STAG Technical Database Section 9

Economy

April 2015

Transport Scotland

Version History

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1	9.3.1 Agglomeration economies	September 2008
2	New section 9.3.5.1 Agglomeration benefits – zonal method (previously 9.3.1)	September 2008
3	New section 9.3.5.2 Agglomeration benefits – APARC method (previously 9.3.5.1)	September 2008
4	New section 9.3.5.3 Competition Impacts (previously 9.3.5.2)	September 2008
5	9.5.18 Vehicle operating costs (fuel)	September 2008
6	9.5.19 Rates of change in fuel VOCs	September 2008
7	9.2.2.1 and 9.5.23 – Rail Appraisal – Road Network Effects	December 2008
8	9.3.6 – Reporting Wider Economic Benefits	December 2008
9	9.5.18 Vehicle operating costs (fuel)	April 2009
10	9.5.19 Rates of change in fuel VOCs	April 2009
11	9.5.22 Rail operating costs	April 2009
12	9.2.2.9 Reliability benefits	December 2009
13	9.2.2.8 Quality benefits	December 2009
14	9.2.2.4 User benefits – values of time	December 2009
15	9.3.3 Increased output in imperfectly competitive markets	December 2009
16	9.5.13 Forecast Growth in Values of Time	April 2012
17	9.5.18 Vehicle operating costs (fuel and electricity)	April 2012
18	9.2.2.2 Traffic growth	April 2012
19	9.2 Transport Economic Efficiency (TEE)	April 2012
20	9.5.13 Forecast Growth in Values of Time	November 2012
21	9.5.6 Units of Account	November 2012
22	9.5.18 Vehicle operating costs (fuel and electricity)	November 2012
23	9.2.2.3 Growth in Public Transport Patronage	November 2012
24	9.2.2.9 Journey Time Reliability Benefits	December 2013
25	Updates to WebTAG references relating to the release of TAG2. References to Transport Scotland Economy Spreadsheet added.	May 2014
26	Hyperlink to Economy Spreadsheet added	August 2014
27	Enhanced guidance on Driver Frustration and Rule of Half Clarification	January 2015
28	Update to fuel consumption parameters used in fuel consumption (FC) equation and forecast improvements in fuel efficiency	April 2015
29	Further clarification of indirect tax revenues.	April 2015

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9. Economy

The Part 2 Appraisal against the Economy Criterion has three sub-criteria which together should summarise the full extent of economic impacts. These are:

- Transport Economic Efficiency (TEE)- the benefits ordinarily captured by standard cost- benefit analysis- the transport impacts of an option (including the use of bespoke values if appropriate and subject to approval by Transport Scotland);
- Wider Economic Benefits (WEBs)- relates to the notion of wider economic benefits derived from the impact of transport upon agglomeration, and the underlying relationship of impacts of agglomeration upon productivity; and
- Economic Activity and Location Impacts (EALIs)- allows the impacts of an option to be expressed in terms of their net effects on the local and/or national economy.

9.1 Introduction

There are two elements to the Economy Criterion – improving the economic efficiency of transport and improving the efficiency of economic activities.

In general terms, economics is the analysis of scarce resources which have alternative uses. If an economic system is Pareto efficient, then it is the case that no one person or group can be made better off without another being made worse off. In the STAG Appraisal the Economy Criterion is concerned primarily with maximising the net benefits, in resource terms, of the provision of transport. This requires maximising consumer surplus by maximising the difference between the willingness to pay of transport users and the resource costs of the provision, operation and maintenance of transport facilities – consumer surplus being measured by the difference between the maximum which an individual transport user is willing to pay to travel and the actual cost of that journey. Therefore, consumer surplus is increased when travel time, operating costs and transfer payments, such as fares, are reduced and when more transport users are able to travel due to the reduction in costs.

The impact of a transport infrastructure project on the economy is assessed via a Transport Economic Efficiency Analysis (TEE) and an Economic Activity and Location Impact (EALI) study. The Wider Economic Benefits (WEB) of a transport option, measured in terms of the additional benefits to economic development, are considered as a separate sensitivity test.

9.1.1 Transport Economic Efficiency (TEE)

The TEE analysis captures the main impacts of an option in terms of economic welfare, as represented by the main costs and benefits of users and operators of the transport system. These impacts are expressed in terms of monetary values, by Cost-Benefit Analysis (CBA), which are added together and discounted to produce a Net Present Value (NPV). Costs to the public sector are itemised separately (see Section 12 Cost to Government).

The TEE analysis presents the key effects disaggregated by particular groups, mode of transport, and by impact (time, vehicle operating costs etc.). In addition to a statement of aggregate impact (NPV, BCR), section 9.2.2.1 now requires the classification of journey time savings by the size.

A TEE analysis should be presented for each option and should demonstrate the change in costs and benefits for each option relative to the do-minimum case.

9.1.2 Wider Economic Benefits

The Economy Criterion is also concerned with improving the efficiency of economic activities. The transport costs and benefits captured by the TEE are intended to represent an acceptable approximation of the full economic impacts of a project, expressed in terms of economic welfare. However, it has been suggested that the benefits, generated through CBA, fail to capture the additional wider benefits of improved transport provision to economic development. The SACTRA (1999) report on Transport and the Economy considered in some detail the extent to which these issues are relevant and commissioned further research.

This research has come to fruition and the approach taken by STAG is to calculate these wider economic benefits (WEBs) as a sensitivity to the TEE results. The main reason for inclusion as a sensitivity is one of evaluation and monitoring – the methodology is such that it is very difficult to monitor or evaluate the benefits captured by WEBs.

Detail on the methodology to be used is presented in Section 9.3

9.1.3 Economic Activity and Location Impacts (EALIs)

Transport projects have the potential to impact upon economic performance at the local level and may influence demand for the location of economic and other activities.

Whilst the TEE and WEBs aim to capture the net economic benefits of a project at the national level, the EALI is more concerned with the spatial distribution of these national impacts to allow an assessment of the impact on the local economy. The EALI complements the TEE and WEB but does not generally identify additional economic impacts that could be added to the TEE and WEB results. Generally the EALI will restate the TEE and WEB impacts using narrower measures of economic welfare..

The nature of EALI analysis is currently subject to a review arising from the inclusion of WEBs within STAG. The current position is that WEBs refine the TEE analysis and may involve issues of double counting with EALIs. However, as TEE/WEB and EALI results are presented separately, the current view is that they represent different ways of representing the same information.

Practitioners may take the view that the inclusion of WEBs, which is a relatively arduous process may reduce the need for EALI analysis. This issue is currently under review; however, the view of Transport Scotland is that EALI analysis remains important as a tool for analysing the distributional impacts of transport, but that the resources committed to it may be reduced with the incorporation of WEBs.

The EALI component remains particularly important in assessing the distributional impact of an option and is particularly relevant to assessing how far a transport project might support regeneration policy objectives in a particular area. Where EALI impacts are expected to be significant, it is suggested that EALIs are assessed directly and presented separately using GDP and/or employment measures.

EALIs must be presented at the Scotland level, and consequently must include both local, or intra-area, impacts and inter-area impacts. Both the positive and negative impacts attributable to a scheme must be identified, including any displacement effects.

The EALI is particularly relevant to assessing how far a transport project might support regeneration policy objectives in a particular area.

9.2 Transport Economic Efficiency (TEE)

The Transport Economic Efficiency (TEE) Analysis provides guidance on how to assess the contribution which a transport option may have on economic welfare through consideration of the resultant transport costs and benefits. The transport costs and benefits captured by the TEE, and collated into an NPV, are intended to represent an acceptable approximation of the full economic impacts of a project, expressed in terms of economic welfare. It provides guidance on the principles which underpin the general approach to be followed and outlines issues and methodologies relating to different sub-criteria. Practitioners must follow this guidance and if required request advice from Transport Scotland on technical matters relating to the appraisal parameters. It should be noted that the method set out is broadly consistent with that previously specified by the Department for Transport (WebTAG) but has some key differences in the scope of impacts and in the interpretation of outputs.

Following the 1999 SACTRA report and work carried forward by DfT, the TEE analysis is now supplemented by Wider Economic Benefits (WEBs) analysis and this methodology is detailed in section 9.3.

9.2.1 Principles of TEE analysis

The central principle of transport economic efficiency analysis is to estimate the welfare gain which results from transport investment, as measured by the individual's willingness to pay for such an improvement and the financial impact on private sector transport operators. Willingness to pay should be consistent with the demand response to the improved transport opportunities.

The accepted best measure of welfare gain is the change in consumer surplus enjoyed by individuals and the change in producer surplus/deficit accruing to transport suppliers. Consumer surplus is defined as the benefit that an individual enjoys over and above the cost they would be willing to pay. In transport, cost is defined in money and time terms (usually called *generalised cost*). Thus, if an individual is currently willing to travel for 15 minutes to enjoy an activity and a transport option reduces that to 10 minutes then the time saving of 5 minutes is an accurate measure of their consumer surplus. However, if new users are attracted to use the facility (either by switching from another mode or by choosing to travel when otherwise they would not have) in response to this time saving, then it is not normally clear at what time saving they would have been willing to switch. Here, the convention is to assume that the switch would have occurred, on average, halfway between the do-minimum and do-something saving.

As the generalised cost of transport falls (from GC0 to GC1 in Figure 9.1) demand increases (from D0 to D1) along the demand schedule. The demand schedule (or demand curve) indicates the demand at different levels of generalised cost. The demand curve slopes downwards, as each additional unit of demand is generated through an incremental decrease in generalised cost.

The change in consumer surplus for each unit of induced traffic is, therefore, less than that experienced by existing users (D0). Furthermore, it becomes progressively less as each additional unit of demand is generated until, for the marginal user, the change in consumer surplus is zero. This is because the marginal user is indifferent between travelling to a new activity and undertaking the activity they were doing prior to the lowering of generalised cost.

It is unusual to know the exact shape of a travel demand curve and, therefore, it is difficult to calculate the exact change in consumers' surplus for a transport intervention.

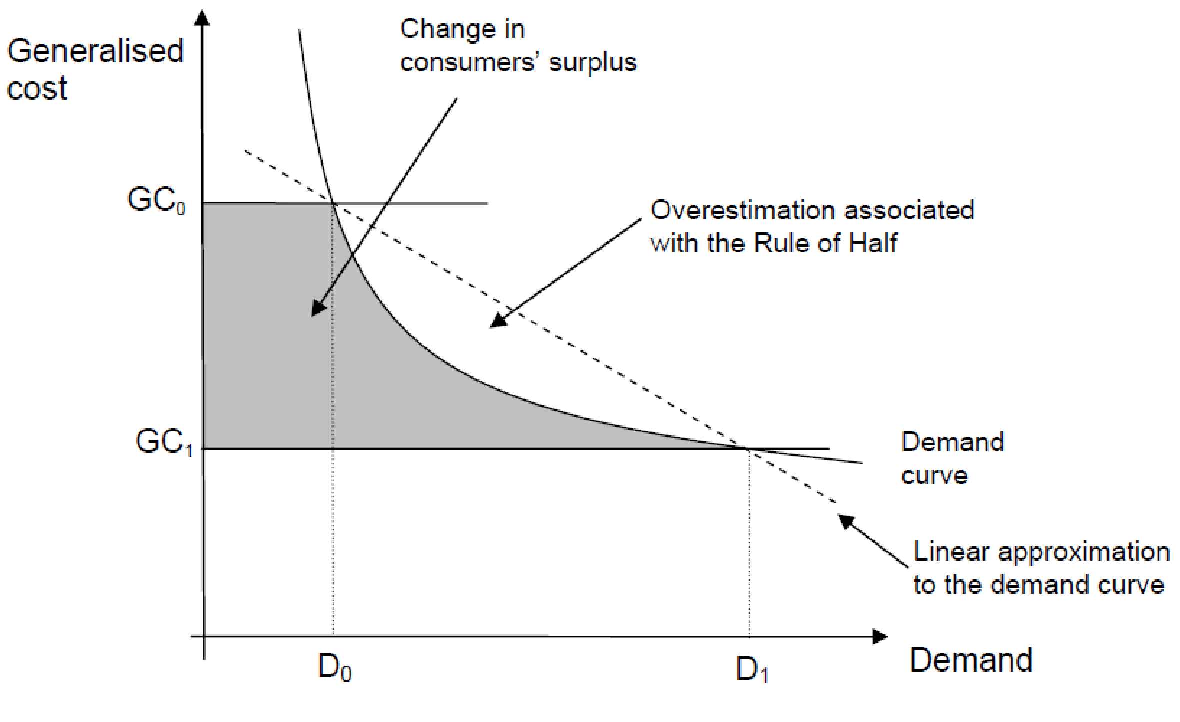
The convention, and that advocated by STAG, is, therefore, to assume the demand curve is linear. This is illustrated in Figure 9.1 Once a functional form for the demand curve has been assumed the change in consumer surplus can be calculated knowing only the generalised cost before and after the intervention, as well as the demand before and after. This approximation is known as the Rule of Half.

This approximation would attribute 2.5 minutes of benefit to new users in the above example.

An important point to note here is that the Rule of Half convention actually overestimates the change in consumer surplus. This is illustrated in Figure 9.1. The overestimation of benefit occurs as the demand curve is convex to the origin. The Rule of Half convention, therefore, assigns more value to induced traffic than it should. This is typically relatively insignificant and the methodology is still appropriate.

However, a limitation of this Rule of Half approximation is where the change in generalised cost is significant. In a mature transport network, large improvements to generalised cost are likely to be difficult to attain, however where transport networks are less developed, for example in rural areas, this is more probable. When cost changes are large the error of approximating the demand curve with a linear schedule becomes important, and so the appraisal practitioner should be aware there where changes in generalised cost are significant this overestimation is likely to be increased. The issues of large cost changes and the introduction of new modes are discussed in detail in Nellthorp and Hyman (2001)[1] and advice on how to address them is given in TUBA guidance.

Figure 9.1



1 NELLTHORP, J. and G. HYMAN. 2001. Alternatives to the rule of a half in matrix based appraisal, Proceedings of the European Transport Conference, 10-12 September, Cambridge. London: AET Transport

As in all aspects of STAG Appraisal, it is important to demonstrate, in several dimensions, the distributional impacts of a scheme within the overall TEE analysis. These include:

- Spatial impacts: how benefits and costs fall across the area of analysis or the modelled area. It should be noted that this is distinct from the spatial distributional impacts analysed in the EALI analysis.
- Socio-economic impacts: how benefits fall to different groups of the population.
- Provider/user impacts: how benefits/costs fall to public transport providers and/or users. For example, a rise in fares will reduce the consumer surplus of existing travellers (and discourage some from travelling by this mode) but will represent a benefit to the public transport provider, assuming demand is inelastic.
- User group impacts: how benefits and costs fall to motorists and/or users of public transport services.
- Time savings impacts: the distribution of journey time changes by size of those time savings.

The relative importance of different types of distributional effects will depend on the option being appraised. Where public transport operators are affected, the breakdown of costs and revenues by mode should be undertaken.

Presentation of journey time impacts by size of time saving is obligatory where a transport model has been undertaken to inform the appraisal.

