68	34.12
Commuting	5.43	6.46	6.46
Other	4.80	5.71	5.71

Source: WebTAG 3.5.6 Tables 1 and 2

An obvious issue is that the database for the Department’s current values is now approaching twenty years old during which time demographic (e.g. age and gender structure of travellers), economic (crises, fuel prices) and technological (in car gizmos, real time information) changes have occurred which might have caused a structural break even if underlying preferences have remained unchanged. The Department has commissioned several pieces of work to examine the need for and scope the potential requirement to update national values of time , which is under consideration by the Department. Extensive advice on values of vehicle operating cost savings is also available, the most recent guidance covering electric cars. VOC is not covered in this review since differences between countries are likely to be technical/engineering rather than economic in nature.

4.1.2. Value of Reliability

Reliability is one of the most important dimensions of transport quality but incorporating reliability within CBA is difficult and demanding because

- Measuring journey time variability on the network is difficult
- The interaction between variability and human behavioural response is important—people form expectations about how long journeys will take and it is failure to achieve expected or scheduled time that needs to be measured. Predictable variation is excluded.
- Appraisal involves valuing changes in travel conditions so we need to model the effects of interventions (e.g. hard shoulder running) on variability.
- Variability arises from two very different sources--- day to day variation due to weather, fluctuations in traffic which may or may not be anticipated, and incidents. INCA is a model that can be used to forecast incident duration and impact on motorways and dual carriageways.
- The value of changes in variability (over and above the changes in mean journey time) then need to be found from willingness to pay type studies.

Some aspects of resilience to events such as weather (bridge collapses, rail flooding) or to security (alarms, actual events) could be viewed as reliability impacts, but temporary closure of facilities for these reasons probably needs different handling and has not yet reached guidance stage.

Reliability benefits do not currently have the same status as time and safety benefits in appraisal. Thus, for motorways and dual carriageways,

‘The reliability benefits should NOT be included in the Analysis of Monetised Costs and Benefits Table and thus not be included in the estimates of the NPV and BCR for the transport intervention, but SHOULD be included in the Appraisal Summary Table and thus be taken into account in the assessment of the overall value for money of the transport project.’ (WebTAG 3.5.7)

So reliability is a relevant impact that happens to be monetised but falls outside the BCR.

The key concept in valuing changes in variability is the Reliability Ratio

$$RR = \text{Value of Standard Deviation of travel time} / \text{Value of travel time} \dots (1)$$

$$\text{Or frequently for rail} = \text{Value of SD of lateness} / \text{Value of lateness} \dots (2)$$

$$\text{AND value of lateness} = \text{factor} * \text{value of travel time} \dots (3)$$

Evidence on values for these concepts is of variable quality but advice can be summarised below

Mode	Reliability Ratio
Car	0.8 (1) above
Rail	1.4 (2) above
Rail factor	2.5 (3) above

For rail the combination of changes in mean late time (3 above) and changes in the variability of late time (2 above) is often taken to be a factor of 3. That is, the value of an increased lateness per minute is somewhat more onerous than the value of an increased wait time per minute.

A stock take of Travel Time Variability by Bates (2010) has recently been published by DfT. No guidance is currently issued on buses nor on logistics in the reliability section of WebTAG. This seems to be a gap. However, a current research project is under way on Bus Journey Time Variability in Urban Areas, which will help to improve the forecasting of changes in reliability.

Overall it is probably fair to say that the issues of modelling and forecasting changes in reliability, rather than valuing them are the most demanding and are therefore the determining factor on progress on this important topic.

4.1.3. Journey Ambience

Journey ambience covers a broad range of factors associated with the comfort (or discomfort) of undertaking a journey. Aspects relating to walking and cycling are discussed above. The literature in this area is dominated by studies of rail facilities where, having accepted the primary factors such as fare, journey time and access/egress costs passengers have a number of requirements. These requirements may relate to station facilities or features of the rolling stock e.g. cleanliness, environment, information provision, security etc. Within the English appraisal system these features are considered to influence the relative attractiveness of different means of travel, but they are not explicitly valued within the appraisal system.

Widely considered as the most important aspect of journey ambience the benefits associated with reducing overcrowding are, however, captured within the appraisal system. Crowding is a source of major concern to many rail travellers, and customer satisfaction surveys consistently put it close to the top of the list of passenger priorities.

A major study into the Valuation of Overcrowding on Rail Studies (MVA Consultancy, 2008) used both stated and revealed preference techniques to update and improve the evidence into how rail passengers value crowding relief and the impact of overcrowding on demand for rail travel. This study played an important role in determining the Passenger Demand Forecasting Handbook (PDFH) methodology upon which current WebTAG advice is based (draft unit 3.15.4).

The study recommended the adoption of passengers per square metre as the appropriate unit by which to measure crowding levels over 100% load factor. This reflects the increasing diversity of internal layouts available in different rolling stock types, some of which have considerably more dedicated standing space than other stock types. It also recommended that crowding penalties

should be expressed as multipliers of the value of time, rather than the previous practice of using a multiplier on the fare paid. Selective in-vehicle time multipliers are provided in Table 5 below.

Table 5: In-vehicle time multipliers for crowding effects

Sector	Stand/Sit	Extent of crowding ¹		IVT multiplier
		Metric	Value	
Intercity	Sit	Load factor	80%	1.03
Intercity	Sit	Load factor	90%	1.05
LSE	Sit	Pax/m ²	1.0	1.16
LSE	Stand	Pax/m ²	1.0	1.65
Intercity	Stand	Pax/m ²	1.0	2.11

4.1.4. Wider Impacts (WebTAG sections 2.8 and 3.5.14)

This section deals with the efficiency impacts on the *additional* wider economy of transport interventions which are not captured within the direct transport impacts. Distributive impacts are considered separately below. The chronology is from the 1998 SACTRA report “Transport and the Economy” to the 2005 Department paper on “Wider Economic Benefits and Impact on GDP” (Department for Transport, 2005) written with particular reference to the appraisal of Crossrail through to the 2006 Eddington Study. The most recent version of the guidance on appraisal of wider impacts was published in April 2012 and confirmed in August 2012. Software (WITA) has been developed and published in WebTAG for benefit computation. Compared with other parts of transport appraisal, wider impact assessment is relatively new and experience is still being gained of practical applications and further work conducted on the evidence base of parameters and elasticities. However, the principles and framework are relatively settled and will be reviewed briefly to facilitate comparison.

Four sources of additional wider impacts on economic efficiency are acknowledged in the guidance:

- Agglomeration impacts: transport quality/cost improvement enables agglomeration which in turn is linked to productivity effects not captured in the direct transport benefit measures
- Output change in imperfectly competitive markets: where changes in transport cost/quality stimulate increases in output, the divergence between price and marginal cost of that increment needs to be added to the transport benefits
- Labour supply impacts: this refers to net induced increases in aggregate employment relative to the base case. Lower transport costs/improved quality can draw labour into employment by reducing the generalised cost of travel and thereby increasing the net take home wage. Individuals make decisions on the basis of their net of tax wage but the value of marginal output is given by the gross of tax wage. A correction is required to allow for this tax wedge effect.
- Move to more or less productive jobs: this effect is on those already in employment and is an analogous tax wedge effect to labour supply impact.

¹ Zero pax/m² is equivalent to 100% load factor

Guidance is given on methods for computing impacts. This is an area where proportionality in appraisal is recognised as a guiding principle. It is not proportionate to estimate all these impacts for all schemes. The first and the last are likely to be relevant for major urban schemes according to the guidance while the second and third are more generic in nature.

Practice regarding wider impact appraisal has progressed over the last decade from being a research topic to being implemented in guidance, and a body of experience of use is being assembled. Graham's work (2007 for example) has reached the international literature and has been influential worldwide. Further research has been commissioned by the Department in various areas --- for example the additional wider impact on the economy of the connectivity benefits of joining up regional or national labour and product markets. This is not well understood at the technical level yet influences the discourse surrounding major schemes considerably. Work on this theme is underway in relation both to HS2 (inter-regional labour and product market effects) and in relation to airport capacity (international business impacts).

The DfT approach to the appraisal of wider impacts has been to develop partial equilibrium methods and evidence. Gunn (2004) in a report for DfT considered the case for adopting Spatial Computable General Equilibrium approaches, concluding that without much better regional accounting data, implementing such approaches would not be feasible.

4.1.5. Regeneration Impacts

Whereas wider impacts are efficiency effects, regeneration impact is a distributive concept related to the social value of enhancing activity in regeneration areas and prospects for their residents. The approach to appraisal of transport schemes needs to be consistent in this respect with other forms of investment with regeneration effects. The approach across all sectors is covered in the EGRUP Guidance 'Assessing the Impacts of Spatial Interventions: Regeneration, Renewal and Regional Development' (2004). A Regeneration Report is required wherever impacts on specific identifiable Regeneration Areas are predicted.

The chosen measure of contribution to regeneration objectives is (changes in) the number of Regeneration Area (RA) residents in employment. It is not necessary to assess whether employment changes are fully or partially displaced from other locations--- this is a target area approach. Jobs associated with the construction or supply of the transport scheme must be excluded since they are so unlikely to be filled from within the RA.

There is extensive guidance in WebTAG 3.5.8 on how to conduct a Regeneration Report. For very large schemes, a LUTI (Land Use and Transport Interaction) model is recommended as a tool for estimating area based employment changes. The method stops short of shadow pricing unskilled or structurally unemployed labour that would not be consistent with the Green Book. This however leaves open the question of how regeneration impacts are added up with other impacts in the overall scheme assessment. Nellthorp and Mackie (2000) found that the implicit value of the regeneration impact scores for highway improvement was significant.

A review of methods for modelling and appraisal of sub-national, regional and local impacts is currently under way for the Department and is expected to inform revisions to guidance going forward.

4.2. Valuing and Applying Safety values in a CBA

Prior to the NATA refresh in 2007 the values and description of the methodology for safety were separated in the TAG Unit 3.4.1 Document (Department for Transport, 2005), and values and methodology in the documents DMRB (1996) and HEN 1 (Department for Transport, 2007). In 2009 these documents were superseded by Department for Transport (2009) that incorporated the previous information held in HEN 1 (2007), DMRB Vol. 13 and TAG Unit 3.4.1 into one document. Since the NATA refresh there have been 4 new versions of WebTAG Unit 3.4.1 in 2009, 2011 and 2012 and the most recent consultation document released in February 2013. Whilst there have been changes to these guidance documents there has been no change in the way that safety values (values for casualties, accidents) have been calculated since the NATA Refresh. Each document states “since 1993, the valuation of both fatal and non-fatal casualties has been based on a consistent willingness to pay (WTP) approach. This approach encompasses all aspects of the valuation of casualties including the human costs and the direct economic costs i.e. an amount to reflect the pain, grief and suffering and the lost output and medical costs associated with road accident injuries.” (WebTag Unit 3.4.1),.

The documents and values have differed for a number of other reasons, which are described below:

- There has been a decline in the accident rate over time and this is taken into consideration in the values for accidents. For example in 2005 a fatal accident on average involved 1.10 fatalities, 0.36 serious casualties and 0.54 slight casualties. By 2009 this had declined and a fatal accident involved 1.08 fatalities, 0.33 serious casualties and 0.48 slight casualties. This impacts on the values applied for accidents
- The values have been presented using different appraisal base years. In 2012 the appraisal base year switched to 2010 from a previous base of 2002.
- The price base for which the accident and safety values are presented in each of the guidance documents have changed.
- The document prior to the NATA refresh did not contain any recommendations for rail appraisal, maritime appraisal and air transport appraisal. The 2009 document incorporated the guidance for rail appraisal based on the recommendations of ORR (2008), which states that “the Department for Transport’s value for prevention of a fatality, should be used to estimate a monetary value of casualty reduction benefits.” This value is then modified using the injury weightings in RSSB (2008) to determine the value for less serious injuries.
- The 2009 document provided a description of the process for maritime and air transport appraisal.
- In 2009 the requirement to evaluate the Social and distributional impacts of accidents was included in the guidance. On the road network it is expected that the impact of accidents on children, older people, young males, pedestrians, cyclists and motorcyclists will be assessed using the STATS19 data (accident database - <http://www.stats19.org.uk/>).
- The model that the DfT recommends and describes for determining the changes in accidents and to calculate the PVB in the guidance has changed. Up until 2013 the COBA model was advised (<http://www.dft.gov.uk/cobaquadro/>). In the 2013 consultation document a new model is described - COBALT.

- Values of safety are grown overtime by real GDP per head and this has not changed. The values for real GDP per head have been updated as frequently as TAG Unit 3.5.6 'Values of Time and Operating Costs' have been updated.
- Values for the costs of the Police were updated in 2012 based on an unpublished research project from 2011. All other values are based on data collected before the NATA refresh.

There have been a number of research studies in the UK that have focused on whether there should be a change in the values used since the NATA refresh. These include:

- DfT commissioned a study in 2010 to evaluate the existing methods and values as applied to casualties and accidents. The phase 1 report is available from NERA (2011).
- HSE (2007) focused on dread risk – whether certain ways of dying are worse than others and whether this should result in a different value being applied.
- Wolff and Shepley (2009) evaluated the use of value of life and health for the Intergovernmental Group on Value of Life and Health.

4.3. Environment

4.3.1. Noise

Before the NATA refresh, the appraisal of noise impacts was covered by a quantitative assessment of noise annoyance (WebTAG Unit 3.3.2, December 2004). Noise levels are calculated using the dB $L_{Aeq,18hr}$ measurement, in contrast to European guidance and handbooks that apply L_{den} dB(A). Road noise levels are converted from dB $L_{A10,18hr}$, and an adjusted annoyance response function from the DMRB is used. A specific noise annoyance curve for railway noise is applied that shows an increasing 'bonus' compared to road noise between 55 dB $L_{Aeq,18hr}$ and 70 dB $L_{Aeq,18hr}$ of up to 6dB. Although the procedure is in principle applicable to airports, specific annoyance response functions for air transport are not included. Recent research on this issue are e.g. the ANASE study (MVA et al., 2007) and Eurocontrol's 5A project (Bristow et al., 2003). The method of quantification of annoyance has been largely unchanged though the response relationships have been updated, in particular a lower cut-off value of 45 dB $L_{Aeq,18hr}$ instead of 55 dB $L_{Aeq,18hr}$ has been introduced.

In addition, a monetary valuation of noise impacts was introduced into the UK appraisal methodology in 2006. In the current version (WebTAG Unit 3.3.2, August 2012), monetary valuation is applied based on a hedonic pricing study, which was carried out by Batemen et al. (2004) in Birmingham. The resulting values were transferred to UK average levels by Nellthorp et al. (2005) and updated to 2010 price levels for the most recent guidance. For forecasts it is further assumed that noise annoyance increases in line with household income over time.

The currently applied valuation method covers only the amenity impacts caused by residential daytime noise. Sleep disturbances, health impacts, impacts on cognitive functions of which recipients are not aware and environmental impacts are not reflected in property values and are thus not included in the monetary valuation. In recognition of these shortcomings, DEFRA (2008a) recommends the application of the impact pathway approach and identified the need for further research with a priority on health impacts. Subsequently, the Interdepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)) (2010) commissioned a study by Berry and Flindell (2009) to review current research on noise impacts and recommends based on their findings

- to include the risk of acute myocardial infarction into the monetary valuation,
- to continue applying the HP values to cover amenity impacts, and
- to apply the IGCB(N)'s quantification to cover hypertension and sleep disturbance.

For the other areas, further research is required to identify whether significant dose-response relationships can be established. Though not monetised, significant changes in exposure to night-time noise or for non-residential receptors should be reported in the qualitative part of the AST, while impacts on tranquillity are included under the landscape objective.

In 2011 guidance on social and distributional impacts was included in the noise appraisal methodology by quantifying noise impacts not only on noise sensitive areas but also by differentiating results by household income groups.

Table 6 provides an overview of the noise appraisal methodology and changes between 2006 and 2013.