The results of economic appraisals should be expressed in the market price unit of account (see section 9.5 Appraisal Parameters), i.e. including indirect taxes. This is consistent with the willingness to pay principle underpinning the calculation of benefits.

9.2.2 Calculation of TEE Inputs

Guidance for the calculation of TEE inputs is provided via the attached links.

9.2.2.1 Benefits to Transport Users

The economic benefits of transport projects are often captured through an analysis of the impacts on transport users. Benefits to users often fall into the following sub-groups:

- Transport users whose travel patterns do not change but who enjoy time saving and/or other benefits;
- Diverting users, who switch from other routes because of changes in relative (generalised) costs;
- Diverting users who switch mode in response to changes in relative (generalised) costs;
- Generated users, whose use was previously frustrated by, for example, traffic conditions on the option, route or service; and
- Redistributed users who may change their origin or destination in response to transport changes (for example, finding employment elsewhere).

Benefits typically arise from a combination of the following:

- Changes in the monetary costs of travel;
- Journey time savings achieved directly, for example by using a new road or bridge rather than the next best alternative;
- Improvements in journey time reliability or journey quality, which may be especially important for certain types of users such as delivery services;

- Improvements in journey time reliability or journey quality, such as comfort or reduction in number of interchanges.

Journey time benefits and disbenefits form a key component of transport user benefits. The process to be applied in quantifying and valuing journey time changes is well established and forms the basis for transport modelling. This is described in section 9.2.2.4 and values of time to be used in appraisal can be found in section 9.5.12.

It is acknowledged that this approach may overlook significant differences in the distribution of journey time (dis-) benefits over space and across transport users.

Economic Activity and Locational Impact (EALI) assessment seeks to understand the distribution of benefits over space.

To give greater transparency to the distribution of (dis-) benefits across transport users, appraisers should, in addition to reporting aggregate journey time (dis-) benefits as a component of overall TEE benefits or costs, present journey time changes (as savings) classified by size. Six size classifications are recommended. This data is produced by the UK Department for Transport's "Transport User Benefit Analysis" (TUBA) software program version 1.8 onwards. The information should be presented as shown below:

Size of time saving	**Total journey time savings (mins)**				**Total monetised journey time savings (£m, %, 2002 prices)**			
Classification	***Work trips***	***% total journey time***	***Non-work trips***	***% total journey time***	***Work trips***	***%***	***Non-work trips***	***%***
< -5 mins	** **		** **		** **		** **	
-5 to -2 mins	**		**		**		**	
>-2 to 0 mins	**		**		**		**	
0 to <+2 mins	**		**		**		**	
+2 to +5 mins	**		**		**		**	
>5 mins	**		**		**		**	

** Data should be provided for the 1st modelled year (after scheme opening) and for the entire appraisal period. These outputs are available from TUBA version 1.8 onwards.

While the classification and presentation of journey time changes by size provides the decision-maker with an understanding of the distribution or equity of journey time as savings among users, this does not exclude projects which do not offer journey time savings nor imply a preference for projects which result in a large number of small journey time savings. Furthermore, journey time savings should continue to be monetised using the standard equity values of time laid out in tables 9.7 and 9.8 until such time as the evidence for the value of small time savings versus large time savings is better established.

As transport projects form part of a system or network, network-wide effects should be considered. This can help show whether transport users of other modes or routes gain if an option is implemented. Network effects which will give rise to benefits to non users include:

- Reduction in journey times on other routes which arise because of some users of the other route(s) switching to the new route or switching mode;
- Improvements in journey time reliability and other aspects of journey quality, arising for similar reasons.

These impacts may be reduced as changes in travel conditions are likely to generate additional traffic on other routes, so that, for example, time savings generated as some users switch routes are reduced, while suppressed demand is released on the other routes. These effects also need to be assessed where they are likely to be significant.

These impacts, which occur outwith or external to the option under consideration, need to be identified at an early stage in the Part 2 Appraisal. Where these are likely to be important in relation to the costs and other benefits of the option, they should be quantified in the same manner as direct benefits and costs. Further guidance on how to calculate these effects is provided in Section 9.5.23.

9.2.2.2 Traffic Growth

The starting point for the assessment of road traffic growth should be the Scottish Trip End Programme (STEP) or, alternatively, the DfT database TEMPRO-NTEM. STEP provides local growth factors consistent with future land-use plans in Scotland. The socio-economic data which forms inputs to the model (population, employment etc.) and STEP are consistent with those used in TEMPRO-NTEM.

However, the factors highlighted in the following paragraphs will also need to be considered on a project specific basis.

It is necessary to make forecasts of traffic growth which distinguish and take account of:

- Growth in demand which will occur in the network whether or not the particular project is undertaken;
- Specific generated traffic growth, which should be treated where possible in a dynamic rather than static framework;
- Collateral traffic growth/generation, i.e. growth due to specific additional activity, defined below.

Provided land-use plans are not dependent on the transport option, then STEP should be the best source of information for the first of these forecasts.

Where forecasts are required to take account of generated traffic growth or in the presence of dependent housing or land use developments, it is recommended that practitioners consult the LATIS service.

If practitioners wish to adopt growth forecasts other than those derived from STEP or TEMPRO-NTEM, they should discuss alternative options with the Scottish Government, Transport Scotland or other relevant funding agency at the earliest opportunity.

In addition to the release and subsequent growth of demand (generated traffic or patronage), options may give rise to factors which alter the overall demand for travel at each level of generalised cost – a shift of the demand curve. This is here termed collateral traffic growth, in order to avoid confusion with the concept of induced traffic growth, which typically refers to direct or indirect generated traffic.

Collateral effects need to be identified and, where important, quantified. These effects are derived from a chain of cause and effect in which the transport option changes the parameters which determine the level of demand at local or national level, and can take place for a number of reasons, including:

- Land-use effects, for example where the transport investment would open up otherwise unavailable land resources for industrial, commercial and residential development;
- Mobile investment which is attracted because of improved accessibility, involving perhaps additional workers and/or the attraction of industries which raise local/regional incomes, leading to additional traffic.

These effects are traffic effects but take place through what are termed EALIs – economic activity and location impacts. As discussed below in the section 9.4 on EALIs, the essential first step is to identify the EALIs and the rationale for them, then to assess their implications for demand for travel.

9.2.2.3 Growth in Public Transport Patronage

Projected trends in public transport patronage should be considered with particular reference to local time-series trends. Practitioners may also wish to take account of:

- Industry projections of growth (for example for the rail network); and
- Forecasts produced by multi-modal area-wide models, such as TMfS.

If growth in public transport patronage is of particular importance for the option under consideration, practitioners may wish to consider developing bespoke public transport growth models. In such circumstances practitioners should discuss their methodology with Transport Scotland or other relevant funding agency.

Where demand forecasting in rail is necessary, Transport Scotland believe that it is not reasonable to expect that demand will grow infinitely and that there should be a cap on rail demand growth. For the purposes of appraisal, demand should be capped in 2032, unless there is a clear argument and explanation of why a different cap has been used.

9.2.2.4 User Benefits - Values of Time

An important factor in the assessment of the transport options is the impact on the time spent travelling, for both personal travel and freight. In order to include these impacts in the estimation of user benefits, it is necessary to put a money value on time savings. In the appraisal process, the general premise is that the value of resources used or saved is reflected in their market prices. This is the principle underlying the valuation of working time savings. However, in the case of non-working time savings, in general there is no market in which time can be traded for money, and therefore no directly observable market price exists. Instead, values are derived from users' willingness to trade money for time, obtained from either revealed preference (RP) or stated preference (SP) surveys.

The standard values of time and the factors for up-rating them are presented in Section 9.5.12.

In a multi-modal or public transport context, there is the complication that non-business travellers do not value time spent walking to or waiting for public transport at the same rate as time spent travelling in the vehicle. This disutility is different for 'commuting' and 'other' journeys. Time spent waiting for public transport services should be valued at two and a half times the value of non-working 'commuting' and 'other' time respectively; time spent in interchange on journeys on public transport should be valued at two times the value of 'commuting' and 'other' time respectively. Where an option may be specifically designed to enhance the waiting environment (for example a bus station) then local surveys to measure disutility and willingness to pay for improvements may be valuable to modify this approach. This may be particularly useful where this represents the main justification for an option.

This issue of wait time is of particular importance when appraising changes to ferry services or their replacement with fixed links. Scheduling costs are defined as the welfare cost imposed upon activity scheduling by transport constraints. Scheduling costs arise as transport constraints prevent activities being undertaken at the desired time or for the desired duration. Such scheduling costs, like travel time costs, form an disincentive to travel and therefore improvements in transport quality – through improved frequency of service – can reduce scheduling costs and improve the overall economic benefit of a transport improvement option. Scheduling costs are more relevant where headways are long and operating hours are short (before the proposed transport improvement) than where services are reasonably frequent and operating hours are also reasonable. Restrictions in departure time choices that will be the primary driver for scheduling costs. Any change in time spent waiting, which is taken as half the service interval, should be included and valued as set out above.

There is also evidence that travellers are willing to pay to avoid interchange between modes in addition to the reduction in time spent waiting for the subsequent leg of the journey.

This 'interchange penalty' must be included in changes to benefits. The factor to allow for this disutility will normally lie in a range between 3 minutes and 15 minutes for urban travel, depending on the quality of the interchange and the distribution of perceptions of users, which can vary widely. Research commissioned by the Scottish Government derived values of 4.5 minutes for bus users and 8 minutes for rail users, each based on research in large cities.[2] For interurban rail travel, the value will be higher. The use of an appropriate value should be justified either through establishing local values through research or with recourse to comparable examples elsewhere. Practitioners should be careful not to double-count time spent waiting for a connecting service within an appropriate interchange penalty.

9.2.2.5 Indirect Taxation Adjustments

All costs and benefits should be quoted in market prices (see Appraisal Parameters Section 9.5.6). The market price values of time for working time include a mark up for indirect taxes of 19.0%, which is equivalent to the average rate of indirect taxation in the UK economy. For non-working time, the benefit is perceived by the individual and is therefore inclusive of indirect tax. These market price values should be used as set out in Section 9.5.6.

In disaggregating the impacts upon user groups, allocations of financial impacts between Government and others is required. For example, a saving in fuel costs for drivers should be valued at current market prices (i.e. including fuel duty), but on the other side of the equation the loss of tax revenue to Government needs to be taken into account. Practitioners should refer to Section 12 Costs to Government.

[2] Laird J., Review of Economic Assessment in Rural Transport Appraisal, (2009), http://www.scotland.gov.uk/Publications/2009/10/29110947/0

9.2.2.6 User Charges

In general terms, any additional charges paid should be treated as a cost to travellers (i.e. a negative value in the AST) and a reduction in charges should be treated as a benefit. For users who switch mode from car to public transport, the additional fare paid will be a disbenefit to the car user, but they will also make a financial gain in terms of savings in vehicle operating costs.

9.2.2.7 Changes in Vehicle Operating Costs

Transport proposals can generate changes in the operating costs incurred by the user. Vehicle operating costs are defined as costs that vary with vehicle usage and are based on vehicle-miles travelled. These costs include fuel, tyres, oil, maintenance, repairs, and mileage-dependent depreciation. This comes about due to changes in the volume of car travel, both through mode switching or induced traffic, and in the speed and distance travelled as a result of route changes.

Vehicle Operating Cost (VOC) calculations should be consistent with the parameters included in Section 9.5.17. This incorporates future changes in the resource cost of fuel and in vehicle efficiency.

9.2.2.8 Quality Benefits

Journey quality could be considered as an important determinant of travel behaviour. For example, it is reasonable to expect that poor journey quality could act as a deterrent to mode or route choice or as a disincentive to make a journey. Travel decisions may be based on the weakest link in the journey and addressing poor quality travel elements may therefore remove barriers to travel.

In transport appraisal there is a debate as to whether willingness to pay for quality benefits should be included in the TEE analysis. However, it is invariably the case that the costs of quality improvements are subsumed within option costs. By not including perceived benefits, there would be a problem of bias against those options that have an explicit objective to improve quality. Willingness to pay for quality benefits has been investigated through stated preference research but the absence of definitive values for quality improvements persists. Consequently, quality benefits should typically be assessed qualitatively in the TEE analysis.

An exception to this under certain circumstances is driver frustration. Depending on the nature of the appraisal and the existing problems, a quality benefit which may be appropriate to apply relates to how the transport interventions will relieve driver frustration. Driver Frustration relates to the psychological state that occurs when a driver is blocked from making progress towards the goals of their journey. The Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 9 lists driver frustration as one of the three components of driver stress. The remaining two components of driver stress are fear of potential accidents and uncertainty relating to the route being followed.

Research undertaken on the monetisation of driver frustration for a rural single carriageway A-class trunk road has found that there is a statistically significant value of time uplift relating to: the presence of oncoming traffic, the degree to which travel is below desired speed; and the number of HGVs in the platoon ahead. These relationships were derived from:

- an experimental study which involves road users watching bespoke computer-simulated video clips showing a range of variables, and accompanying questionnaires for road users to rate frustration on a scale; and
- a stated preference (SP) self-completion route choice exercise.

Values of time multipliers are derived from users' willingness to trade route choice options obtained from SP surveys. In most circumstances the value of time multipliers are not transferrable between routes and bespoke value of time multipliers should be applied. Outputs from microsimulation modelling relating to factors which may cause driver frustration by link and vehicle purpose for each time period can be used to apply the value of time outputs thus providing Present Value of Benefits (PVB) related to relieving driver frustration.

By comparing actual total link time and perceived total link time additional time perception can be quantified. Applying standard values of time allows the values to be monetised. It is necessary run and average a minimum of five seed runs of a microsimulation model to provide robust results. The monetisation of driver frustration applies only to drivers and not to passengers.

Caution should be exercised in applying value of time multipliers to reflect travel at below desired speed as the application of travel at below desired should apply to free flow time. Research is ongoing to refine to refine the range of values which are affected. Until this research is finalised it is recommended to present the monetisation of driver frustration as a sensitivity to the standard TEE analysis.

9.2.2.9 Journey Time Reliability Benefits

The measurement, assessment and valuation of journey time reliability has gained increasing recognition as the potential contribution of projects to improved journey time reliability has been realised, most notably, in the case of Intelligent Transport Systems (ITS) projects.

Travellers are sensitive to the consequences, such as prolonged waiting times, missed connections and arrival at the destination either before or after the desired or expected arrival time. Over time, there is evidence to suggest journey time unreliability, valued more highly than journey time, can itself become predictable and, correctly or incorrectly influence traveller mode or route choice.

Evidence suggests that travellers value changes in excess travel time (i.e. late running) higher than changes in scheduled travel time and that the value of journey time depends on the probability of delay.

Scoping
Transport Scotland recognize that the calculation of reliability benefits can be resource intensive, depending on the modelling tools which practitioners have available. As such, it is important that the need to undertake an assessment of reliability benefits is properly scoped at Part One Appraisal, to ensure that the resource dedicated to the analysis is proportionate to the requirements of the study and the scale of the expected impacts.

Definitions
Journey time reliability is defined as the variation in journey time that drivers or passengers cannot predict. It arises from random and non-random effects as follows:

- Day to day variability- variability in congestion in the same period every day;
- Variability due to random events including incidents, accidents etc.