Table 6: Overview of noise appraisal methodology

Coverage	UK 2006	UK 2013
- Impacts (monetised, quantitative, qualitative, not included)		
○ Residential	quantitative	monetary
○ Non-residential	qualitative	qualitative
○ Outdoor – recreation / tranquillity, nature	partly under landscape objective	partly under landscape objective
- If monetised,		
○ Which approach (HP, SP, CV, AC, other)?	n.a.	HP
○ Which impacts covered? (Annoyance, decreased property values, health impacts, cognitive functions, sleep disturbance)	n.a.	Annoyance through property values, daytime only
○ Income elasticity applied?	n.a.	$\epsilon = 1$ (growth in line with real GDP per household)
- Social / distributional impacts?	impacts on sensitive receptors	impacts on sensitive receptors and by household income groups
- For quantification and non-monetary assessment:		
○ Noise indicator and differentiation (time of day)?	$L_{Aeq,18hr}$, net difference in population annoyed, cut-off value 55 dB	$L_{Aeq,18hr}$, net difference in population annoyed, cut-off value 45 dB
○ Scoring applied?		
- Modes covered?	Road, rail	Road, rail, aviation
○ Mode specific annoyance functions?	Increasing 'bonus' for railway noise	Increasing 'bonus' for railway noise

4.3.2. Air Quality (Local and Regional Air Pollution)

In the first step, air quality impacts are quantitatively assessed using mass emissions for regional pollutants (NO_x , PM_{10}), the exposure at properties for local pollutants (NO_2 , PM_{10}) at the plan level, and changes in number of zones experiencing increasing or decreasing emissions of local pollutants at the strategic level. The quantification of emissions and exposure for roads follows the method laid out in the DRMB and has been largely unchanged since 2004 (WebTAG units 3.3.3 and 3.3.4, February 2004, now consolidated to unit 3.3.3). The emission factors toolkit for vehicle emissions,

published by DEFRA,² has recently been updated to incorporate NO_x emissions and vehicle fleet information. The emission factors are based on European standard driving cycles, which might not reflect local driving situations accurately, see e.g. Carslaw et al. (2011, 2013). Models for cold start emissions are additionally provided which can be used to assess specific local developments, but more research is required to calculate local emissions more accurately. Simplified emission factors for rail, but no emission factors for aviation are provided in the guidance.

As for noise, guidance on social and distributional impacts was included in the appraisal methodology in 2011 by differentiating air quality impacts for five income domain groups based on the Index of Multiple Deprivation (IMD).

Since 2012, a monetary valuation using a damage cost approach for NO_x and PM₁₀ emissions is applied. These have been produced by the Interdepartmental Group on Costs and Benefits Air Quality Subject Group (IGCB(AQ)) (DEFRA, 2008b). The values include impacts on health through increased mortality and morbidity risk as well as damages to the built environment (building, materials). For NO_x, the approach is based on emissions, for PM₁₀ on concentrations. Uncertainties due to potential time lags between changes in air quality and impacts are taken into account using low (40 year lag), central and high (0 year lag) values. DEFRA (2010a) have since published guidance providing updated health costs for fine particles PM_{2.5} and recommend further work to improve the methodology for the valuation of air pollution health impacts. The monetary values for the health evaluation in the recommendations by IGCB are in particular based on a study by Chilton et al. (2004) who applied a contingent valuation approach to elicit willingness-to-pay values for a reduction in mortality due to air pollution.

Currently under consultation is an updated version of WebTAG unit 3.3.4 that introduces a valuation of NO_x emissions based on marginal abatement costs in case EU limit values are exceeded. This is based on a report by IGCB(AQ) (DEFRA, 2010b). This methodology takes into account limitations of the damage cost approach with respect to efficiency, equity and uncertainty by determining least costs of abatement measures to achieve maximum acceptable concentrations. It is expected that such abatement cost curves will be developed for other pollutants as well, in particular for particulate matter.

² <http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html>

Table 7 provides an overview of the air quality appraisal methodology and changes between 2006, 2013 and the 2013 draft guidance for consultation.

Table 7: Overview of air quality appraisal methodology

Coverage	2006	2013	2013C
- Pollutants			
o monetised	-	-	PM ₁₀ , NO ₂ , NO _x
o non-monetary	PM ₁₀ , NO ₂ , NO _x	PM ₁₀ , NO ₂ , NO _x	PM ₁₀ , NO ₂ , NO _x
- If monetised,			
o Which approach? (HP, SP, CV, AC, DC, other)	n.a.	damage costs (NO _x emissions, PM ₁₀ concentrations), includes contingent valuation for YOLL,	damage costs (NO _x emissions, PM ₁₀ concentrations), includes contingent valuation for YOLL, marginal abatement cost (NO _x)
o Which impacts (Health, social, built environment, agriculture etc.)	n.a.	Health, built environment	Health, built environment; Others indirectly in AC
- For quantification and non-monetary assessment:			
o how measured (exposure, concentration, emissions?)	mass emissions (NO _x , PM ₁₀); exposure at properties (NO ₂ , PM ₁₀)	mass emissions (NO _x , PM ₁₀); exposure at properties (NO ₂ , PM ₁₀)	mass emissions (NO _x , PM ₁₀); exposure at properties (NO ₂ , PM ₁₀)
- For which modes applied?	road, rail	road, rail, aviation	road, rail, aviation
- Sensitivity analysis or uncertainty covered?	-	lower, central and high values for valuation	lower, central and high values for valuation
- Social / Distributional impacts?	-	differentiated by IMD income domains, graded on nine point scale	differentiated by IMD income domains, graded on nine point scale

4.3.3. Greenhouse Gases

A monetary valuation of changes in greenhouse gas (GHG) emissions through transport interventions was introduced into the UK appraisal methodology in 2006 (WebTAG unit 3.3.5). Previously, a quantitative assessment based on changes in CO₂ emissions, converted into tonnes of carbon, was carried out. Other GHG are considered to be negligible for road and rail transport, though the most recent guidance applies CO₂ equivalent (t CO₂e) as measurement, which in principle allows their inclusion. DECC (2012, p. 10) provides conversion factors.

The calculation of emissions is based on CO₂e emissions per litre of fuel consumption. Fuel consumption is calculated according to the procedure described in WebTag unit 3.5.6 under the calculation of operating costs. The fuel consumption functions are based on the New UK Road Vehicle Emission Factors Database and assume for future projections that the EU CO₂ emission targets are achieved. An area of future research mentioned in the guidance is the refinement of functions for electric vehicles. For the calculation of CO₂e emissions factors per unit of energy are applied, which take into account future developments on increases in biofuel use based on the Renewable Transport Fuel Obligation Order requirements. For railways, the DfT is working on emission factors by stock type. Emission factors for aviation are not provided.

Initially, monetary values for carbon emission were calculated based on social cost of carbon. In 2008, this was replaced by the shadow prices of carbon, based on guidance by DEFRA (2007a) and the Stern Review (Stern, 2006). An increase in value of 2% p.a. in real terms was applied. In 2010, abatement cost values differentiated for carbon emissions from traded and non-traded sectors were introduced. For non-traded sectors, i.e. the majority of transport emissions, carbon values are determined based on marginal abatement costs to achieve the Government's GHG reduction targets

and for traded sectors based on expected EU ETS allowance prices. These values were updated in 2011 to higher values in line with recommendations by DECC (2011). Values for the traded and non-traded emissions increase over time with expected rising costs of abatement and converge towards 2030, assuming that functioning global carbon markets covering all sectors are in place.

Through application of the avoidance cost approach, the majority of impacts from GHG emissions can be captured through setting of appropriate target levels, which ensure that impacts stay below acceptable levels. A shortcoming of the approach, however, is that costs of emissions below the targets are not taken into account.

In order to take uncertainties in the valuation into consideration, a sensitivity analysis with lower, central and upper estimates is suggested, in particular if large impacts on carbon emissions are expected.

In its most recent guidance, DECC (2012) suggests the identification and – where possible – valuation of further impacts, such as embedded emissions, rebound effect and distributional impacts. Rebound effects are included in transport appraisal through variable demand responses to changes in transport costs.

Table 8 provides an overview of the methodology and changes between 2006 and 2013. No significant methodological changes were identified for the current draft guidance for consultation.

Table 8: Overview of greenhouse gas emissions appraisal methodology

Overview of coverage	2006	2013
- Which GHG included?		
o CO ₂	quantified	monetary
o Non-CO ₂	-	- (planned for draft update June 2013)
- If monetised,		
o Which approach? (AC, DC, SOC, other)	n.a.	MAC for non-traded sectors, expected market prices for traded sectors
o Which impacts (Health, social, physical, agriculture etc.)	n.a.	Dependent on set targets
o Temporal development of cost values	n.a.	Increasing, traded and non-traded converging
- In non-monetary,		
o how measured?	equivalent tonnes of carbon	tonne CO ₂ e
o indirect emissions included?	-	-
- For which modes applied?	Road, rail	Road, rail, aviation
- Sensitivity analysis or uncertainty covered?	-	lower, central and high values for valuation

4.3.4. Environmental Capital

The environmental capital approach (WebTAG unit 3.3.6) is a more qualitative approach applied for appraising environmental and culturally significant resources, such as landscape, townscape, biodiversity, historic heritage and water environment.

The principal approach has been unchanged since 2006. It follows a multi-criteria framework in which environmental features are appraised, the expected impacts categorised and an overall assessment score on a standard seven point scale produced.

For the types of impacts covered by the environmental capital approach, intangible as well as indirect use values and non-use values such as existence and bequest values play a significant role and are often site specific, so generic monetary values are difficult to establish. However, more recent guidance by HMT and Defra (2012) suggest the application of the ecosystem services framework, in which the characteristics are broken down into essential services which allows a wider quantification and potentially monetisation of impacts (Defra, 2007b). This approach is also applied by UNEP in its Millennium Ecosystem Assessment (UNEP, 2003); see also the UK National Ecosystem Assessment work (2011). Most recent draft guidance (February 2013) suggests that main elements of the ecosystem service framework are covered through the environmental capital approach, but that further research is required to identify potential gaps. A recent report by Atkins and Metroeconomica (2013), commissioned by the DfT, identified areas where the current appraisal methodology could be strengthened based on existing literature, e.g. impacts on urban green spaces, wetlands, water quantities or loss of carbon storage.

4.3.5. Landscape, Townscape, Heritage and Historic Resources

The appraisal methodologies for these areas (WebTAG units 3.3.7, 3.3.8, 3.3.9) have not changed since 2006 and follow the environmental capital approach as described above. The guidance should now also be applied for aviation (unit 3.18). Table 9 to Table 11 provide an overview of the methodology and the main features included in the assessment of importance of sites and potential impacts.

A recent study was carried out by ITA and Atkins and (2013) for the DfT with the aim to explore potential methods for the valuation of improvements to townscape and pedestrianisation. In this study, a pilot WTP study using a combined priority ranking and stated preferences method was carried out and provides indicative ranges of values for a three different scheme types. The report provides recommendations how the results from these surveys could be applied in future guidance and for further research, in particular extending the type of schemes covered.

Table 9: Overview of landscape appraisal methodology

Overview of coverage	2006	2013
- Qualitative Assessment		as 2006 + aviation
o Which characteristics included?	Aesthetic features + pattern, tranquillity, cultural, landcover	
o Which parameters used to assess features and impacts?	Scale, rarity, importance, substitutability, impact, additional mitigation	
o Scoring applied?	Standard seven point scales	
- Quantification		
o Impacts quantified (e.g. loss of areas)?	-	
- If monetised,		
o Which approach? (AC, DC, SOC, other)	-	
o Which impacts ?	-	
- For which modes applied?	Road, rail,aviation	
- Sensitivity analysis or uncertainty covered?	-	

Table 10: Overview of townscape appraisal methodology

Overview of coverage	2006	2013
- Qualitative Assessment		as 2006 +aviation
o Which characteristics included?	Layout, density and mix, appearance, human interaction, cultural, land use	
o Which parameters used to assess features and impacts?	Scale, rarity, importance, substitutability, impact, additional mitigation, changes in do minimum	
o Scoring applied?	Standard seven point scales	
- Quantification		
o Impacts quantified (e.g. loss of areas)?	-	
- If monetised,		
o Which approach? (AC, DC, SOC, other)	-	
o Which impacts ?	-	
- For which modes applied?	Road, rail,aviation	
- Sensitivity analysis or uncertainty covered?	-	

Table 11: Overview of heritage of historic resources appraisal methodology

Overview of coverage	2006	2013
- Qualitative Assessment		as 2006 +aviation
o Which characteristics included?	Form, survival, condition, complexity, context, period	
o Which parameters used to assess features and impacts?	Scale, rarity, significance, impact,	
o Scoring applied?	Standard seven point scales	
- Quantification		
o Impacts quantified (e.g. loss of areas)?	-	
- If monetised,		
o Which approach? (AC, DC, SOC, other)	-	
o Which impacts ?	-	
- For which modes applied?	Road, rail,aviation	
- Sensitivity analysis or uncertainty covered?	-	

4.3.6. Biodiversity & Water

The appraisal methodology for these areas (WebTAG units 3.3.10, 3.3.11) has not changed since 2006 and follows the environmental capital approach as described above. Special attention is given to protected sites, which determines the level of importance given to an area. A matrix is provided in order to derive the overall assessment category from the results for the magnitude of potential impact crossed with the nature conservation value of sites impacted.

Table 12: Overview of biodiversity appraisal methodology

Overview of coverage	2006	2013
- Qualitative Assessment		as 2006 +aviation
o Which characteristics included?	Qualitative description	
o Which parameters used to assess features and impacts?	Scale, importance, trend, biodiversity value, magnitude of impact	
o Scoring applied?	Standard seven point scales	
- Quantification		
o Impacts quantified (e.g. loss of areas)?	-	
- If monetised,		
o Which approach? (AC, DC, SOC, other)	-	
o Which impacts ?	-	
- For which modes applied?	Road, rail, aviation	
- Sensitivity analysis or uncertainty covered?	-	

Table 13: Overview of water appraisal methodology

Overview of coverage	2006	2013
- Qualitative Assessment		as 2006, + aviation
o Which characteristics included?	Qualitative description, dependent on type of water course	
o Which parameters used to assess features and impacts?	Quality, scale, rarity, substitutability, importance, magnitude of impact, significance	
o Scoring applied?	Standard seven point scales	
- Quantification		
o Impacts quantified (e.g. loss of areas)?	-	
- If monetised,		
o Which approach? (AC, DC, SOC, other)	-	
o Which impacts ?	-	
- For which modes applied?	Road, rail	
- Sensitivity analysis or uncertainty covered?	-	

4.4. Accessibility

Under accessibility, four sub-objectives are considered: option values, severance, access to the transport system and personal affordability.

- The **option values** sub-objective (WebTAG unit 3.6.1) covers option (the principle willingness to pay of people for transport services for potential use in the future) as well as non-use values (existence of transport systems) for changes to public transport services or highway schemes. The non-use values were added to the guidance at the end of 2006. The methodology includes a quantitative assessment of the number of households affected which is then assigned a qualitative score for the scale of impact (large adverse to large beneficial). A monetary valuation is proposed only for changes in public transport connections between suburbs / outlying towns and major employment or services centres. Values are based on a study by Humphreys and Fowkes (2006) for rail and Bristow et al. (1991) for bus services.
- **Severance** (WebTAG unit 3.6.2) is determined on a qualitative scale and changes due to implementation of schemes are scored on a seven point scale (large negative to large positive), depending on the level of change and the number of people affected. A monetisation of e.g. pedestrian delays is not carried out. The guidance was updated in 2010 to reflect guidance on Social and Distributional Impacts. It requires the differentiated analysis of impacts on particularly vulnerable groups such as no-car households, young people, elderly and disabled.
- The TAG unit on **accessibility** (WebTAG 3.6.3) replaced the previous unit on Transport Access in 2011. The approach focuses on the changes in accessibility by public transport for vulnerable user groups, assigning a qualitative score on a seven point scale depending on the proportionate change for different groups and destinations. This is combined with an accessibility audit for the public transport system into an overall accessibility indicators score for each accessibility criterion. The previous guidance applied a much less differentiated approach in which an access indicator was calculated as a percentage of the population of a zone who have access to a car or live within 250 m of a daytime hourly public transport service.
- The guidance unit on **personal affordability** (WebTAG 3.6.4) was added to the accessibility appraisal in 2011. It assesses the number and social distribution of people that are affected

by cost changes in transport and the typical magnitude of these changes. If all cost elements are covered in transport models, the User Charge Distributional Analysis function of TUBA can be used to provide estimates of the changes, however, for most modes this will not be possible.

4.5. Housing Developments

This is a new appraisal unit (3.16) that has been released in draft form in 2010. It covers the appraisal of transport interventions in circumstances where significant housing development is planned, as these will potentially significantly alter transport demand. One element are transport user benefits that accrue to residents of new housing development. These can be captured using more detailed zones in transport models and use standard techniques for capturing transport user demands such as implemented in TUBA. If a housing development is dependent on the implementation of transport schemes, a three step process is used: appraise the project without the dependent development, add the enhanced land value induced by the project, estimate the external costs of congestion for existing users associated with the development.