Appraisal is normally concerned with journey time unreliability as a problem or issue to be measured and addressed. Conversely, the assessment of potential improvements to journey time reliability forms the basis for the evaluation of benefits associated with a project.

Public Transport Journey Time Reliability measurement and evaluation
Reliability in the context of public transport is conceived of in terms of "lateness" defined as the difference between travellers' actual and timetabled arrival times. Note, early arrivals are ignored in the valuation of public transport journey time reliability. In the case of rail, early arrivals are recorded but not used in the calculation of Passenger Performance Measures (PPM).

Two measures of lateness must be considered: average lateness; and the variability of lateness, measured by the standard deviation of lateness. To assess these and the number of passengers affected, data from a number of sources is required:

- Service timetables;
- Service headways;
- Recorded delay information;
- Passenger Performance Measures (PPM) for relevant rail routes and operators;
- Proportion of rail services subject to delay;
- Estimates of current and forecast passenger demand by origin-destination (or journey length) and journey purpose for relevant services and routes with and without the project.

A measure of rail performance must also examine the rate of cancelled services or reliability. To make allowance for the total lateness caused by cancelled trains we usually multiply the service interval by 1.5. This cancellation factor is in line with the notion that in this case the delay impacts on waiting rather than in-vehicle time. Waiting time incurs higher disutility than in-vehicle time because of the additional discomfort involved. The resulting lateness should then be multiplied by the lateness factor of 3 to capture the full costs of poor performance.

Therefore a central lateness factor of three, which includes the uplift of 20% for a change in variability, should be used in the general case. Where sufficient evidence can be provided to justify the application of a different lateness factor a value higher or lower than 3 should be adopted. In the general case one minute of average lateness is valued by passengers as being equivalent to three minutes of scheduled journey time. This conversion to scheduled journey time allows us to place a monetary value on reliability using the appropriate value of time.

Where no delay data is available for an intermediate station the analyst should use delay data from the final destination. In this case it may be appropriate to use a different lateness factor. But a robust rationale should be provided for any departure from the recommended central factor of 3.

The Passenger Demand Forecasting Handbook (PDFH) provides guidance for the measurement and valuation of lateness and unpredictable delay affecting rail passengers and the assessment of the impact of rail projects upon journey time reliability.

To estimate the monetised benefit of changes in the variability of lateness (for public transport), money values are needed. The concept of the reliability ratio enables changes in variability of lateness or of journey time to be expressed in monetary terms. The reliability ratio is defined as:

Reliability Ratio = Value of SD of lateness / Value of lateness.

Broadly, the value of average lateness for public transport is expected to be the same as the value of time spent waiting for public transport, that is, at 2.5 times the value of in-vehicle time; the value of the reliability ratio ranges from 0.6 to 1.5 for public and about 0.8 for private passenger travel.

For the purposes of appraisal, the recommended reliability ratio values are shown below:

Journey Purpose	Mode	Reliability ratio
All	Train	1.4
All	Bus/Tram/Metro	1.4

If the reliability ratio has a value of, for example 0.5, then a 1 minute reduction in the standard deviation of delay is equivalent to a 0.5 minute reduction in mean delay.

Given that it is rare that we ever have a complete knowledge of the delay distribution with which to calculate the standard deviation of journey time, an alternative method can be used. 'The Valuation of Reliability for Personal Travel', Transportation Research Part E 37, Bates, J., Polak, J., Jones, P and A. Cook (2001) suggested that it is the "pure" lateness effect which tends to dominate the calculations, because the effect of variability is less important given that rail passengers have already made some "compromises" in selecting arrival or departure time of their preferred scheduled train.

Indeed, as noted earlier, some travellers may find that variability brings them closer to their preferred arrival time than an "on-time" arrival would. Consequently a 20% uplift of the lateness factor is an acceptable proxy for the additional disutility incurred as a result of variability in delay.

Road Journey Time Reliability measurement and evaluation

The preferred measure of journey time reliability for drivers and passengers on the road network is the standard deviation in travel time for a particular hour/period of the day. This, by definition, assumes travel times are normally distributed. Reliability can be usefully stated as the coefficient of variation; the ratio of the standard deviation of journey time and average journey time for a particular hour/period of the day. This can be complemented by an assessment of reliability, which may reflect:

- the consequences for subsequent activities should unexpected variability arise;
- the likelihood of encountering an incident which reduces capacity and
- other implicit effects which cause unreliability and variability in the average journey times.

The current standard deviation of journey times on a route-by-route basis can be calculated using observed data from a range of sources including bluetooth and floating vehicle journey time data and from data automatic traffic counters (see section 2.4.1)

The appraisal of transport schemes or policies should aim to place a value on any changes to unpredictable journey time variability because of the extra costs it incurs on drivers and passengers. To estimate the monetised benefit of changes in the variability of journey time (for private road vehicles), money values are needed. The concept of the reliability ratio enables changes in variability of lateness or of journey time to be expressed in monetary terms. The reliability ratio is defined as:

Reliability Ratio = Value of SD of travel time / Value of travel time

Using a standard value of time, the value of the standard deviation of journey times can be calculated using the recommend reliability ratio values below.

Journey Purpose	Mode	Reliability ratio
Commuting/Business/Other	Car	0.8

The way in which the change in the level of JTV is forecast will, in the light of current knowledge, vary according to the context. Different methodologies have been developed for inter urban motorway and dual carriageway roads, urban roads, and other roads, as discussed below.

In appraising travel time reliability on highway schemes, it is important to distinguish whether the scheme being appraised is an Urban Road (defined usually as having a speed limit of 30 or 40 miles per hour) or Inter Urban Road (which usually have a speed limit of 50 plus miles per hour). On Inter Urban Roads it is also important to further distinguish between Motorway roads; Dual carriageway roads and single carriageway roads.

Inter Urban Motorway and Dual Carriageway Variability

Research has shown that as long as demand is below capacity, incidents will be the main source of JTV, and DTDV is much less important except in urban areas where the two effects cannot be readily separated. The additional delays caused by congestion unrelated to incidents and any associated variability can be assumed to be allowed for in the journey time forecasts. However, in the case of delays due to incidents a separate element for average delays will usually need to be added to the variability element.

INCA (Incident Cost Benefit Analysis) enables the estimation of the monetised benefits of measures affecting journey time variability covering incidents on motorways and dual carriageways. INCA requires substantial inputs from a suitable transport or traffic model of the scheme being appraised. The INCA model derivation assumes a dual carriageway layout and the parameters are based on data for motorways only. It is therefore not suitable for single carriageways, though the model may be used for dual carriageways as well as motorways. The resulting estimates of benefits cannot be taken to be as robust as those for time savings or accident reductions, for example.

The outputs of INCA reflect how delays caused by incidents may vary according to the severity and length of the incident, the number of lanes blocked and the volume of traffic at the time. Changing the number of lanes available to traffic changes both the probability of encountering an incident (or its aftermath) and the delays caused by incidents

For motorways and dual carriageways, alternative routes avoiding particular sections usually have limited capacity making it difficult for large numbers of drivers to divert if they encounter delays due to an incident. In the absence of significant "transient excess demand" (temporary periods of demand exceeding capacity), incidents are the main source of unpredictable variability and INCA should be used. Practitioners should refer to the latest release note and model documentation prior to use.

Urban Road Variability

Models predicting journey time variability from all sources have been developed for urban areas. In such areas alternative routes are more readily available than on motorways and there are many ways for drivers to divert away from incidents which reduce capacity on a particular route. This affects the relative importance of incident and day to day variability (DTDV) effects.

A generalised model has been developed which permits the forecasting of the Standard Deviation of Journey Time for urban roads.

The model takes, as input, forecast Journey Time (t) and Distance (d) for each origin to destination flow. These can be estimated or taken from a suitable transport or traffic model. The model is subject to the assumption that the distribution of trip distances (alternatively, Origin-Destination distances within the demand matrices) and free-flow speeds do not change as a result of the scheme.

The change in journey time variability (represented by $\Delta\sigma_{ij}$) is given by:

$$\Delta\sigma_{ij} = 0.0018\,(t_{ij2}^{\;2.02} - t_{ij1}^{\;2.02})\,d_{ij}^{\;-1.41}$$

Where

- t_{ij1} and t_{ij2} are the journey times for the journey from **i** to **j** (seconds) between the Do Minimum/Reference Case ("before") and the Do Something ("after").
- $\Delta\sigma_{ij}$ is the change in standard deviation of journey time for the journey from **i** to **j** (seconds) between the Do Minimum/Reference Case ("before") and the Do Something ("after").
- d_{ij} is the journey distance from **i** to **j** (km)

The reliability benefit applying the rule of a half is therefore calculated using:

$$Benefit = -\sum_{ij} \Delta\sigma_{ij} * \left(\frac{T_{ij2} + T_{ij1}}{2}\right) * VOR$$

Note that the value of reliability (VOR) is obtained by multiplying the value of time by the reliability ratio and T_{ij1} and T_{ij2} are number of trips before and after the change.

The model permits the calculation of reliability benefits for travellers with different journey purposes and corresponding trip length distributions.

Although the model above can be used to estimate the effect of schemes and their reliability benefits in urban areas, a locally calibrated model or at least a local validation is preferable.

Other Road Types

For journeys predominantly on single carriageways outside urban areas, it is not currently possible to estimate monetised reliability benefits.

Assessing journey time reliability benefits in multi-modal environments

For multi modal studies, highway and public transport reliability should be measured and appraised separately, employing the methods currently available for each mode.

Reporting Reliability

Journey time reliability benefits should be identified separately from the standard TEE benefits, and not included as part of the core NPV or BCR. They should be reported and details included within the ASTs.

9.2.2.10 Impacts on Private Sector Operators

Impacts on private sector transport providers should be recorded in the TEE analysis. These include changes in investment costs, operating and maintenance costs, operator revenues and grant/subsidy payments. In all instances the cost included should be adjusted for optimism bias (see section 13.3).

Financial costs (and benefits) to the Government should not be included in the TEE assessment. These impacts are covered in Section 12. The cost to Government should be compared with all of the benefits (i.e. across all five STAG Criteria) in order to assess overall value for money rather than the costs and benefits quantified in the TEE analysis.

9.2.2.11 Revenues

Extra revenue should be treated as a benefit to operators. Revenues are related to user charges, as user charges (fares etc) represent money transfers from users to operators which become revenues from the operator's point of view. However, this does not mean that the economic benefit of changes in user charges is the same to the traveller and the operator. In fact, for travellers, the economic benefit of a change in charges is the resultant change in their consumer surplus. For those who do not change their behaviour, the change in consumer surplus is the same as the change in money paid, but for those who do change their behaviour, this is not the case. For operators, however, the economic benefit of a change in charges is simply the change in net revenue received. Therefore, the values for User Charges under User Benefits and the values for Revenues under Private Sector Operator Impacts will usually not be equal in size.

In many cases extra revenues to one operator will to some extent represent a transfer from other operators. For example, a rail investment may lead to modal switch from buses, which represents a loss to bus operators. Where such impacts are likely to be significant, they should be taken into account and the revenue impacts should be disaggregated by mode in order to identify the distributional effects.

9.2.2.12 Investment Costs

These should include all infrastructure costs and vehicle costs incurred by private sector operators which are additional to those incurred in the do-minimum scenario. Fees, design, land acquisition and other preliminary works should be included. Investment costs should always be recorded as a negative entry in the TEE table.

9.2.2.13 Operating and Maintenance Costs

Operating and maintenance costs should include the additional annually recurring costs incurred by the private sector in running and maintaining the facility. Examples of these costs include operating costs for new public transport services, and maintenance costs of vehicles and facilities. Operating and maintenance costs should always be recorded as a negative entry in the TEE table.

9.2.2.14 Grant and Subsidy Payments

In the majority of cases, private sector operator revenues are unlikely to cover the investment and operating costs of an option, and hence some form of grant or subsidy will be required to deliver actions by private sector operators (e.g. First ScotRail, bus operators, etc). Any such grant or subsidy represents a benefit to operators and these should always be recorded as positive amounts in the TEE table.

At the appraisal stage funding agencies are unlikely to be able to give commitments or to be precise about the amounts of support likely to be available. However, the deficit arising from private sector provision without the benefit of grant or subsidy will be indicative of the level of support likely to be required to deliver the strategy or project (although it should be noted that the private sector is likely to require an additional profit margin/return on capital). Consideration should also be given to whether the level of grant or subsidy would be likely to meet the relevant decision criteria published by funding agencies.

There may be a need to disaggregate the market into different operators in order to assess overall subsidy requirements. For example, a rail enhancement may lead to a loss of bus revenue but there will generally be no requirement to compensate the bus operator (although this should still be recorded as a disbenefit to bus operators under "revenues").

In some cases, it may be possible to identify potential developer contributions. In effect, these are 'negative grants', which should be recorded both as a cost to the private sector and a benefit to the public sector (for further guidance please refer to Section 12 Cost to Government). In the TEE table, these appear as negative benefits, while in the Public Accounts table they appear as revenues. Including these contributions in the Public Accounts table clarifies their effect in reducing demands on public funding for schemes, while their inclusion in the TEE table highlights their impact on business.

9.2.2.15 Freight Benefits

The inclusion of freight user benefits should not be used other than those delivered through operating cost and time savings.

Changes to the transport network which impact on freight can affect businesses and the economy in two ways:

- Cost changes – any change to freight operating costs as a result of a transport intervention is transferred to the recipient and eventually the consumer; and
- Production changes – changes in freight provision which allow firms to improve their production results in greater output and therefore consumption within the economy.

When assessing the costs and benefits of any potential transport option, the current STAG methodology already takes account of key factors such as the value of time, vehicle operating costs and network characteristics. Consequently, the first impact is already well accounted for in any transport appraisal assuming the correct data defining actual and projected freight traffic is input into the assessment.

The second impact has traditionally been difficult to capture within appraisals and often ignored. It should be pointed out that this was an issue which related not only to freight, but to all travel which affected businesses' daily operation, such as business travel, etc. This impact is now captured under the Wider Economic Benefits of the Economic Appraisal. As a result Transport Scotland continue to believe that that potential freight impacts are appraised to the same standard as all other impacts within the transport appraisal.

9.3 Wider Economic Benefits

The second sub-criterion found under the Economy Criterion, concerns Wider Economic Benefits (WEBs) derived from the impact of transport upon agglomeration, and the underlying relationship of impacts of agglomeration upon productivity.