5. Use of economic appraisal in England for decision-making

5.1. Appraisal and the Project Cycle

Appraisal is used to inform decision-makers throughout the development of a scheme, from the early stage of option generation to the final approval. By providing those responsible for the project with a means of identifying, designing, selecting and refining options, the appraisal process avoids being no more than a hurdle over which the chosen option has to jump. DfT guidanceⁱ sets out the requirements for economic appraisal to inform not only the economic case but also the strategic, financial, management and commercial parts of the Business Case (see section 5.2 below). The guidance also covers the scope of the appraisal required at each stage in the development of the project, from a high level scoping based on existing information to the detailed appraisal derived from a transport model for estimating the impacts of the selected options. At each stage in the cycle, ministers are informed and their agreement, or the agreement of those to whom the decision has been delegated, is required before moving to the next stage.

For the first stage of the cycle, a wide range of options aimed at addressing the problem facing transport users are identified and worked up a way which facilitates comparison through using appraisal methods and criteria without necessarily having access to a full transport model. The advice suggests using existing data and focusing, in particular, on the strategic case for the scheme. The DfT has published advice on using its Early Assessment and Sifting Tool (EAST) and made available a spreadsheet for the presentation of results from EAST to inform decision-makers about the strength of the case for proceeding to the next stage of the investment cycle. The inputs to this spreadsheet also provide information about the performance of each option against the objectives of the commercial, financial and management cases. The outputs of this stage are an Options Assessment Report, identifying the options that are rejected and the reasons for their rejection, and an Appraisal Specification Report, outlining the analytical methods required for the next stage of the cycle.

The second stage of the cycle requires the more detailed appraisal of those options which have been short-listed. At this stage full compliance with WebTAG requirements is mandatory, with full account being taken of advice on proportionality so as to avoid unnecessary expenditure on modelling in cases when this is not justified. The outputs from this stage are the Appraisal Summary Table and the full supporting documentation as detailed in WebTAG. As shown in figure 1, many of the outputs from the economic case form part of the evidence used to develop the other parts of the business case, and for some options, such as those which include pricing, there may be a further iteration between the financial or commercial case and the economic case.

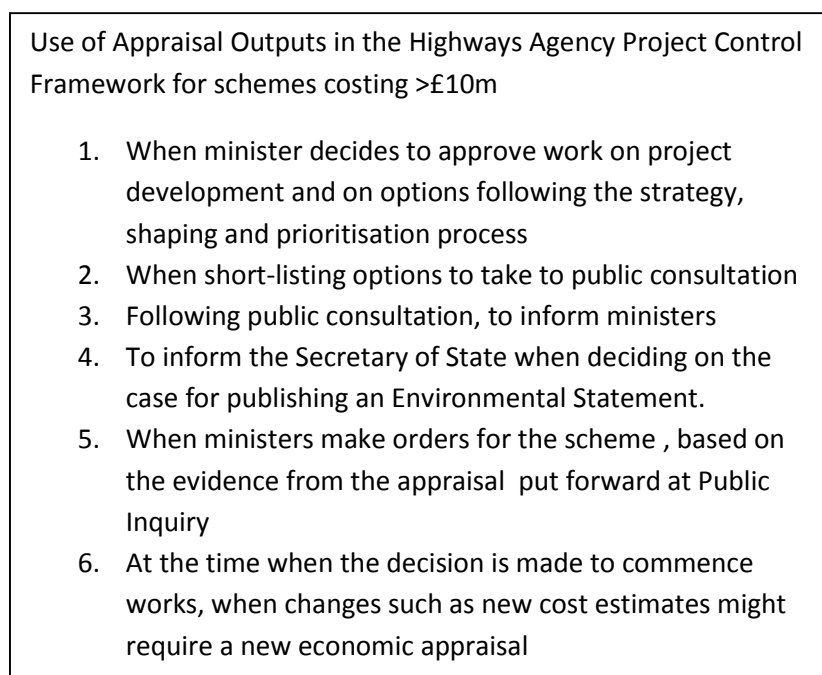
The third stage of the investment cycle, not illustrated in figure 1, takes place prior to the implementation of the scheme, when the planned phasing of the delivery is reviewed to establish whether any changes are needed in order to better manage costs, and when plan for monitoring and evaluation are drawn up.

While the DfT guidance sets out the principles for the development of the Business Case, the details of the use of appraisal during these stages differs according to the delivery organisation responsible and the way in which the scheme is funded. Figure 2 shows an example. Many Highway Agency schemes involve extensive consultation and a public inquiry, at each of which the economic appraisal and the evidence base will be open to examination.

Figure 1 Appraisal requirements at each stage in developing the business case

Appraisal of impacts		Development of evidence for business case					
Study outputs		Strategic case	Economic case	Financial case	Delivery case	Commercial case	
Guidance available in WebTAG	Stage 1: Option development	Outputs from Early Assessment and Sifting Tool (EAST)	✓	✓	✓	✓	✓
		Options Assessment Report	✓	✓	✓	✓	✓
		Appraisal Specification Report					
	Stage 2: Further Appraisal	Appraisal Summary Table	✓	✓	✓		✓
		Transport Economic Efficiency table		✓	✓		✓
		Public Accounts		✓	✓		
		Analysis of Monetised Costs and Benefits		✓			
		Greenhouse gas worksheet	✓	✓			
		Noise worksheet	✓	✓			
		Air quality worksheet	✓	✓			
	Social Distributional Impact worksheet	✓	✓				
Other guidance & tools	Social Research evidence, guidance and tools		✓				
	Carbon Tool for Local Authorities		✓	✓			
	Value for Money guidance			✓			
	Advice on Public Private Partnership (PPP) and Private Finance Initiative (PFI)						✓
	DfT's Evaluation guidance including evaluation plans and benefits realisation					✓	
	Office of Government Commerce's Gateway Review guidance					✓	
	Network Rail's management & control process for enhancements (GRIP)		✓	✓	✓	✓	✓
	Highway Agency's project control framework (PCF)		✓	✓	✓	✓	✓

Figure 2 The role of appraisal in informing each part of the Business Case



5.2. The Decision-making Process – the Transport Business Case

In April 2011 the Department for Transport adopted the Treasury 5 Case Business Case Model as a means of formalising the information which is provided to decision-makers on the strength of the overall business case for a scheme. The aim of this initiative is to ensure that all of the information which needs to be considered before a decision can be reached is presented to decision-makers. It enables decision-makers to weigh up all of the factors that have a bearing on the decision through receiving the right information at the right time. Details of the Transport Business Case were published as part of the Department’ commitment to being open and transparent, thus informing those with an interest in understanding the Department’s decision-making process and advising those intending to develop proposals for investment.

The Transport Business Case describes both the stages through which a scheme is developed and the evidence which decision-makers need to draw on in order to reach the right decision about a scheme.

The 5 Case Business Case Model is made up of the following elements;

The strategic case, which sets out the alignment between the project and the Government’s overall strategic objectives and demonstrates the case for change

The economic case, which demonstrates the value for money based on economic appraisal

The financial case, which assesses the affordability of the project and contains details of the funding arrangements, the financing options which have been considered and the key financial risks.

The commercial case, which describes the commercial viability of the project and the procurement strategy, including the handling of risks in procurement

The management case, which focuses on how the project is to be delivered, the governance through which risks are managed, the key decision points, the monitoring and measurement of progress in the delivery of the scheme, so as to ensure that the planned outputs are delivered and the anticipated benefits are realised.

The financial, management and commercial cases can be regarded as setting out the conditions which need to be satisfied before a scheme can go ahead. The Department needs to know that the resources required to fund the project can be covered from its budget and that provision will be made for any continuing expenditure or revenues. The project is unlikely to be delivered to time or to budget without a workable plan for managing its delivery and continued operation and for the appropriate allocation of risk. The commercial case ensures that plans for the effective procurement of the project are in place and that risks arising from the procurement process are allocated and managed effectively. While in relation to these three cases, the model may be formalising past good practice, the approach provides the opportunity for ensuring consistency in each part of the Business Case between the assumptions on costs, prices, revenues and timing which go into the presentation of the overall case to Ministers.

Each part of the Transport Business Case draws on a common evidence base, with each providing a different perspective according its role in the overall business case. The strategic case shares much of its evidence base with the economic case, although it sets the outputs of the project more firmly in the context of the Government's policy agenda. It differs in emphasis from the economic case in setting out why action is needed now and in providing evidence to support the case for change. While less comprehensive than the economic case, it is intended to enable decision-makers to understand how far a project fits in to the government's wider strategic objectives, for example in terms of contributing to economic growth and of reducing carbon emissions.

A particular example concerns the objective of better regional balance in the economy. Economic appraisal methods are not very well suited to identifying where the final impacts of projects will occur, nor at indicating the spatial benefit of transfers of economic activity between location A and location B. From a city region perspective there is a gap between the national appraisal perspective and the regional economic impact perspective. The current DfT project on assessment methods for regional and local economic impacts of transport could help to fill this gap and thereby contribute to the development of the strategic case.