A set of suggested methodologies for appraisal of Wider Economic Benefits was published by the UK Department for Transport in summer 2005 covering a range of welfare and GDP benefits. Four possible further types of additional transport impacts were identified:

- WB1 Agglomeration economies
- WB2 Increased competition as a result of better transport
- WB3 Increased output in imperfectly competitive markets
- WB4 Wider benefits arising from improved labour supply

9.3.1 Agglomeration economies

"*Economies of agglomeration* describe the productivity benefits that some firms derive from being located close to other firms. This could be because proximity to other firms facilitates more sharing of knowledge or because locating close to other firms means access to more suppliers and larger labour markets."[3]

The methodology employed for measuring a firm's access to markets is 'effective density' (Graham, 2005). Effective density is a measure of the accessibility of zone *i* to jobs in all zones. The formula for effective density, of zone i, in situation *X* (*X* is base, Do-minimum or Do-Something) is given by:

$$d_i^X = \sum_j \left\{ \frac{E_j^X}{(g_{ij}^X)^\alpha} \right\} \qquad (1)$$

where E_j^X is the employment in zone *j* and $(g_{ij}^X)^\alpha$ is the generalised cost of travelling between zone *i* and *j* in situation *X*. The parameter α represents the importance of distance in determining access to markets.

As such, although termed agglomeration benefits, practitioners should not assume that these benefits are exclusive to dense agglomerations, as the theory underlying them, that improved transport provides benefits by giving firms better access to markets and factors of production, applies equally to both areas of high and low initial levels of agglomeration. The name is an indication that benefits area associated with increases in agglomeration, rather any particular base level. Indeed, research suggests that there are diminishing returns to agglomeration, which implies that the greatest potential for a given change in transport costs to result in agglomeration benefits is in areas with a low initial effective density.

[3] Transport, Wider Economic Benefits and Impacts on GDP, *Department for Transport* (2006)

As a result, practitioners should not assume that agglomeration benefits will be focussed in urban areas rather than rural ones. Indeed, within agglomerations, which tend to have a very mature transport infrastructure, evidence shows that it is difficult to generate significant changes in the overall cost of travel and as such it is unlikely that any single transport scheme will result in significant changes to effective density in an agglomeration.

In contrast, although more rural areas will tend to have a smaller population exposed to any change in effective density, it is possible to achieve greater changes in transport costs, and therefore more significant changes in effective density, in these areas.

Practitioners should note, however, that any estimated agglomeration benefits will be affected by the assumptions regarding the α parameter. Although current best estimates of the value of α are that it is equal to one, this is an area subject to ongoing research and it is possible that it will be revised in the near future. As such, estimates of agglomeration benefits have a relatively high degree of associated uncertainty, and are to be treated as a sensitivity to the standard TEE analysis. Further detail on the calculation of agglomeration benefits and the parameters to be used is given in Section 9.3.5.

9.3.2 Increased competition as a result of better transport

Benefits arising from increased competition as a result of transport improvements (WB2) was identified by DfT as theoretically possible. The current position at DfT is that there is little evidence to be found on the relationship between transport and competition and on the basis of that available, DfT does not expect that there will be significant wider benefits owing to increased competition.

There is a view among analysts in Transport Scotland that due to geographical reasons this may not be the case within certain parts of Scotland. In the absence of further information, the current position is that WB2 be treated as neutral.

9.3.3 Increased output in imperfectly competitive markets

"Where there is imperfect competition in a market, we've seen that the value placed on additional production, the price, is normally higher than production costs. Firms and consumers would therefore be jointly better off if firms were to increase production. If better transport induces firms to increase production there are precisely such benefits … the value attached to time savings would underestimate the true benefits."[4]

As set out by the DfT (2005) WB3 is calculated on the basis of an "uprate factor" *V* applied to the direct cost savings to firms, i.e. business time savings (BTS) and reliability gains (RG).

$$WB3 = (BTS + RG).V$$

where *V* is an uplift factor based on price-cost margins. The simple and recommended way of calculating this benefit is to apply an appropriate uplift to business user benefits. At present this uplift is 10% in almost all cases.

[4] Transport, Wider Economic Benefits and Impacts on GDP, *Department for Transport* (2006)

Recent research commissioned by Transport Scotland has indicated that price cost margins are likely to be higher in rural areas. [5] In such situations, it is reasonable to apply a higher uplift. For schemes in very remote rural areas, defined in accordance with the Scottish Government 8-fold urban rural classification as areas with a population of less than 3,000 and over a 60 minute drive time to a settlement with a population of 10,000 or more, an uplift of 20% should be applied. Note that, for schemes which impact on journeys across different area types, the uplift should be applied only to business journeys which originate or terminate in very remote rural areas. Due to limited evidence for the scale of this impact (data is only available for fuel costs, rather than all business costs), the 20% uplift should only be applied as a sensitivity.

9.3.4 Wider benefits arising from improved labour supply

The DfT's work identifies three labour market effects which could have consequences for GDP and which may contribute to welfare benefits through the tax take:

- WB4a: More people choosing to work as a result of commuting time savings (because one of the costs of working – commuting costs – has fallen)
- WB4b: some people choosing to work longer hours (because they spend less time commuting)
- WB4c: relocation of jobs to higher-productive areas (because better transport makes the area more attractive to firms and workers).

The data requirements for WB4 are extensive and further guidance on the application within Scotland will be forthcoming.

9.3.5 Calculation of Wider Economic Benefits

This section details the current position regarding the calculation of Wider Economic benefits (WEBs) within the STAG Appraisal. Details on the presentation of results are given in 9.3.6 but it should be remembered at all times that the current position is that WEBs should be treated as a sensitivity to standard TEE analysis.

9.3.5.1 Agglomeration Benefits – Zonal Method

The methodology proposed (DfT, TAG Unit A2.1)is based on the observed correlation between density of employment and productivity.

$$WB1 = \sum_i \left[\left[\left(\frac{d_i^S}{d_i^B} \right)^e - \left(\frac{d_i^M}{d_i^B} \right)^e \right] \times h_i \times E_i^S \right] \qquad (2)$$

where:

WB1 are the agglomeration benefits of the option (the 'do-something' situation (S)) compared with the do-minimum situation (M), to be calculated; *i* is a zone for which agglomeration benefits are being calculated - all of the modelled zones are included in the summation; d_i^S, d_i^M are the effective densities of zone *i* in the do-something

[5] Laird J., Review of Economic Assessment in Rural Transport Appraisal, (2009), http://www.scotland.gov.uk/Publications/2009/10/29110947/0

situation S and do-minimum situation M respectively, calculated as shown below; d_i^B is the effective density of zone *i* in the base year (all other values are for the forecast year), likewise calculated using the formula shown below; *e* is the elasticity of productivity with respect to effective density (Graham D.J, (2005)"Wider Economic Benfits of Transport Improvements); *h* is GDP per worker in *i* (see 9.3.5.1 below); and E_i^S is employment (in the do-something case).

Effective density is a measure of the accessibility of zone *i* to jobs in all zones. The formula for effective density, of zone i, in situation *X* (*X* is base, Do-minimum or Do-Something) is given by:

$$d_i^X = \sum_j \left\{ \frac{E_j^X}{g_{ij}^X} \right\} \qquad (3)$$

where E_j^X is the employment in zone *j* and g_{ij}^X is the generalised cost of travelling between zone *i* and *j* in situation *X*. This notion of generalised cost is given by a weighted average over:

- Passenger travel (commuter and in-work purposes) and goods movement;
- Traveller modes or goods vehicle types;
- Car-ownership levels, for passengers; and
- Times of day, routes and public transport sub-modes.

The weights used in these steps are the numbers of trips (persons or goods vehicles) by mode and purpose in the base case. These weights are based on the numbers of trips between the pair of zones considered in each calculation.

A detailed transport model, such as Transport Model for Scotland (TMfS), can be used to produce a value of agglomeration benefits using the methodology outlined above.

9.3.5.2 Agglomeration Benefits – APARC Method

Using a combination of the Transport Model for Scotland (TMfS) and its land-use component – Transport Economic Land-use Model of Scotland (TELMoS), it is possible to implement the methodology discussed above in Scotland. The level of disaggregation is to each TMfS zone. This is fairly time consuming and requires, at the very least, the use of TMfS.

An alternative, simpler approach is outlined here - the Agglomeration Productivity Aggregate Response Calculator. It should be noted that this approach does not significantly differ theoretically from that discussed above, but is simply an alternative and less resource intensive application. In practice either approach may be used.

The basic principle of the approach is to define a single zone for the purposes of the calculation,.

Applying this assumption means that equations 1 and 2 become:

$$WB1 = \left[\left(\frac{E^S}{g^S} \bigg/ \frac{E^B}{g^B} \right)^e - \left(\frac{E^M}{g^M} \bigg/ \frac{E^B}{g^B} \right)^e \right] .h.E^S \qquad (3)$$

Where superscripts *S* and *M* indicate the do-something and do-minimum cases respectively. The key term is *g*. This represents, under the single zone assumption, a measure of the generalised cost of travelling in the defined zone. It is helpful to rewrite equation 3 as:

$$WB1 = \left[\left(\frac{E^S}{E^B} \frac{g^B}{g^S} \right)^e - \left(\frac{E^M}{E^B} \frac{g^B}{g^M} \right)^e \right] .h.E^S \qquad (4)$$

and thus, the terms $\frac{g^B}{g^S}$ and $\frac{g^B}{g^M}$ represent the ratio of the generalised cost of travel in the base year versus the do-something and do-minimum respectively. This is useful as it means that the precise form of generalised cost is not important – what is important is the proportional change of both the do-minimum and do-something over the baseline. This method has the advantage in that the modelling resource requirements are kept to a minimum – any transport model should, in theory, be able to generate a change in total generalised cost.

It is worth noting that g_{ij}^X as originally defined is a distance based measure – two zones are clearly a physical distance apart as the crow flies although new infrastructure may mean the distance that needs to be traveled may change. The generalised cost measure in the aggregate case is not distance based in the same way.

The first data requirement is the elasticity parameter, *e*. The current best estimate of this value is 0.041.

Values are also required for *h*, the level of GDP per worker in the zone. In order to avoid double counting, this value is kept constant between the do-minimum and do-something scenarios.

It is also suggested that total employment is assumed to be constant between the do-minimum and do-something.

Standard assumptions should be applied in terms of GDP and employment growth from the base to the forecast year or years and onward. For consistency with current appraisal techniques, all values are expressed in 2010 prices and discounted over 60 years from scheme opening using standard Green Book values.

These parameters are fixed and suggested values are given in Table 9.1 below for base years between 2002 and 2006. Note that when TMfS is used to calculate agglomeration benefits, it calculates the generalised cost of travel for Scotland as a whole, and therefore national employment and GVA per worker figures should be used. These are also given in Table 9.1. Practitioners should note that the 2% GVA growth figure will be adjusted over time in line with the Government Economic Strategy.

Table 9.1 – Agglomeration Productivity Aggregate Response – Fixed data:A parameter	1				
Elasticity parameter	0.041				
GVA growth (per annum)	2%				
Employment growth (per annum)	0.2%				
	2002	**2003**	**2004**	**2005**	**2006**
Employment (000's)	2341	2390	2402	2411	2405
GVA per worker (2002 prices) £	31,653	31,925	32,556	33,389	33,680

The method of arriving at a measure of total generalised cost (GC) for each case is as follows:

1. For each mode/time of day a measure of GC per km traveled is calculated.
2. The total measure of GC is calculated, for each case, by multiplying the GC/km figure for each mode and time of day by the appropriate level of vehicle km in the **Base**.

It should be noted that there may be variations in the amount of information provided into the above calculation. If this is the case then the basic principle outlined should be followed.

This is consistent with the full methodology and captures the fact that agglomeration is dependent on the impact of changes in the transport system compared with the base. It is worth noting that congestion effects, etc., are captured in the case specific GC figures.

Equation 4 should be used to calculate the extent of agglomeration benefits in each of the forecast years. Values should be discounted back to 2010 for consistency with standard appraisal. If a single forecast year is available, then the agglomeration impact should be held constant in subsequent years. If two forecast years are available, linear interpolation should be used to calculate interim values and the agglomeration benefits should be held constant after the second forecast year.

A spreadsheet is available that can perform the calculation. This can be found in the Section 17.1, or the Downloads and Worksheets section, titled Agglomeration Spreadsheet.

9.3.5.3 Competition Impacts

The existence of imperfect competition in markets means that prices are higher than production costs (in the economic sense, including a return to capital). As such, business time savings captured in standard Cost Benefit Analysis will underestimate the total benefits to these industries. Data on price-cost margins suggests that a 10% uplift should be added to the value of business time to account for this difference.

This component of wider economic benefits is straightforward to calculate. Standard Transport Economic Efficiency tables should, by default, report the value of business time savings. To calculate the impact of increased output in imperfectly competitive markets, then 10% of this value should be calculated (Laird, J (2009) "Wider Economic Impacts in Remote Areas").

9.3.6 Reporting of Wider Economic Benefits

The results from the Wider Economic Benefits calculations should be presented as an additional sensitivity to the TEE results. The current position of Transport Scotland is that WEBs should not be included in the standard calculation of an NPV and BCR as detailed above. However, a second NPV, termed NPV_{WEB}, and BCR, termed BCR_{WEB}, that sum the standard TEE and WEB results may be presented.

It is important to note that this must, at this stage, be clearly labelled as a sensitivity and the standard TEE results should remain the core reported figure. It is anticipated that this position may change in the future but remains guidance at present. If **only a single figure** is reported it should remain as the standard value.

The primary driver for this distinction is the difficulties associated with Monitoring and Evaluating the outturn of WEBs. The view is that a stronger focus on WEBs at this stage would undermine the monitoring and evaluation of schemes put forward under STAG.

A suggested approach is shown below:

NPV	
BCR	
Agglomeration Impacts WB1	From equation 5
Imperfect competition impacts WB3	10% of business time savings
Total Wider Economic benefits	Sum of WB1 +WB3
Adjusted NPV (NPV web)	
Adjusted BCR (BCR web)	

Transport Scotland recognises that the calculation of agglomeration benefits is an emerging science, and that innovative methodologies are frequently applied. Whichever methodology is employed, practitioners should ensure that their results are reported in a transparent manner. Supporting technical information should be provided, either as part of the Economy AST or as a separate technical annex. Examples of technical data that practitioners may wish to supply are changes in generalised cost, income per worker, and agglomeration elasticities for key zones; however the choice of data deemed most appropriate to support the calculations is left up to the judgement of individual practitioners.

9.4 Economic Activity and Location Impacts (EALI)

The Economic Activity and Location Impact (EALI) analysis provides an assessment of the impact of transport investment or policy measures on the economy, measured in terms of income (GDP or GVA) and/or employment. The EALI analysis assesses the distribution of the national impacts captured through the TEE and WEB, identifying the impacts on different areas. The EALI does not generally identify additional economic impacts that could be added to the TEE or WEB results. However, where market failures exist, the EALI analysis may capture the economic impacts that the TEE analysis may not have fully assessed.

The Scottish Government has Scotland-wide interests and responsibilities and is therefore interested in economic impacts at both the national and local level. The impacts of transport projects are generally highly pervasive and not limited to particular areas. Accordingly, in looking at impacts on the economy it is necessary to assess these at both the Scotland and the regional or sub-regional level.

It will be noted that there has been a change in emphasis from the previous system of EALI with the introduction of the Wider Economic Benefits (WEB) analysis. With the introduction of WEB, the approximation of the total economic impact of an option is more fully captured than with TEE alone. Additionally, the employment effects of an option are captured by the WB4 analysis. As such, there is potentially slightly less focus on the EALI section than may have been the case before the inclusion of WEB.

This issue is currently under review; however, the view of Transport Scotland is that EALI analysis remains important as a tool for analysing the distributional impacts of transport, but that the resources committed to it may be reduced with the incorporation of WEBs.

Net impacts at the Scotland level are likely to be important mainly in larger options that may have some impacts on the level, location or distribution of economic activity, or where there are "threshold" changes in accessibility (generalised cost) that will give rise to changes such as access to labour or to markets. However, the overall net impact is derived from a number of different gross impacts, some of which may be positive and others negative. As a result, even quite small options will have EALIs which are positive for specific areas or for particular groups, and negative for others.

Economic Activity and Location Impact analysis will only be necessary if it has been identified as important or significant within the Part 1 Appraisal. If so, practitioners should seek to identify and qualify impacts at the national and local level. As a practical approach to identifying and quantifying EALIs (at least in orders of magnitude), it is necessary to consider the nature and scale of these on a case by case basis. This is particularly relevant to small projects. The level of depth required in the analysis should be proportional to the size of the option or policy being appraised. However, any decision to omit an EALI analysis must be clearly justified.

9.4.1 Presentation of EALIs

This section provides guidance on the appropriate presentation of EALIs.

9.4.1.1 Gross and Net Impacts

The net impact of a transport option on the Scottish Economy is captured by the TEE and WEB analysis. In STAG, EALIs are reported in two ways, both of which are of interest to decision makers:

- As a net impact at the Scotland level; and
- In terms of its gross components, which will distinguish impacts on particular areas and/or on particular groups in society.

Given the advent of WEB, in practice, the primary interest in EALI analysis will therefore be more on local and distributional impacts, where analysis of gross rather than net changes must be considered. This is because even small options have the potential to give rise to changes in economic activity which will benefit some areas or groups while disadvantaging others. For example, replacing parking spaces with bus lanes may have an adverse effect on retail businesses on bus routes, but in general this would lead to a redistribution of retailing activity to nearby areas. By implication, net economic impacts may be negligible at the local level and certainly at the national level. Nevertheless, the gross impacts are important, particularly in terms of determining the likely public acceptability of the option.

Therefore, at the stage of developing an option, decision makers should consider the potential beneficiaries and losers from an option, and the scale of both positive and negative impacts. The EALI approach will provide a structure for identifying such distributional impacts, even though at the Scotland level the net result is likely to be zero.

For most options seeking funding from the Scottish Government the important appraisal output to be considered by the Scottish Government will be the level of net economic benefits as captured by TEE and WEB at the Scotland level and detailed within EALI analysis. This is because the Scottish Government has to assess the use of Scottish resources at the level of Scotland as a whole. However, there are exceptions. These include instances where options affect people/social groups who are the subject of other Scottish Government (or UK Government) policies, such as those suffering from social exclusion and people in remote rural areas.

The EALI appraisal process therefore enables the consideration of aspects of appraisal, such as how economic activity benefits (costs) are distributed. In cases where socially excluded groups or regeneration areas are likely to be affected by an option, the minimum requirement is for the distributional impacts to be included.

9.4.1.2 EALIs and Appraisal Summary Tables (AST)

As described in Section 5, EALIs will be scoped qualitatively in the Part 1 AST in order to establish whether there is a need to undertake a detailed Part 2 Appraisal. The depth of analysis should be proportional and a detailed Part 2 Appraisal of EALIs is unlikely to be required for small options, except where economic impacts are their principal or sole justification, or where the scoping exercise indicates that there are significant positive or negative impacts on particular areas or groups. This is especially important where areas or groups are targeted by other policies such as those designed to tackle social exclusion or regeneration.

9.4.1.3 Inclusion of EALIs in the Appraisal

The results of detailed investigation should be reported in the Part 2 Appraisal and summarised in the Part 2 AST. If the detailed appraisal demonstrates that there are no gross EALIs, this should be stated in Part 2 and the relevant sections of the Part 2 AST need not be completed.

9.4.2 EALIs as the Rationale for a Transport Project

In developing the case for a transport project, it is necessary to consider the extent to which that case rests on economic development or regeneration impacts, rather than on direct transport impacts. For example, where a project is proposed because it will effectively address problems of congestion without expectations of other collateral economic activity impacts (such as attracting local employment by opening up land for industrial and commercial development), then the option appraisal would be conducted against transport objectives.

However, where tackling congestion is seen as essential to the attraction of further economic development, for example in areas experiencing rapid economic growth, then the objectives of that option are in reality economic development rather than transport – transport is a means to economic ends in such a case.

Where the objectives of an option are solely or substantially concerned with economic development or regeneration, the reasons for preferring a transport option rather than other economic development measures needs to be clearly articulated. In keeping with guidance on
setting objectives and sifting options, it will be necessary to demonstrate that other economic development measures, as well as transport measures, have been properly considered. This should include consideration of potential synergies between the various measures being appraised.

Where there is a development or regeneration agenda for a particular area, it is likely that in most instances the transport investment will be only one component of a strategy. In this case alternative transport inputs should be tested against total (economic development/regeneration) outcomes.

It is important to make the distinction between projects which facilitate regeneration through transport outcomes and projects that facilitate regeneration as a secondary impact. By way of example, it is quite possible that a new rail link may encourage regeneration from a transport perspective. On the other hand, the upgrading of a transport facility which includes the addition of office or retail space is defined as contributing to regeneration via secondary impacts (although there may be direct transport impacts as well).

It is accepted that these secondary impacts may well be considered important. However, as the STAG Appraisal is concerned primarily with the transport impacts of options, these secondary impacts must be considered separately from the direct transport impacts and should not be presented together with the transport related impacts.

In all cases, but especially where EALIs are central to the case for the option, it is necessary to be able to demonstrate how the economic development or regeneration outcomes can be attributed to the transport option. This should include a discussion of the reasons why the market will not address the economic development or regeneration objectives.

9.4.3 The Basis of Analysis of EALIs

9.4.3.1 Links between EALIs and a Transport Option

In order to identify and assess the scale of any potential EALIs, it is necessary to develop an understanding of how the transport option will generate impacts in terms of GDP (or GVA) and employment. This can be thought of as developing a credible chain of cause and effect, linking the transport option (inputs) to its final economic outcomes, namely output and employment impacts.

In order to develop this, it might be useful to consider a series of questions, beginning with the transport impacts:

- What will the transport option achieve in terms of transport benefits and costs; for simplicity, focussing on benefits such as time savings, improved accessibility, improved journey quality and so on;
- Who will benefit from these impacts, and who, if anyone, will lose; where are the beneficiaries (and losers) located:
- It will be useful here to consider the economic roles of those affected – businesses, workers, tourists and so on;
- If the nature of commuting time savings is likely to have labour market effects;
- What are the likely responses of the gainers and losers in terms of travel behaviour; and
- What are the likely responses in terms of economic behaviour.

To use an example, the link from an improved ferry service to an island through to economic activity and location impacts is straightforward to conceptualise, as improved accessibility should make that island more competitive as a leisure destination (for most of the market). This should lead to an increase in visitor numbers and hence expenditure, and this in turn should expand employment and output.

9.4.3.2 Assessing Gross and Net Impacts

As discussed above, in both the scoping (Part 1 AST) and detailed (Part 2 AST) appraisals, it is necessary to consider:

- How individual (gross) impacts arise;
- How these affect particular areas and/or groups; and
- How these combine to give net impacts at "local" and national (Scotland or UK depending on sources of funding) levels.

In undertaking this analysis, it is necessary to consider how the transport option potentially affects economic activity, first at a local level and then at the Scotland level. It is then necessary to undertake research on this at a level commensurate with the size of the transport option and the significance of potential EALIs as part of the case for that option. Guidance on practical approaches is given below in the section on the Part 2 AST and in the section on further technical guidance.

First, however, it may be useful to illustrate the point regarding gross and net impacts using the above example of a ferry service. Tourist visitors to that island who would come even without the improved service gain through improved accessibility, but this may have little overall impact for the island as a whole, but time savings might translate into re-distributing visits to more remote parts of the island.

In addition, improved access could also lead to more people travelling to that island and hence more tourist bed-nights, which generate both an output and employment impact at the level of that particular island. Here there could be both positive and negative gross impacts; there could for example be a negative impact from loss of expenditure by tourists who decide not to come if the island is perceived to have become "crowded", but a larger positive impact arising through a larger increase in new visitors who would not have come had the ferry not been improved.

However, where the extra travellers would have come to Scotland regardless of the improved ferry service, the impact of the service for these visitors is to re-distribute their travel and associated expenditure to the island with the improved ferry service at the expense of other areas.

Thus the impact at the island level may be positive, and within the island there may also be redistribution benefits, but at the Scotland level the net impact is likely to be zero, as the additional expenditure on the island will almost certainly be at the expense of places elsewhere in Scotland. If a case were made for a positive (or negative) net impact, convincing evidence would be required to justify such a case.

9.4.4 Part 2 AST – Identification and Quantification

In cases where the Part 1 scoping has identified EALIs as potentially important or significant, in Part 2 it will be necessary to identify and quantify the impacts. As a practical approach to identifying and quantifying EALIs (at least in orders of magnitude), it is necessary to consider the nature and scale of these impacts on a case by case basis. Such an approach was recommended by SACTRA for all but the largest options, for which a more comprehensive approach involving formal modelling might be more appropriate.

9.4.4.1 Developing a Case by Case Approach

A case by case approach must be tailored specifically to the transport option under consideration and to the appropriate area or spatial level. This forms a partial analysis, which involves a detailed segmentation of the economic actors in the spatial areas relevant to the appraisal of the option. The following sets out a feasible approach which involves completing two analysis forms (shown here in Tables 9.2 and 9.4). The information used in completing these tables can be transferred directly to the Part 2 AST.

The approach outlined here can be tailored to particular studies and local circumstances, with the degree of quantification appropriate to the size of the study, the scale of the option under consideration and the expected relative significance of EALIs (both positive and negative) in the overall appraisal.

The case specific approach suggested here involves analysis of the potential behavioural responses of different "sectors" of economic activity. Here, the term "sector" has been used to describe different types or areas of economic activity, such as the manufacturing sector. Within each sector are "economic actors" whose decisions affect the economic performance of an area or region. Economic actors include businesses both in an area and outside it, land and property developers, and individuals in their roles as residents, workers, shoppers, visitors and tourists.

The following is a possible segmentation, adopted in Table 9.2, which could be used:

- Existing manufacturing and process industries, which produce physical products: this may usefully be segmented by sector/industry, and/or by size;
- Service businesses, which may be sub-segmented into those serving the local area and those which export services outwith that area; and/or by whether a physical product is produced;
- Mobile/inward/foreign direct investment, which may be capable of being attracted to the area;
- Tourists, who may be considered as a specific market served primarily by local service industries;
- Day visitors including shoppers, also a specific service sector market; and
- Working residents, who may migrate from or to the area and who may have jobs in or outwith the area.

The above is suggested as a general starting point for segmentation of economic activity into sectors; however, not all will be relevant or important in some areas, while in other areas it might be necessary to sub-segment sectors, for example where there are many different types of manufacturing industries where different industry responses to a transport option might be expected.

Once a usable segmentation has been selected, this approach involves investigating how the economic actors relevant to each sector might be affected by, and respond to, the changes in costs or accessibility brought about by the transport option under analysis. As outlined below, in most instances much of the required analysis will be based on survey evidence and accessibility analysis.

For example, in considering the business sectors, including the tourism industry and retailing, a combination of data gathering and structured interviews could be used in order to establish:

- Current performance, including size, recent growth, profitability/margins;
- Future objectives and aspirations – products, size, markets, production locations;
- Current and future/expected constraints, to include physical resources, human resources, management and capital;
- Output/product market conditions/competitiveness; location and size of main competitors;
- The significance of transport and accessibility to the business; and
- The role of changes in transport costs and journey time reliability in overcoming constraints and achieving future objectives and aspirations.

This process could also be advised by other data gathering, analysis and interviews, including suppliers and professional advisers, and in particular the property and recruitment sectors. The latter are important with regard to gathering information and opinion on impacts relating to land-use and labour market factors respectively.

The EALI assessment table includes these, albeit in a simpler form, but a fuller treatment of these can be found in SACTRA (paragraph 10.158 *et seq.*). Here the basis of the analysis is to assess how a transport option will impact upon each sector of the spatial economy under consideration. Such impacts will arise through factors such as:

- Market and competitiveness changes, such as costs of delivery or increased reliability of logistics systems and lower costs of access to supplies;
- Labour market impacts through access to a larger pool of labour, which might have efficiency benefits;
- Land and property impacts arising through access to land for business development and expansion or the attraction of mobile investment; and
- The distribution of the Agglomeration impacts from WB1.

In order to adopt a systematic approach to the identification and quantification of impacts, each case should be segmented to identify the principal sectors which act as the sources or drivers of economic performance at the appropriate spatial level. Then for each sector, the potential role of the option in enhancing its economic performance needs to be considered. Generally, this will require an understanding of the potential responses of the economic actors within each sector to the transport option. This could usefully be informed by the methodology set out in Section 11 for Accessibility and Social Inclusion impacts. Change in accessibility for each people group and employment sectors indicates the positive and negative pressures and assists in developing understanding of the links between causes and effects.

The suggested way of bringing together information is to use the Summary Assessment Table, shown as Table 9.2. For most options, this should be derived from completion of individual sector tables. It should be noted that the activity sectors shown in Table 9.2 are indicative and may be changed depending on the option and its likely impacts. In some instances, sectors might be omitted while some sectors might require further segmentation to permit the necessary level of analysis. An example of a completed summary table is shown in Table 9.3.

Table 9.2: Potential EALIs – Summary Assessment Table

Year of Assessment	**Summary of Impacts**			
(year):	**Local**		**National**	
Sector	**Gains / Gainers**	**Losses / Losers**	**Gains / Gainers**	**Losses / Losers**
Manufacturing and Processing				
Locally Traded Services				
Externally Traded Services				
Inward/Mobile Investment				
Tourism				
Day Trips/Shoppers				
Residents				
Sector Interactions/ Synergies				
Total Gross Impacts				
Net Impact	**Overall Impacts Local: National:**		**Summary of Distributional Impacts Local: National:**	

Table 9.3: Completed Example of Potential EALIs – Summary Assessment Table

<table>
<tr><td>Year of Assessment</td><td colspan="4">Summary of Impacts</td></tr>
<tr><td>(year): 2006</td><td colspan="2">Local</td><td colspan="2">National</td></tr>
<tr><td>Sector</td><td>Gains / Gainers</td><td>Losses / Losers</td><td>Gains / Gainers</td><td>Losses / Losers</td></tr>
<tr><td>Manufacturing and Processing</td><td>1200-1300 jobs
£70–90m in GDP</td><td>None</td><td>as local</td><td>Very limited – loss estimated up to 100 jobs</td></tr>
<tr><td>Locally Traded Services</td><td>Zero</td><td>Zero</td><td>Zero</td><td>Zero</td></tr>
<tr><td>Externally Traded Services</td><td>Zero</td><td>Zero</td><td>Zero</td><td>Zero</td></tr>
<tr><td>Inward/Mobile Investment</td><td>500–1000 jobs
£40–80m GDP</td><td>Zero</td><td>Zero</td><td>Zero</td></tr>
<tr><td>Tourism</td><td>Zero</td><td>Zero</td><td>Zero</td><td>Zero</td></tr>
<tr><td>Day Trips/Shoppers</td><td>Zero</td><td>Zero</td><td>Zero</td><td>Zero</td></tr>
<tr><td>Residents</td><td>500–1000 additional residents</td><td>Zero</td><td>Zero</td><td>Zero</td></tr>
<tr><td>Sector Interactions/ Synergies</td><td>200–500 jobs
£15–40m</td><td>Zero</td><td>100–200 jobs
£10–20m GDP</td><td>Zero</td></tr>
<tr><td>Total Gross Impacts</td><td>1900–2800 jobs
£125–210m GDP</td><td>Zero</td><td>1300–1500 jobs
£80–110m GDP</td><td>loss of 100 jobs, up to £10m GDP</td></tr>
<tr><td>Net Impact</td><td colspan="2">Overall Impacts Local: 1900–2800
jobs; £125–210m GDP
National:
1200–1400 jobs; £70–100m GDP</td><td colspan="2">Summary of Distributional Impacts Local: potential for benefits in regeneration areas affected by the option, and also at peripheries of TTWA National: minimal losses in competitor companies, likely to be short term as external markets expanding</td></tr>
</table>

Table 9.4 should be completed to set out those impacts which have been examined in detail and quantified. An example of a completed sector table is shown in Table 9.5.