The economic case considers the economic, environmental, social and distributional impacts of the scheme, with the evidence derived from the WebTAG compliant economic appraisal. The composition of the appraisal summary table was changed in 2010, with the impacts now grouped under the following headings;

Economy, covering benefits to business transport users and transport providers, regeneration and wider impacts

Social, including all non-business transport users' benefits, accident savings and impacts on non-users such as severance, access and option values

Environmental, providing for a comprehensive assessment of all impacts on the environment including landscape, noise, carbon and air quality

Public accounts, including both scheme costs and revenues and the effects on indirect tax revenues.

The economic case is not based solely on the BCR resulting from the CBA part of WebTAG, but includes consideration of non-monetised impacts in a MCA-style approach when assessing the prioritisation category into which the scheme is to be placed, as detailed in section 5.4 below.

The document describing the transport business case sets out the sources of evidence to be used in developing each of the five parts of the business case. As noted in section 5.1 above, the evidence from the economic appraisal is the primary source of information which feeds into the other parts of the business case. This is supplemented by other sources, such as the results of surveys on public attitudes or behaviours which are relevant to the strategic case.

5.3. Schemes and Spending Covered by the Transport Business Case

The Transport Business Case covers the approach used by ministers when taking major investment decisions. It is not mandatory for all policy options or revenue spending but is often applied as best practice. Similarly, WebTAG guidance on economic appraisal should be followed for highways and public transport schemes requiring government approval but the guidance, or elements of it, is often applied to identify the costs and benefits of other policy options. For example, the 2004 Road Pricing Feasibility Study was supported by a full assessment of its costs and benefits through the use of WebTAG methods. The Green Book requires an ex ante appraisal for policy and revenue spending decisions. Whether or not such programmes are supported by a full, WebTAG-style appraisal would depend on whether it is appropriate and proportionate to do so. WebTAG is used to inform the decisions both about investment in enhancements that are delegated to Network Rail, drawing on the WebTAG Unit 3.13.1-2 Rail Appraisal Guidance, and to inform decisions about aviation which involve some element of government intervention, such as the provision of surface access.

5.4. Presentation of results – economic case

The Department has adopted an input indicator aimed at demonstrating that the transport schemes it approves deliver economic benefits well in excess of their costs. Guidance on how the Department assesses the Value for Money of its capital investment programme explains the relationship between the BCR derived from the economic appraisal and a wider definition of value for money. The BCR is based on all of those costs and benefits to which money values are accorded in the current version of WebTAG. As noted elsewhere in this report, the continuing process of updating and extending the Department's appraisal methods has resulted in a greater proportion of the overall benefits forming part of the monetised BCR than in the past. However, significant impacts still remain outside the scope of the monetised benefits, while there have been occasions in the past

when other benefits, while quantified, have been regarded as less robust and were excluded from the initial measure of the BCR.

The Department's Value for Money metric is derived from allocating projects to categories according to the value of their BCRs and then reviewing this categorisation in the light of the information provided in the AST about the importance of the non-quantified or other impacts omitted from the BCR. Schemes are initially classified as follows on the basis of their BCRs;

- Poor VfM if the BCR is less than 1.0
- Low VfM if the BCR is between 1.0 and 1.5
- Medium VfM if the BCR is between 1.5 and 2.0
- High VfM if the BCR is between 2.0 and 4.0
- Very high VfM if the BCR is above 4.0

Decision-makers are then required to consider whether, in their judgement, the evidence from the appraisal on the impacts that are omitted from the BCR is likely to be of sufficient importance to shift the scheme to a lower or higher VfM category. In these cases the scheme is put into the different category. The category to which a scheme is allocated is relevant because, under present financial constraints, few schemes which are outside the top VfM categories are likely to be approved. This substitution of a monetised BCR with more judgemental estimate of Value for Money is conceptually quite demanding since it implicitly values the bundle of non-monetised impacts within a range.

The delivery of projects within the high VfM categories forms one of the Department's business planning input indicators. As evidence of the Department's delivery of this objective, a record of the proportion of investment spending on schemes which are estimated to deliver "high" or "very high" VfM is published in the Department's annual business plan. The latest Plan shows that almost all spending was on such schemes and further information on these schemes is published on the DfT Websiteⁱⁱ. The detailed table shows the adjusted BCRs of the schemes, which include those monetised impacts which were at the time of the appraisal regarded as less robust and therefore not included in the "initial" BCR, and finally the VfM category. 30.3% of all investment spend is classified as in the "very high" category and 69.7% as "high". Less than 0.1% was in the medium category. A further constraint on decision-makers is the requirement imposed by Treasury on the Permanent Secretary in his role as chief accounting officer to ensure value for money from the Department's budget. Ministers are advised by the Permanent Secretary that, should they wish to approve a project which is classified as "poor" VfM, the Permanent Secretary will seek a formal written direction from the minister to proceed with the scheme. The Accounting Officer is encouraged to discuss the matter with Treasury and to take steps to inform the Public Accounts Committee.

There are other less formal constraints on ministers' decisions about the projects that they approve. The main purpose of the public inquiry into the case for the compulsory purchase of any land or property needed for the scheme is to establish whether the public interest case for the scheme justifies the government exercising the powers of compulsory purchase. Such a case is unlikely to be sustainable for schemes for which the benefits that are identified in the economic appraisal are less than the project costs.

5.5. Decision-making in Practice

A Transport Business Case should be completed at three stages in a project's life: Strategic Outline Business Case; Outline Business Case; and Full Business Case. At each stage, the relevant Investment Board will make a recommendation, based on the evidence presented in the five elements, about whether or not the project should proceed. The evidence and recommendation are then presented to ministers, who, again based on the evidence in all five parts of the business case, ultimately make the decision about whether to proceed.

The application of the Transport Business Case is still being tested and it lacks the long history that has evolved through the practice of applying economic appraisal to projects. The strategic component in particular is a challenge. It is neither the summation of the other four cases nor is it entirely distinct from them. Developing and codifying practice on what can enter the strategic case and how to maintain consistency within the Business Case as a whole is key to ensuring a consistent and evidence based approach to decision-making.

It is not possible at this stage to form a view about the weight implicitly placed on the different elements of the business case by decision-makers. Evidence from the Department's record of approving schemes with only "high" or "very high" VfM would suggest that significant weight is attached to the economic appraisal but this does not necessarily indicate that less weight is put on the other elements. For example, the economic case is generally closely aligned with the strategic case. Both include the contribution of the scheme to the government's key objectives, namely enabling economic growth and reducing carbon, with the Economic Case aiming to provide a comprehensive coverage of the impacts rather than focusing on those which are at the top of the policy agenda. It is arguable that for a typical medium sized transport project, the economic and strategic cases will generally cover the same set of impacts, with the strategic case putting more weight on the area of strategic fit, contributions to land use and development and taking specific account of the regional case for the scheme.

The quantification of some of the impacts may differ between the two cases. For example, as is made clear in the Department's 2005 Discussion Paper "Transport, Wider Economic Benefits and Impacts on GDP", the GDP based measure of the outputs of a transport scheme is very different, both in its magnitude and in the concept of what is to be measured, from the way in which the same additional output is treated in the welfare based measure in the economic appraisal. However, it is difficult to reach any general view about the respective roles of these two components of the Transport Business Case as the form of the strategic case is not codified in the same way as are the requirements of the economic case through the extensive mandatory WebTAG guidance. The other challenge area concerns the earlier stages of the project cycle. Having a clear presentation of the business case to support the final decision is important. But so too is the process by which schemes are considered for development to Full Business Case stage. This can be demanding in terms of the availability of modelling and appraisal outline results to enable screening and sifting to happen in timely fashion. This is especially true where the scheme promoter is not one of the department's agencies but a local authority or ITA.

References

All documents for WebTAG units can be found under the following links:

current, in draft and consultation: <http://www.dft.gov.uk/webtag/documents/index.php>
previous versions: <http://www.dft.gov.uk/webtag/documents/history.php>
<http://www.dft.gov.uk/webtag/documents/archive.php>

All internet links have been accessed and checked for validity 21/04/2013.