This two step approach is suggested because a review of the qualitative version should help practitioners in identifying which impacts are most important (in gross terms) and hence to determine where to focus efforts to derive quantitative estimates of impacts.

Taking the individual sectors first, for each sector of activity, the assessment (shown in Table 9.4 and completed as an example in Table 9.5) should:

- First, provide an analysis of current market conditions and constraints relating to each individual sector: these can be analysed under the headings of land/physical resources, labour/human resources and product market impacts, which can be analysed at local and national levels. In certain cases it might also be necessary to include access to natural and /or manufactured resources and supplies;
- Second, provide (and justify) an assessment of how the transport intervention is expected to contribute towards enhanced performance in each sector: this must address inter and intra regional/area impacts;
- Third, consider how sectors might interact: for example, where there are links between sectors or where growth of one activity might feed through to impacts in other sectors, the assessment should at least describe potential interactions; and
- Fourth, set out an overview of the gross output (GDP or GVA) and/or employment impacts at the appropriate local and national spatial levels.

Once this analysis has been completed for each identified sector or driver, the results should be summarised using Table 9.1; the completed example shown as Table 9.2 suggests how these findings might be summarised and presented.

Table 9.4: Sector Table Qualitative/Quantitative Analysis of First Round Impacts (Manufacturing and Processing)

Sector		**Manufacturing and Processing**	
Sources / Types of Impact		***Qualitative***	***Quantitative***
Market / Competitiveness Context			
Labour Market Impacts			
Land / Property Impacts			
Product Market Impacts	***Local***		
	National		
Overall Impacts	***Local Gainers***		
	Local Losers		
	National Gainers		
	National Losers		

Table 9.5: Completed Example of Qualitative/Quantitative Analysis of First Round Impacts (Manufacturing and Processing)

Sector		**Manufacturing and Processing**	
Sources / Types of Impact		***Qualitative***	***Quantitative***
Market / Competitiveness Context		High % of firms & jobs in highly competitive markets where changes in transport costs will have potential impacts. Principal markets in England and Europe: local accessibility poor & journey times very unreliable, impacts on need for non-optimal working times & use of vehicles / drivers	Total of 3,500 manufacturing jobs in local TTWAs, 2,500 – 2,700 in volume / low margin sectors suffering from local transport related constraints
Labour Market Impacts		Labour shortages in skilled & semi-skilled trades currently constraining output in 60 – 70% of firms accounting for around 80% of total employment. Labour pool area constrained because of local accessibility / costs / travel times. Potential to tap under/unemployed labour in wider TTWA	Potential to recruit / train / employ 200 – 300 additional workers in short – medium term
Land / Property Impacts		Half of all major firms seeking additional land, 3 have alternative locations in Scotland, 4 considering non Scotland expansions. Land severely constrained by access, planning and cost factors	Potential loss of around 1,000 jobs which could be retained if land can be made available locally
Product Market Impacts	***Local***	None expected; non Scottish firms have very limited market presence & surge of imports considered very unlikely: no displacement impact expected.	Zero
	National	Principal markets are external; potential for expansion of sales through lower cost access to markets and access to labour which currently limits output and adds to costs. Very high % of Scottish output within TWWAs examined.	Expansion of output and employment: est'd GDP annual value of £20m, (excluding any multiplier effects); 200-300 jobs in short–medium term

Overall Impacts	***Local Gainers***	Two principal sources of impact: • output & employment impacts through combined labour & product market impacts • substantial output & employment benefits through retention of existing manufacturing activity which otherwise would relocate due to limited access and land for expansion Gainers are those with skills or semi skilled living in wider TTWA plus some jobs to people in regeneration areas – requires job access and training schemes by LEC	Output impacts estimated GDP annual value of £20m, excluding multiplier effects Plus up to 1000 jobs retained, accounting for estimated £50 – £70 million
	Local Losers	No local losers identified	
	National Gainers	As above, plus possible multiplier impacts within wider TTWA where there are unemployed resources	As above
	National Losers	Limited expected losers as almost all production concentrated in the group of TTWAs examined	Very limited potential displacement within Scotland

9.4.5 Further Technical Guidance

For further information in this area please consult the report by SACTRA, *Transport and the Economy*.

9.4.5.1 Applying a Sectoral Approach

Existing Industries and Activities

Market conditions set the context for economic activity impacts. It is therefore important to consider the competitive conditions in each sector, and how these will be affected by the transport option. Where competition is imperfect, for example in industries in which there are few players and barriers to new competition, a transport option might promote greater competitiveness leading to more efficient production and/or better use of human and/or physical resources.

Such changes will generally enable an increase in output and employment: however, as noted by SACTRA (in *Transport and the Economy*), competitiveness impacts are a potential consequence where inter-regional links are improved. For example, businesses in a formerly remote region might benefit if the transport option reduces delivery costs into external markets; however the same option also opens up the markets in that region which were previously protected from external competition by transport costs. This illustrates why it is important to look at gross impacts, as this enables this so-called "two way street" effect to be considered.

Competitiveness impacts may also occur through factor markets, for example expanding the labour market catchment area and making it easier and quicker for companies to recruit personnel, or by expanding the supply of land suitable for industrial and commercial activities.

In addition to competitiveness based impacts, consideration should be given to other potential market failures.

Inward Investment

The ability to attract mobile or inward investment is frequently put forward as a reason for a transport option, generally in relation to land-use or access to rail, air or port facilities. It is not enough simply to assert that such investment will arise, however, and evidence needs to be obtained to show that there is demand from potential investors which cannot be met in some other way or in some other location. As with other economic actors, this will generally involve use of survey information.

In looking at this issue, information could be gathered from investors who did locate in the appropriate spatial area and with others who considered the area but chose to locate elsewhere. This should include information/opinion on why an area was selected/not selected; as far as possible, survey techniques should be used which elicit information on the relative importance of transport factors. In practice, it may be necessary to rely to a large degree on agencies involved in inward investment.

Population Change and Economic Performance

Gain or loss of working residents may be an important driver of local income performance, and the attraction of people with skills can help an area to attract new investment. The attraction of more people with jobs either in or outwith the in-scope area will also add to local spending power and the tax base, while loss of people will reduce income if not replaced. Inter-area and intra-area transport accessibility will play a role in the attraction of people and the location of place of residence in relation to place of work, as will factors such as housing availability and costs, location of services such as schools and other factors which affect overall quality of life.

In examining this issue, evidence may be gathered through surveys of individuals in cases where this is seen to be an important benefit from the option under consideration. In other instances, information from property agents may be adequate to show that transport infrastructure plays a role in the ability of an area to attract/retain residents. Additional information on this sector could involve discussions with the development industry, property agents and the public sector, the latter as planning authority and provider of basic infrastructure.

It should be noted that attracting residents who would otherwise locate elsewhere involves displacement, and should be treated as a positive impact only where increasing resident numbers or strengthening the social mix of the population is a policy objective, as may be the case in regeneration areas.

While partial and to a degree qualitative, this approach can be used to consider both future economic and other trends in an area, and also future developments such as housing. The role of the transport option in inducing or enabling such development can be considered, but this will also help to identify developments which are not induced by the transport option but which may give rise to additional demand on the transport network.

9.4.5.2 Selection of the Appropriate Spatial Level for Assessment

In all cases, the impacts need to be reported at a national level, but in presenting findings, it will generally be necessary to indicate how different areas or regions are affected. Where areas affected include locations with some form of regeneration designation, or where the justification for an option depends upon impacts affecting a particular area, the impacts on such areas need to be distinguished as specific distributional impacts.

In order to look first at the immediate and direct consequences emanating from the transport option, it may be useful to conceptualise impacts as intra-area and then inter-area. It is necessary to consider “two way street” effects, whereby transport links between regions open
up scope for new economic interactions. An example of this is where a new road links two regions; firms in region A are then better able to compete within region B, but similarly firms in region B are better able to compete in region A’s market. The net impact may be lower prices and more production at the Scotland level, but more detailed analysis would be needed to assess the impacts on individual regions.

While impacts need to be reported at the Scotland and appropriate local/regional levels, consideration must be given to how best to conduct the appraisal and in particular the data gathering required. In deciding how to conduct research to assess EALIs, it will generally be useful to consider:

- The direct or immediate EALIs which will arise within the area directly affected by the transport option; and
- The spatially wider EALIs, which will arise as these direct effects work through to the rest of the economy.

It is likely that, where a transport option is relatively small and can be expected to have only localised transport impacts, a high proportion of both transport and economic impacts will accrue within a distinct travel to work area. Impacts outside that area are likely to be dispersed and difficult to assess efficiently. In such instances it will generally be sensible to focus on the local impacts.

9.4.5.3 Place and People Impacts

A further factor to be examined in considering the spatial level(s) for the appraisal is the people dimension. While it is convenient to think in terms of spatial areas, especially where there are regeneration areas, policies are ultimately targeted at people rather than places. Policies which address place issues such as the visual environment do so in order to bring about some ultimate benefit for the people living in or experiencing that environment.

Therefore while it is helpful to begin by looking at areas, the ultimate consideration is the extent to which people or social groups who are targeted by Government policies on social inclusion will in reality be the beneficiaries. For example, where a new tram option stimulates developer interest in an area and helps to open up land for development in or close to a regeneration area, the associated jobs might be claimed as a benefit because of their location in or close to a regeneration area.

However, if the jobs are all for graduates then the people living in the regeneration area are very unlikely to benefit from these jobs. Accordingly, in claiming a gross or distributional employment impact, care must be taken to ensure that there is a sound case. This should be based not only on place/location arguments but also on the argument that the people or social groups targeted by regeneration policies are actually likely to benefit from the jobs arising from the transport project.

9.4.5.4 Multiplier Impacts

Where there is spare capacity in the economy, there may be subsequent multiplier impacts arising through the purchasing of inputs by businesses and by the spending of wages and salaries. Such effects will be highly pervasive beyond local impacts, and the smaller the area under consideration, the greater the likelihood that the income will "leak" out of the area. Given the economic context of the option, consideration should be given to whether such effects are likely.

For example, in areas where there are skill or labour shortages, it is difficult to argue that there is spare capacity in the economy and hence to include local multipliers in the appraisal. However, there may be multiplier impacts at the Scotland level where businesses and residents in the local fully employed area purchase goods and services from areas with spare capacity.

In contrast, in regeneration areas multiplier impacts are more likely, provided income is spent within the area, as such areas are characterised by the availability of spare labour capacity.

In all instances where a multiplier impact is considered, account needs to be taken of where incomes are generated and where they are spent. If income is earned by residents of a regeneration area but is largely spent outside that area, it will not be appropriate to apply local level multipliers to all of the identified increase in local income. Where the regeneration area is small, the level of leakage is likely to be very high, and in such cases multiplier effects may be minimal.

Where it is proposed to include multipliers in the estimates of EALIs additional advice on this topic can be obtained from the Scottish Government. Useful advice on values for regeneration areas will be found in *A Framework for the Evaluation of Regeneration Projects and Programmes* (HM Treasury, January 1995).

9.4.5.5 Defining Areas – The Role of Travel to Work Areas

In cases where the immediate impacts are expected to be relatively localised, the travel to work areas within which the transport impacts occur may realistically be the areas within which to commit effort in assessing the immediate EALIs arising from that transport option. This would be appropriate where, for example, much of the impact arises from changes in accessibility within local labour markets.

However, there may be circumstances where there will be further impacts outside the focus area which need to be considered, for example where increased labour productivity within that area might result in other impacts elsewhere in the economy.

For larger options, a number of travel to work areas may be involved, and for such options the appropriate spatial level for considering labour market impacts may be a whole sub-region such as central Scotland. Larger transport projects are also more likely to affect product markets or sectors such as tourism or the attraction of mobile investment, and accordingly the economic impacts will fall over a very wide area and need to be considered at a regional or national level.

9.4.5.6 The Use of Gross Impacts

Economic development arguments for investment are frequently made on a distributional basis, typically in order to benefit a particular area or social group. Areas include those which are the focus of other economic policy initiatives, such as remote rural areas, urban housing estates and under-performing/regeneration areas; social groups include the long-term and young unemployed and single parents, many of whom have multiple problems of accessibility to jobs and training.

While a transport investment may have EALIs for a particular area and/or social group, for example by significantly enhancing access to jobs or opening up land which is otherwise not available, it is highly unlikely that these impacts will be net benefits at the national level when measured purely in terms of the value of national output. This is because measures such as improving jobs access will generally redistribute employment opportunities without expanding labour demand through an associated impact on output by employing industries. This results in offsetting displacement elsewhere, while not increasing the total number of jobs available. How this is treated will, however, depend upon the areas affected.

In particular, where impacts accrue to areas which receive special treatment or additional resources in order to achieve regeneration objectives, it might reasonably be argued that these benefits should not be totally "netted out" at the national level. Therefore a gain of 100 jobs to residents of a "regeneration area" might be presented as a positive employment distribution benefit of up to 100 jobs, even if it results in a displacement effect of 100 jobs in a non-regeneration area and no gain in output. In other words, some or all of the displacement might arguably be discounted in certain circumstances; however, outside such areas, displacement impacts need to be fully netted out.

There may, of course, be instances where accessibility improvements result in gains in output. For example, such impacts could arise where labour markets are so constrained by poor accessibility that there is an inability to achieve a match between skills on offer in some areas and skills required in others. In such circumstances, better accessibility should lead to more output through productivity effects of better skill matches and shorter periods to fill skilled vacancies. Similarly, where improved accessibility to training expands the availability of labour skills which are in short supply, it is possible that output will increase as a consequence of better accessibility.

However, where the impact of accessibility change falls on people who have no, or inappropriate, skills and who are not in short supply, then where such people gain jobs because of accessibility improvements, the impacts are likely to be distributional. This is because in a situation where this category of labour is in excess supply, others would have been employed had the accessibility improvements not been made; as a consequence, this will involve displacement. If there are specific regeneration objectives for the area, a change which enables residents of such areas to obtain employment may properly be regarded as a distributional welfare gain and should be noted as such under distributional impacts, provided this gain is not at the expense of residents of other regeneration areas. The earlier footnote provided further guidance on this point.

Similarly, opening up development land in one area will almost always represent activity that would have taken place elsewhere, in which case there will be no additional impact. However, if the area in which development takes place is one designated as a regeneration area, there is a potential distributional gain provided that development clearly enables residents of the regeneration area to secure (additional) employment. Accordingly, it is necessary to make clear the spatial level at which the appraisal is being conducted, and where a sub-national level is used, to make a case for doing so based on factors such as regeneration policy.

It is likely that in practice the core transport analysis will be conducted for an area considered to be in-scope for the effects of the transport improvements such as journey times. This may be a small area or a whole corridor, depending on the nature and scale of the intervention. As discussed above, it will in practice be necessary to decide on the most appropriate spatial area at which to conduct the EALI analysis, and this will involve a judgement regarding how and how far the economic effects of the particular transport changes are transmitted and the practical issue of information gathering.

It is essential to report impacts at both the local and the national level. In reporting EALIs it will be necessary to set out estimates of gross additional (attributable) impacts, both positive and negative, at the appropriate spatial levels, and also to show displacement impacts also at the appropriate spatial levels.

In practice, in reporting impacts at the Scotland level, an appraisal where there are no “regeneration” or special policy areas may usefully distinguish:

- Direct or immediate impacts within the travel to work area(s) affected by the transport option being appraised; and
- Positive and negative economic impacts outside this area, in order to present a net assessment.

Table 9.6 below might be useful in showing these impacts.

If it is expected that some of the displacement impacts will fall within a “regeneration” area, these should be noted separately within the rest of Scotland impacts, using a supplementary table based on the above. Similarly, where impacts within the immediate travel to work area fall within a “regeneration” area, these should be shown separately within the immediate area impacts.

Table 9.6: Sample Presentation of Spatial Impacts

Area	**Employment impact**	
Immediate travel to work/local area *Employment gains (additional)* *employment losses (displacement)*	 200 140	 a b
Net impact within immediate area	60	a – b
Rest of Scotland (outside above area) *Employment gains (additional)* *Employment losses (displacement)*	 20 55	 c d
Net impact - rest of Scotland	- 35	c –d
Net impact — Scotland	25	= (a-b) + (c-d)

9.4.5.7 Measurement Over Time

The economic activity and location impacts of transport projects will be experienced as a future flow of additional GDP/GVA and jobs, and as such it may be necessary to consider impacts over time, rather than just at a particular point in time. The summary table (Table 9.2) provides a column in which the time frame for assessment should be stated, and this should also be used to refer to more detailed supporting information on the assumptions and caveats relating to forecasting or projecting impacts over future years.

In principle, the EALI analysis could be treated in the same manner as TEE benefits, by creating an estimated flow of impacts which is then discounted to a present value at the prevailing discount rate. While this is in principle relatively straightforward in the case of output (although even here there may be issues regarding use of market values, and the need to allow for costs to Government), the treatment of employment is more complex and would require specific guidance. In practice, there are real difficulties forecasting industry level impacts even a few years ahead.

For employment, the familiar measure is a "job" but for appraisal purposes it is necessary to consider what this means over a period of years. The accepted convention is that a job equates to 10 person years of employment, discounted at the prevailing rate. Therefore, where an option generates a stream of person years of employment, these need to be discounted and divided by 10 to give a "job". Further information may be found in the EGRUP guidance, *A Framework for the Evaluation of Regeneration Projects and Programmes* (HM Treasury January 1995).

9.4.5.8 Full and Temporal Additionality

The term "full additionality" refers to situations where a change in output/employment is the difference between what would happen with and without the transport option. For example, if a road option would enable a site to be developed, the local impact might be stated as, say, 250 jobs, if no other site were available for development if the option did not go ahead.

However, in many cases a transport project will simply enhance what is happening in a local economy, and might therefore simply accelerate the rate of development of sites. This in effect changes the time profile of development when comparing the "with" and "without" option scenarios, and the impact of the project has to be measured as the difference between the stream of impacts with and without the option.

Where GDP/GVA impacts can be measured and valued, this is simply a matter of discounting the "with" and "without" streams to the present day and showing the present value of the difference between these streams. In the case of employment, the principle is the same, namely that the "with" and "without" streams of person years of employment must be discounted to the present day and each divided by 10 to get the "job" impact. The "temporal additionality" impact of the option is the difference between the two "jobs" totals.

In practice, there may be difficulties in projecting output and employment impacts forward, and simplifying assumptions may be required. As a minimum, there should be a brief statement of the expected impacts, expressed as a range and with an indicative time frame, over a 3 to 5 year horizon and with some qualitative indication of potential longer term impacts. For consistency and comparability, these ranges of impacts should be projected ahead to provide time streams of impacts which can then be discounted to present values. Where the impact of the transport option is to increase the rate of growth/development of an area over an expected trend/rate based on the do-nothing or do-minimum (or without option) scenario, the forward projections need to be undertaken at the different estimated "with" and "without option" growth rates. Caveats and assumptions should in all cases be made explicit and justified.

9.4.5.9 Construction and Operations Related Employment

Construction jobs are frequently claimed as a benefit from the implementation of transport (and other) investment options. Similarly, the employment of people to operate transport equipment and maintain the infrastructure is also frequently claimed as a benefit. However, a number of factors affect the validity of such claims.

Construction jobs tend to be temporary, often using outside labour, and are unlikely to contribute to local employment in the longer term. The construction sector, like many other areas, also has a high incidence of skill shortages, and the use of construction labour for one project will in such areas simply displace that labour from other projects, resulting in delays to other work and/or escalation of construction costs. In other areas, where there is spare capacity in the construction sector, it might be reasonable to argue that the employment associated with the implementation of a transport option represents an employment benefit at the local level. This would have more validity if the labour were drawn from regeneration or other policy priority areas.

Similar arguments apply to labour required to operate a new transport option, and here direct displacement of employment arising from, for example, transfer of travellers from one mode to another should also be considered.

In quantifying such employment impacts, the principles set out above regarding temporal additionality should be applied.

9.4.5.10 Land-Use and Development Related Impacts

In practice, for many transport projects the source of economic activity and location impacts is an expected release of constraints on land availability. Where a transport investment does enable land that would otherwise be incapable of development to be developed for productive uses, there is potentially a local economic benefit, where the use of the land gives rise to output and employment impacts.

However, even at a local level the argument that the EALI is additional is valid only where no other site is available which could be developed in a similar manner. Where there is a potential site whose use is ruled out through environmental/planning considerations, the benefit of using the site released by the transport project is in effect related to planning and/or environment objectives rather than economic objectives. However, it is very unlikely that no alternative site would have been available for that development, and therefore the impact at the Scotland level should be noted as zero, unless there is a convincing argument that the development would have gone elsewhere. Similar considerations apply to employment impacts.

It is possible that even where there is no economic (output or employment) impact, because development would take place elsewhere, there may be an *environmental* gain, where that alternative land has a higher environmental value than that made accessible and developable through the transport intervention. If such a gain were expected, it would be useful to note this in the EALI section, so as to make decision makers aware of how this impact has been assessed. However, as this is an environmental gain, it should be addressed fully in the section on environment.

It should be noted for options requiring SEA, that the SEA Directive's definition of "environment" includes not only the natural environment and the historic environment, but also some human effects such as health and material assets. Therefore within the SEA process, significant effects on material assets should be assessed and presented in the SEA Environmental Report. Material assets include land-use and development-related impacts such as effects on infrastructure, and property.

9.4.6 Additional Guidance for Part 2 AST

9.4.6.1 Reporting EALIs

For consistency in appraisal, consideration must be given to the scale and nature of possible EALIs in all cases. Where no impacts are expected, this must be stated, together with the reasons why this is the case, using the EALI section of the AST.

In all cases therefore, there are three elements in the AST which need to be completed. This section provides some additional guidance in completing these sections.

9.4.6.2 Local and National Economic Impacts

These two sections should be used to summarise output (GDP/GVA) and/or employment impacts at both the local level and the national level, based on the information provided in Table 9.2.

Either GDP or GVA (GDP at basic prices, excluding taxes (less subsidies) on products) can be used to measure output. The Scottish Government uses the GVA measure in its quarterly series. Each is a standard measure of economic activity; GDP impact should be estimated on the basis of expected changes in output arising from the option. Under the heading quantitative information, there should be a brief statement of the expected impacts, expressed as a range and with an indicative time frame, for example over a 3 to 5 year horizon and with some indication of longer term impacts. Depending on the sources of impacts and the scale of the option, GDP impacts should be provided at a detailed level using an appropriate segmentation of economic activity in the in-scope area.

Under the heading qualitative information, the rationale for expecting such changes in output should be provided, and this should include the factors noted above, including in particular changes in competitiveness, labour market impacts and effects on land supply/constraints.

Where there is an expected release of constraints on land availability, such impacts should be indicated clearly. It should be noted that where a transport investment enables land which would otherwise be incapable of development to be developed for productive uses, there is potentially a local economic benefit, where the use of the land gives rise to output and employment impacts. However, it is very unlikely that no alternative site would have been available for that development, and therefore the impact at the Scotland level should be noted as zero, unless there is a convincing argument that the development would have gone elsewhere.

It is possible that even where there is no economic (output or employment) impact, because development would take place elsewhere, there may be an *environmental* gain, where that alternative land has a higher environmental value than that made accessible and developable through the transport intervention. If such a gain is expected, it should be noted here and quantified, if possible, in the section on environment.

The information used to estimate output changes could also provide the basis for estimation of employment changes, and similar considerations to those set out above also apply to employment impacts. Employment changes can be measured in a variety of ways, but ideally should be measured by estimating numbers in employment at different dates over the life of the option, in order to produce an estimate of person years of employment. This should be provided under the heading quantitative information.

In smaller options, simpler indicators can be used, such as jobs in snapshot years. Changes in employment are of particular interest where the project will benefit people who are unemployed or underemployed, as occurs in regeneration areas, for example. The rationale for expecting changes in employment should be provided under the heading qualitative information.

9.4.6.3 Distributional Impacts

The GDP/employment sections of the AST are intended to present a summary of the appraisal in terms of GDP and employment, and impacts will generally be shown as net impacts. However, there may be cases where a statement of the net impact hides important gross changes, especially where these affect particular areas or social groups.

Practitioners should generally include such gross impacts in their AST and these would be presented in the section on distributional impacts. Depending on the context, it may be helpful to show impacts separately in terms of both "place" (area) impacts and "people" impacts (by social group).

Distributional impacts will be particularly important where an option affects a regeneration area or a particular social group targeted by the Government. In this part of the AST, it is important to indicate any positive or negative distributional impacts arising from an option which affects regeneration areas and/or socially excluded groups. This should include those impacts arising from changes in the spatial characteristics of economic activity.

In such cases it is necessary to indicate where and how a particular "regeneration" area and its residents are affected. This should show gross impacts affecting regeneration and non-regeneration areas. The nature and sources of such impacts should be indicated under the heading qualitative information, while quantitative estimates of gross impacts should be shown under the quantitative information heading.

Even where there is not a designated regeneration area, there may be groups such as the long term unemployed, the elderly and the disabled who could be affected by an option. Impacts upon such groups should be indicated under the qualitative and quantitative headings. Where relevant, these impacts should be cross-referenced to the section dealing with accessibility and social inclusion.

It should be noted for options requiring a SEA, that the SEA Regulations' definition of "environment" includes human effects such as population. As such there is some overlap with the assessment of distributional impacts within the STAG Appraisal. Therefore, within the SEA process, significant effects on population, if relevant to the plan or programme, should be assessed and presented in the SEA Environmental Report.

9.5 Appraisal Parameters

9.5.1 Appraisal Period

The appraisal period used for all transport appraisals will be 60 years. The extension to a 60 year appraisal period was prompted by the reduction to the discount rate in the 2003 version of the HM Treasury Green Book.

For some projects, the project life may be determined from the limited life of its component assets. In these cases, the practitioner should set out the evidence, and select an appropriate end year for the appraisal, subject to a maximum of 60 years. Guidance may be sought from the Scottish Government and/or Transport Scotland on the appropriate appraisal period.

9.5.2 Inflation

When forming base cost estimates for transport options, practitioners should apply realistic assumptions about changes in real costs i.e. above the rate of growth in general prices across the economy. For example, the inflation rates relevant to the delivery of many of the current transport schemes in Scotland (all modes) are currently higher than the general rise in prices across the economy. It is not practical to identify general inflation rates that would apply generally to all transport options so practitioners are advised that any assumptions should be based on the best information on current and forecast inflation from industry sources appropriate to their scheme. These assumptions and the sources of evidence should be clearly stated in the appraisal documentation.

9.5.3 Discounting

Discounting is a technique used to compare costs and benefits that occur in different time periods. It is a separate concept from inflation, and is based on the principle that, generally, society prefers to receive goods and services now rather than later, and to defer costs to future generations. This is known as 'social time preference'. The 'social time preference rate' (STPR) is the rate at which society values the present compared to the future.

9.5.4 Discount Rates

HM Treasury recommends a discount rate of 3.5%, which declines over time (i.e. 3.5% for appraisal years 0 to 30 and 3.0% for years 31 to 75 etc. – refer to Table 6.1 of Green Book). Consequently transport appraisals should adopt the standard rate of 3.5% for the period up to 30 years from the year of appraisal and the lower rate of 3.0% for years 31 to 60. Using these discount rates, £1 would be worth roughly the same value in 60 years as it would have been worth in using the previous rates and 30 year appraisal period.

9.5.5 Base Year for Discounting

The base year that all costs and benefits should be discounted to is currently 2010.

9.5.6 Units of Account

The Treasury Green Book recommends the use of market prices as the basis for appraisal. NATA requires the use of a market price base, arguing that this is consistent with the use of 'willingness to pay', as recommended in Sugden's report *Developing a Consistent Cost-Benefit Framework for Multi-Modal Transport*.

The market price unit of account expresses prices in market prices. Market price refers to the price paid by consumers for goods and services in the market and therefore includes all indirect taxation (indirect taxation refers to taxation levied on a product and therefore includes excises, duties and VAT). Prices that do not include taxation (e.g. public transport fares) are still perceived by consumers in the market price unit of account.

The factor cost unit of account expresses prices in resource costs. Resource costs are costs that are net of indirect taxation. The prices paid by Government for goods and services are not subject to indirect taxation as any tax that is paid by Government bodies is recovered by Government and thus may be ignored. Government expenditure is therefore in the factor cost unit of account. Business costs and benefits are also assumed to be in the factor cost unit of account as businesses are free of indirect taxation because they can claim it back. An exception to this is fuel duty, which businesses cannot claim back.

Costs can be converted to (or from) market prices by multiplying (or dividing) by the indirect tax correction factor, (1+t), where t is 19.0% (equivalent to the average rate of indirect taxation in the UK economy).