- ACTRA (1978) Report of the Advisory Committee on Trunk Road Assessment (the Leitch Committee Report) HMSO, London
- AHCG (Accent and Hague Consulting Group) (1999) The Value of Travel Time on UK Roads. The Hague, Netherlands
- Atkins and Metroeconomica (2013) Applying an Ecosystem Services Framework to Transport Appraisal. Final report to Department for Transport, February 2013
- Atkins and MVA (forthcoming) Assessing Social and Distributional Impacts in Transport Scheme Appraisal. Report to Department for Transport.
- Bateman I.J., B.H., Day, and I. Lake (2004) The valuation of transport-related noise in Birmingham. Non-technical report to the Department for Transport.
- Batley. R, Mackie P and Wardman M (2011) Review of the Value of Time assumptions for business travellers on HS2. Report to Department for Transport
[\[https://www.gov.uk/government/publications/its-leeds-peer-review-review-of-the-value-of-time-assumptions-for-business-travellers-on-hs2\]](https://www.gov.uk/government/publications/its-leeds-peer-review-review-of-the-value-of-time-assumptions-for-business-travellers-on-hs2)
- Berry, B. and Flindell, I. on behalf of the Interdepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)) (2009) "Estimating Dose-Response Relationships between Noise Exposure and Human Health in the UK"
[\[http://archive.defra.gov.uk/environment/quality/noise/igcb/publications/healthreport.htm\]](http://archive.defra.gov.uk/environment/quality/noise/igcb/publications/healthreport.htm)
- Bristow, A., Wardman, M. et al. (2003) Attitudes to Aircraft Annoyance Around Airports (5A) – Survey Report. Eurocontrol report EEC/SEE/2003/002
[\[http://www.eurocontrol.int/eec/public/standard_page/proj_5A.html\]](http://www.eurocontrol.int/eec/public/standard_page/proj_5A.html)
- Bristow, A.L., Hopkinson, P.G., Nash, C.A., Wardman, M. (1991), Evaluation of the Use and Non-Use Benefits of Public Transport, Development of Survey Methodology. Working Papers 309 and 310, Institute for Transport Studies, University of Leeds
- Carlaw, D. C., Beevers, S. D., Tate, J. E., Westmoreland, E.J., Williams, M. L. (2013) Recent evidence concerning higher NO_x emissions from passenger cars and light duty vehicles, Atmospheric Environment, Volume 45, Issue 39, December 2011, Pages 7053-7063
- Carlaw, D. C., Williams, M. L., Tate, J. E., Beevers, S. D. (2011) The importance of high vehicle power for passenger car emissions, Atmospheric Environment, Volume 68, April 2013, Pages 8-16
- CE Delft, INFRAS, ISI (2011) External Costs of Transport in Europe - Update Study for 2008. Report. Delft, November 2011
[\[http://www.cedelft.eu/publicatie/external_costs_of_transport_in_europe/1258\]](http://www.cedelft.eu/publicatie/external_costs_of_transport_in_europe/1258)
- Chilton, S., Covey, J., Jones-Lee, M., Loomes, G and Metcalf, H. (2004) Valuation of Health Benefits Associated with Reductions in Air Pollution. London: DEFRA
[\[http://archive.defra.gov.uk/environment/quality/air/airquality/publications/healthbenefits/airpollution_reduction.pdf\]](http://archive.defra.gov.uk/environment/quality/air/airquality/publications/healthbenefits/airpollution_reduction.pdf)

- DECC (2009) Carbon valuation in UK policy appraisal: a revised approach.
[\[https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41798/1_20090715105804_e_carbonvaluationinukpolicyappraisal.pdf\]](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41798/1_20090715105804_e_carbonvaluationinukpolicyappraisal.pdf)
- DECC (2011) Updated short term traded carbon values for UK public policy appraisal (October 2012)
[\[https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41794/6667-update-short-term-traded-carbon-values-for-uk-publ.pdf\]](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41794/6667-update-short-term-traded-carbon-values-for-uk-publ.pdf)
- DECC (2012) Valuation of energy use and greenhouse gas emissions for appraisal. Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government. October 2012
[\[https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal\]](https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal)
- DEFRA (Department for Food, Environment and Rural Affairs) (2007a) The Social Cost Of Carbon And The Shadow Price Of Carbon: What They Are, And How To Use Them In Economic Appraisal In The UK, Economics Group, Defra, December 2007
[\[https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42408/background.pdf\]](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42408/background.pdf)
- DEFRA (Department for Food, Environment and Rural Affairs) (2007b) An introductory guide to valuing ecosystem services. [\[http://archive.defra.gov.uk/environment/policy/natural-environ/documents/eco-valuing.pdf\]](http://archive.defra.gov.uk/environment/policy/natural-environ/documents/eco-valuing.pdf)
- DEFRA (Department for Food, Environment and Rural Affairs) (2008a) An Economic Valuation of Noise Pollution – developing a tool for policy appraisal.
[\[http://archive.defra.gov.uk/environment/quality/noise/igcb/publications/firstreport.htm\]](http://archive.defra.gov.uk/environment/quality/noise/igcb/publications/firstreport.htm)
- DEFRA (Department for Food, Environment and Rural Affairs) (2008b) Economic analysis to inform the air quality strategy:
[\[http://www.defra.gov.uk/environment/quality/air/airquality/publications/stratreview-analysis/index.htm\]](http://www.defra.gov.uk/environment/quality/air/airquality/publications/stratreview-analysis/index.htm)
- DEFRA (Department for Food, Environment and Rural Affairs) (2010a) Valuing the Overall Impacts of Air Pollution. March 2010.
[\[http://archive.defra.gov.uk/environment/quality/air/airquality/panels/igcb/documents/100303-aq-valuing-impacts.pdf\]](http://archive.defra.gov.uk/environment/quality/air/airquality/panels/igcb/documents/100303-aq-valuing-impacts.pdf)
- DEFRA (Department for Food, Environment and Rural Affairs) (2010b) Air Quality Appraisal – Valuing Environmental Limits. Interdepartmental Group on Costs and Benefits. Air Quality Subject Group. March 2010.
[\[http://archive.defra.gov.uk/environment/quality/air/airquality/panels/igcb/documents/100303-aq-valuing-env-limits.pdf\]](http://archive.defra.gov.uk/environment/quality/air/airquality/panels/igcb/documents/100303-aq-valuing-env-limits.pdf)
- Department for Transport (2005, revised 2006) Transport, Wider Economic Benefits and Impact on GDP. Discussion Paper.
[\[http://webarchive.nationalarchives.gov.uk/+http://www.dft.gov.uk/pgr/economics/rdg/webia/webmethodology/sportwidereconomicbenefi3137.pdf\]](http://webarchive.nationalarchives.gov.uk/+http://www.dft.gov.uk/pgr/economics/rdg/webia/webmethodology/sportwidereconomicbenefi3137.pdf)
- Department for Transport (2007), Highways Economics Note No.1 (HEN 1), DfT, London. Valuation of the Benefits of Prevention of Road Accidents and Casualties.
[\[http://www.medicine.mcgill.ca/epidemiology/courses/EPIB654/Summer2010/CBA/UK%20Economic%20Note%20Value%20for%20a%20life.pdf\]](http://www.medicine.mcgill.ca/epidemiology/courses/EPIB654/Summer2010/CBA/UK%20Economic%20Note%20Value%20for%20a%20life.pdf)
- Department for Transport (2009) NATA Refresh: Appraisal for a Sustainable Transport System.
[\[http://webarchive.nationalarchives.gov.uk/+http://www.dft.gov.uk/consultations/archive/2008/consulnatarefresh/natarefresh2009.pdf\]](http://webarchive.nationalarchives.gov.uk/+http://www.dft.gov.uk/consultations/archive/2008/consulnatarefresh/natarefresh2009.pdf)

Department for Transport (2011) Transport Analysis Guidance - Guidance for the Senior Responsible Officer. September 2011 [<http://www.dft.gov.uk/webtag/documents/expert/pdf/guidance-senior-responsible-officer.pdf>]

Department for Transport (2013) The Transport Business Cases. [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4467/transportbusinesscase.pdf]

Department for Transport (no date) Early Assessment and Sifting Tool (EAST) Guidance [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4475/east-guidance.pdf]

Department for Transport (2004) Feasibility study of road pricing in the UK - Full report. [<http://webarchive.nationalarchives.gov.uk/20090505152230/http://www.dft.gov.uk/pdf/pgr/roads/introtoroads/roadcongestion/feasibilitystudy/studyreport/feasibilityfullreport>]

Department for Transport (undated) Value for Money Guidance <http://assets.dft.gov.uk/publications/value-for-money-assessments-guidance/vfmguidance.pdf>

Department for Transport (2012) Business Plan 2012-2015 Department for Transport https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3367/dft-2012-business-plan.pdf

Department for Transport (2012) Input and Impact indicators <https://www.gov.uk/government/publications/input-and-impact-indicators>

DMT (Danish Ministry of Transport) (2002) Brug af samfundsøkonomiske metoder i udvalgte lande (Use of socio-economic methods in selected countries) [<http://www.trm.dk/~media/Files/Publication/2002/rapport.pdf>]

Eddington (2006) The Eddington Transport Study . Stationery Office, London

Eftec (2010) Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal [<http://archive.defra.gov.uk/environment/policy/natural-environ/using/valuation/documents/non-tech-summary.pdf>]

EGRUP (2004) Assessing the Impacts of Spatial Interventions: Regeneration, Renewal and Regional Development

Graham D.J. (2007) Agglomeration, Productivity and Transport Investment. Journal of Transport Economics and Policy vol 41 pp 317-343

Gunn H.F. (2004) SCGE Models: Relevance and Accessibility for use in the UK, with emphasis on implications for Evaluation of Transport Investments. Report to DfT.

Health and Safety Executive (2007) Valuation of health and safety benefits: Dread Risks [<http://www.hse.gov.uk/research/rrpdf/rr541.pdf>]

HEATCO (2006) Developing Harmonised European Approaches for Transport Costing and Project Assessment – Deliverable 1 Current Practice in Project Appraisal ; D5 Proposal for Harmonised Guidelines ;Deliverable 7, Final Technical Report. Stuttgart. [<http://heatco.ier.uni-stuttgart.de>]

HM Treasury (2007) Managing Public Money. http://www.hm-treasury.gov.uk/d/mpm_whole.pdf

HMT and DEFRA (2012) Accounting for environmental impacts: Supplementary Green Book guidance. February 2012 [http://www.hm-treasury.gov.uk/d/accounting_environmental_impacts.pdf]

Humphreys, R.M., Fowkes, A.S. (2006) The significance of indirect use and non-use values in transport appraisal. International Journal of Transport Economics, Vol XXXIII (1) pp17-35.

INFRAS, CE Delft, ISI, University of Gdansk (2008) Handbook on estimation of external costs in the transport sector. Report produced within the study Internalisation Measures and Policies for All external Cost of Transport (IMPACT), Version 1.1. Delft, February 2008. [http://ec.europa.eu/transport/themes/sustainable/doc/2008_costs_handbook.pdf]

INFRAS, IWW (1995) External Costs of Transport. Karlsruhe/Zurich/Paris : UIC

INFRAS, IWW (2000) External Costs of Transport : Accident, Environmental and Congestion Costs of Transport in Western Europe. Zürich/Karlsruhe : INFRAS and IWW (University of Karlsruhe)

INFRAS, IWW (2004) External costs of transport : update study. Karlsruhe/Zürich/: INFRAS and IWW (University of Karlsruhe)

Interdepartmental Group on Costs and Benefits Noise subject group (IGCB(N)) (2010) Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure.
[\[http://archive.defra.gov.uk/environment/quality/noise/igcb/publications/noisehealthreport.htm\]](http://archive.defra.gov.uk/environment/quality/noise/igcb/publications/noisehealthreport.htm)

ITS (2003) Values of Travel Time Savings in the UK. University of Leeds

ITS and Atkins (2013) Valuation of townscapes and pedestrianisation. Final Report for the Department of Transport. [\[https://www.gov.uk/government/publications/valuation-of-townscapes-and-pedestrianisation\]](https://www.gov.uk/government/publications/valuation-of-townscapes-and-pedestrianisation)

John Bates Services (2010) Stock-Take of Travel Time Variability. Report to Department for Transport. [\[https://www.gov.uk/government/publications/stock-take-of-travel-time-variability\]](https://www.gov.uk/government/publications/stock-take-of-travel-time-variability)

Lyk-Jensen, S (2007) Appraisal methods in the Nordic countries – Infrastructure assessment, Danish Transport Research Institute for Transport and Energy Ministry, Report 3, 2007 [\[www.dtf.dk\]](http://www.dtf.dk)

Mackie, P. and Kelly, C (2007) Transport Appraisal in other countries: lessons for the NATA Refresh. Report for DfT, Version 1.1. Leeds, October 2007

Mott Macdonald (2011) Bexhill/Hastings Link Road—Social and Distributional Impacts 2 vols. Report to Department for Transport

Mott MacDonald et al (2009) Productive Use of Rail Travel Time and the Valuation of Travel Time Savings for Rail Business Travellers. Report to Department for Transport
[\[https://www.gov.uk/government/publications/productive-use-of-rail-travel-time-and-the-valuation-of-travel-time-savings-for-business-travellers-final-report\]](https://www.gov.uk/government/publications/productive-use-of-rail-travel-time-and-the-valuation-of-travel-time-savings-for-business-travellers-final-report)

MVA (2008) Understanding the Passenger, Valuation of Overcrowding on Rail Services (Report for Department for Transport)

MVA, John Bates Services, Ian Flindell, RPS (2007) ANASE – Attitudes to Noise from Aviation Sources in England
[\[http://webarchive.nationalarchives.gov.uk/20071105200725/http://www.dft.gov.uk/pgr/aviation/environmentalissues/Anase/\]](http://webarchive.nationalarchives.gov.uk/20071105200725/http://www.dft.gov.uk/pgr/aviation/environmentalissues/Anase/)

MVA/ITS/TSU (1987) The Value of Travel Time Savings. Policy Journals, Newbury

Nellthorp J. and Mackie P. (2000) The UK Roads Review : A Hedonic Model of Decision Making. Transport policy vol 7 pp 127-138

Nellthorp, J., Bristow, A., & Mackie, P. (2005). Developing Guidance on the Valuation of Transport-Related Noise for inclusion in WebTAG. Leeds

NERA (2011) Updating the VPF and VPis: Phase 1: Final Report Department for Transport
[\[http://assets.dft.gov.uk/publications/pgr-economics-rdg-updatingvpfvpi-pdf/vpivpfreport.pdf\]](http://assets.dft.gov.uk/publications/pgr-economics-rdg-updatingvpfvpi-pdf/vpivpfreport.pdf)

Odgaard T. , C. Kelly and J. Laird J (2005): Current practice in project appraisal in Europe. Analysis of Country reports. HEATCO Deliverable 1.

ORR (2008) Internal Guidance on cost benefit analysis (CBA) in support of safety related investment decisions. [\[http://www.rail-reg.gov.uk/upload/pdf/risk-CBA_sdm_rev_guid.pdf\]](http://www.rail-reg.gov.uk/upload/pdf/risk-CBA_sdm_rev_guid.pdf)

Rail Safety and Standards Board (RSSB, 2008) The weighting of non-fatal injuries, T440 fatalities and weighted injuries.
[\[http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/research/T440_rb_final.pdf\]](http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/research/T440_rb_final.pdf)

- SACTRA (1998) Transport and the Economy
- Stern (2006) Stern Review on the Economics of Climate Change, HMT, October 2006
[\[http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/sternreview_index.htm\]](http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/sternreview_index.htm)
- UK National Ecosystem Assessment (2011) [\[http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx\]](http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx)
- UK National Ecosystem Assessment [\[http://archive.defra.gov.uk/environment/policy/natural-enviro/ documents/eco-valuing.pdf\]](http://archive.defra.gov.uk/environment/policy/natural-enviro/ documents/eco-valuing.pdf)
- UNEP (2003) Ecosystems and Human Well-being - A Framework for Assessment.
[\[http://www.unep.org/maweb/en/Framework.aspx\]](http://www.unep.org/maweb/en/Framework.aspx)
- WHO (2011) Health economic assessment tools (HEAT) for walking and for cycling. Methodology and user guide. Economic assessment of transport infrastructure and policies.
[\[http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/Transport-and-health/publications/2011/health-economic-assessment-tools-heat-for-walking-and-for-cycling.-methodology-and-user-guide\]](http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/Transport-and-health/publications/2011/health-economic-assessment-tools-heat-for-walking-and-for-cycling.-methodology-and-user-guide)
- Wolff, J. and S.W. Orr. (2009) Cross-Sector Weighting and Valuing QALYs and VPFs: A report prepared for the Interdepartmental Group for the Valuation of Life and Health.
[\[http://www.ucl.ac.uk/cpjh/docs/IGVLH.pdf\]](http://www.ucl.ac.uk/cpjh/docs/IGVLH.pdf)
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