Perceived costs are those which are actually experienced by users. Perceived costs are different for work and non-work trips because businesses can claim back VAT on purchases. Businesses cannot, however, claim back fuel duty and therefore this is included in their perceived cost. (where certain classes of PSV can claim back fuel duty this should be treated as a subsidy). Note that business users perceive costs in the factor cost unit of account, while consumers perceive costs in the market price unit of account.

Indirect tax revenues should be included in the numerator of the BCR calculation.

The most common indirect tax impact in transport appraisal arises from the differential between road and rail. Put simply, an increase in road activity (and therefore fuel used) will lead to an indirect tax benefit, whereas a shift from road towards rail will typically result in an indirect tax disbenefit, as there is no duty changed on rail fares. It is important to note however that while there is no duty on rail fares, a scheme that results in an increase in rail vehicle kilometres will have an indirect tax impact as rail diesel is subject to fuel duty. Electricity is not subject to fuel duty, therefore battery electric vehicles are exempt from fuel duty.

There are three main sources of indirect tax effects in rail appraisal: (a) when rail revenue changes between the with and without scheme scenarios, expenditure shifts from/to goods or services attracting the average level of indirect taxation to/from rail fares – this has an indirect tax effect as there is no VAT on rail fares; (b) when people switch modes from road to rail (or vice versa), they stop (or start) paying the level of indirect taxation on fuel, which is higher than the average level of indirect taxation. This element of the indirect tax impact for uni-modal model appraisals is generally calculated as one of the elements of Marginal External Costs; (c) if the quantity of rail diesel vehicle kms changes as a result of the scheme, there will be an indirect tax effect as rail diesel is subject to duty.

In rail appraisal, the indirect tax impact of shifts from/to car use should be estimated with the indirect tax element of the marginal external costs. For public transport schemes, this should be complemented with the indirect tax impact from increased/reduced spending on public transport fares (on which VAT is not applied) and from changes in fuel use relating to public transport provision (when indirect tax is paid on that fuel).

9.5.7 Price Base Year

The price base year should also be the standard base year of 2010. All prices in the appraisal should be adjusted for inflation back to 2010 prices.

9.5.8 Model Base Year

The model base year will depend on the currency of the dataset used to develop the model. On the assumption that significant new datasets will be collected, the model base year is likely to be the current year (the year in which the surveys will be conducted).

9.5.9 Forecasts

In the case of a single intervention, forecasts are ideally required for the year of opening (see below) and a second 'forecast' year, some years after opening. In the case of a strategy or plan, forecasts are ideally required for at least the year of opening of each of the main elements of the option and for the future 'forecast year'. However, it may not always be practical to conduct forecasts for the opening years of every one of the main elements of an option. In such cases an appropriate common year should be chosen so that streams of costs and benefits can reasonably be inferred from a variety of different starting points.

9.5.10 Opening Year

In order to establish streams of costs and benefits for use in the CBA, it is necessary to assume an option opening year. This will be the year in which operating and maintenance costs begin to be incurred and typically the year in which the users begin to gain positive benefits from the option. Where elements of an option have different opening years, a reasonable approach to estimating cost and benefit streams without making an excessive number of model runs will be required. This will typically involve extrapolation and interpolation of the costs and benefits back from a common year for which the model is run.

9.5.11 Forecast Year

The 'forecast year' is the future year - typically 10 to 15 years after the opening year - for which the model is also run to generate single-year costs and benefits from which the streams of costs and benefits may be inferred. The forecast year may vary, depending on:

- The timing at which problems are thought likely to become critical and in need of solution;
- The kinds of solution considered appropriate and the time likely to be required for implementation; and
- The availability of model input data on future trends, economic growth, and so on.

Thus, a study which is concerned with problems which are in need of urgent resolution in the next few years and for which traffic management solutions, for example, are considered appropriate, may use a forecast year only a few years away from the model base year. On the other hand, a study in which problems are thought likely to persist over a longer timeframe may use a forecast year 20 to 30 years away from the model base year.

A study may involve preparing forecasts and conducting analyses and appraisals for more than one forecast year. For example, if a strategy involves phased implementation of the options or if there is expected to be significant change in the rate of growth in user benefits over the appraisal period, then it is recommended that the model be run to generate forecasts for a set of time points which will enable the whole benefit and cost stream to be calculated.

9.5.12 Values of Time

The tables below provide the latest recommended values of time for application in most standard transport appraisals (all expressed in average 2010 values and prices). The data presented is taken from Table A 1.3.1 of the WebTAG data book.

An Economy Spreadsheet which supports Section 9 – Economy of the STAG Technical Database has now been published. This spreadsheet provides tables 9.7 to 9.25 in Excel format for ease of use. This can be found in the Section 17.1 or the Downloads and Worksheets section.

The use of mode specific values could potentially increase the risk of not accounting for people who switch between modes. Where the number of people switching modes is high relative to the number of existing users it may be inappropriate to use the values below. Under these circumstances the practitioner should contact Transport Scotland for advice.

Table 9.7: Values of Working Time Per person (£ per hour) (Source: WebTAG data book Table A1.3.1)

Vehicle Occupant	Resource Cost	Perceived Cost	Market Price
Car driver	22.74	22.74	27.06
Car passenger	17.25	17.25	20.52
LGV (driver or passenger)	10.24	10.24	12.18
OGV (driver or passenger)	12.06	12.06	14.35
PSV driver	12.32	12.32	14.66
PSV passenger	13.97	13.97	16.63
Taxi driver	10.89	10.89	12.96
Taxi/minicab passenger	21.96	21.96	26.13
Rail passenger	26.86	26.86	31.96
Underground passenger	22.08	22.08	26.28
Walker	17.54	17.54	20.88
Cyclist	17.47	17.47	20.78
Motorcyclist	19.42	19.42	23.11
Average of all working persons	22.75	22.75	27.07

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Table 9.8: Values of Non-Working Time Per person (£ per hour) (Source: WebTAG data book Table A1.3.1)

Vehicle Occupant	Resource Cost	Perceived Cost	Market Price
Commuting	5.72	6.81	6.81
Other	5.08	6.04	6.04

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Practitioners should note that the values for non-working time (commuting and other) spent waiting for public transport is two and a half times the values presented in Table 9.8.

9.5.13 Forecast Growth in Values of Time

The recommended forecast values of time are presented in Table 9.9 in the Economy Spreadsheet which supports this section of the STAG Technical Database. The data presented in Table 9.9 has been taken from the Department for Transport's WebTAG data book Table A1.3.2)

9.5.14 Vehicle Occupancies

Car occupancy data extracted from the 1999-2001 National Travel Survey are shown in Table 9.10**.** This presents the sum of driver occupancy (always 1) and passenger occupancy.

Table 9.10: Car Occupancies (2000)

Journey Purpose	Weekday					Weekend Average	All Week Average
	7am – 10am	10am – 4pm	4pm – 7pm	7pm – 7am	Weekday Average		
	Occupancy Per Vehicle Kilometre Travelled						
Work	1.23	1.19	1.17	1.18	1.20	1.28	1.20
Commuting	1.16	1.15	1.13	1.13	1.14	1.14	1.14
Other	1.71	1.78	1.82	1.77	1.78	1.97	1.85
Average Car	1.45	1.68	1.60	1.52	1.61	1.88	1.68
	Occupancy Per Trip						
Work	1.26	1.19	1.20	1.21	1.21	1.30	1.22
Commuting	1.16	1.14	1.14	1.13	1.15	1.13	1.14
Other	1.72	1.70	1.76	1.71	1.72	1.96	1.79
Average Car	1.44	1.57	1.50	1.53	1.52	1.86	1.60

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Occupancies for all other vehicles are illustrated in Table 9.11**.** Different occupancy figures for LGVs are available for a weekday and weekend. Only all week average occupancy figures are available for all other vehicles and these should be applied for all time periods.

Table 9.11: Other Vehicle Occupancies (2000)

Vehicle Type and Journey Purpose	Occupancy per vehicle Kilometre Travelled		
	Weekday Average	Weekend Average	All week Average
LGV			
Work (freight)	1.20	1.26	1.20
Non Work (commuting and other)	1.46	2.03	1.59
Average LGV	1.23	1.35	1.25
OGV1 Work Only	1.00	1.00	1.00
OGV2 Work Only	1.00	1.00	1.00
PSV			
Driver	1.00	1.00	1.00
Passenger	12.20	12.20	12.20

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

The forecast decline in car passenger occupancies (annual percentage change) to 2036 is shown in Table 9.12, below. After 2036 car passengers are assumed to remain constant. The occupancy rates for all other vehicles should be assumed to remain unchanged over time.

Table 9.12: Annual Percentage Change in Car Passenger Occupancy to 2036 (% per annum)

Journey Purpose	Weekday					Weekend Average	All Week Average
	7am – 10am	10am – 4pm	4pm – 7pm	7pm – 7am	Weekday Average		
Work	-0.48	-0.40	-0.62	-0.50	-0.44	-0.48	-0.45
Non-Work (commuting and other)	-0.67	-0.65	-0.53	-0.47	-0.59	-0.52	-0.56

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

9.5.15 Journey Purpose Splits

National Travel Survey (1999-2001) data is also used to produce journey purpose splits for work and non-work travel, based on distance travelled and the number of trips made. This allows the calculation of values of time per vehicle for the average vehicle. These journey purpose splits are assumed constant over time.

The Proportions of Travel / Trips in Work and Non-Work Time are presented in Table 9.13 and 9.14 in the Economy Spreadsheet which supports this section of the STAG Technical Database. The data presented in Table 9.13 and 9.14 has been taken from the Department for Transport's WebTAG data book A1.3.4). Due to the small sample sizes involved these data should be treated with caution.

9.5.16 Values of Time Per Vehicle

The market price values of time per vehicle are presented in Table 9.15 in the Economy Spreadsheet which supports this section of the STAG Technical Database. The data presented in Table 9.15 has been taken from the Department for Transport's WebTAG data book A1.3.5).

These values are based on distance travelled and are calculated by multiplying the relevant data from Tables 9.7, 9.8, 9.10 and 9.11. Using national average vehicle proportions for 2010, the market price value of an average vehicle is £13.91 per hour, 2010 prices and values.

9.5.17 Vehicle Operating Costs (VOC)

The use of the road network by private cars and lorries generate operating costs for the user. Vehicle operating costs are defined as costs that vary with vehicle usage and are based on vehicle-miles travelled. These costs include fuel, tyres, oil, maintenance, repairs, and mileage-dependent depreciation. Clearly transport projects or policies can generate changes in vehicle operating costs by affecting the volume of car traffic, either through mode switching or induced traffic, and the speed and distance travelled through route changes.

9.5.18 Vehicle Operating Costs (Fuel and electricity)

Fuel consumption is estimated using a function of the form:

$$L = (a + bv + cv^2 + dv^3) / v$$

Where:
$L =$ consumption, expressed in litres per kilometre;
$v =$ average speed in kilometres per hour; and
$a, \; b, \; c, \; d$ are parameters defined for each vehicle category.

Evidence of the energy consumption of electric cars is currently limited. At present, it should be assumed that energy consumption is proportional to distance by independent of speed (i.e. equivalent to a "b" parameter in the fuel consumption formula with the a, c and d parameters all zero). The appraisal of electric cars is a developing area and it is expected that speed related curves will be developed in the future.

The parameters needed to calculate the fuel/energy consumption element of VOCs are presented in Table 9.16. The fuel consumption parameter values are based on a 2010 vehicle fleet, whilst the electrical energy consumption values are based on 2011 values.

Table 9.16: Fuel/Energy Consumption Formulae Parameter Values (Source: WebTAG data book Table A1.3.8)

	Parameters			
Vehicle Category	**a**	**b**	**c**	**d**
Fuel Consumption Parameter Values (litre per km, 2010)				
Petrol Car	1.11932	0.04400	-0.00008	0.000002
Diesel Car	0.49215	0.06218	-0.00059	0.000005
Petrol LGV	1.95083	0.03453	0.00007	0.000004
Diesel LGV	1.39688	0.03348	-0.00023	0.000008
OGV1	1.43145	0.25802	-0.00391	0.000034
OGV2	2.67011	0.55716	-0.00798	0.000060
PSV	5.98005	0.24528	-0.00306	0.000031
Energy Consumption Parameter Value (kWh per km, 2011)				
All electric vehicles	0.12564			

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Table 9.16 no longer provides consumption values for an 'average car', as units for electric cars (kWh) differ from the units for petrol and diesel cars (litres). However, it is possible to convert the consumption values into costs and estimate the fuel/energy per kilometre for an average car. Examples of this are given in Table 9.17 (which gives 2010 values, excluding electric cars) and Table 9.18 (which gives 2011 values, including electric cars and a combined average for petrol, diesel and electric cars).

Table 9.17: Fuel/Energy VOC Formulae Parameter values (2010 values and prices)

	Parameters			
Vehicle Category	**a**	**b**	**c**	**d**
Values excluding VAT (for vehicles in course of work)				
Petrol Car	96.167	4.135	-0.00453	0.000201
Diesel Car	44.364	5.949	-0.05327	0.000419
Average Car	75.067	4.874	-0.02438	0.000290
Petrol LGV	155.266	6.410	-0.07427	0.001003
Diesel LGV	106.091	5.877	-0.04394	0.000815
Average LGV	108.973	5.908	-0.04571	0.000826
OGV1 (diesel)	149.948	24.929	-0.36259	0.003110
OGV2 (diesel)	344.145	40.028	-0.47118	0.003646
PSV (diesel)	417.720	31.105	-0.42694	0.003707
Values including VAT (for vehicles in course of other purposes)				
Petrol Car	112.996	4.858	-0.00532	0.000236
Diesel Car	52.127	6.991	-0.06260	0.000492
Average Car	88.204	5.727	-0.02865	0.000340
Petrol LGV	182.438	7.531	-0.08726	0.001179
Diesel LGV	124.657	6.905	-0.05163	0.000957
Average LGV	128.043	6.942	-0.05371	0.000970

Note: In 2010 it is assumed there are no electric cars, so the 'Average Car' is an average over petrol and diesel.

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Table 9.18: Fuel/Energy VOC Formulae Parameter values (2011 values and prices)

	Parameters			
Vehicle Category	**a**	**b**	**c**	**d**
Values excluding VAT (for vehicles in course of work)				
Petrol Car	102.735	4.417	-0.00484	0.000215
Diesel Car	48.546	6.510	-0.05830	0.000458
Electric Car	0.000	1.732	-0.00000	0.000000
Average Car	79.423	5.315	-0.02780	0.000319
Petrol LGV	168.293	6.947	-0.08050	0.001087
Diesel LGV	115.668	6.407	-0.04790	0.000888
Average LGV	118.518	6.437	-0.04967	0.000899
OGV1 (diesel)	166.939	27.754	-0.40367	0.003462
OGV2 (diesel)	383.142	44.564	-0.52457	0.004059
PSV (diesel)	465.054	34.630	-0.47532	0.004127
Values including VAT (for vehicles in course of other purposes)				
Petrol Car	123.282	5.300	-0.00581	0.000257
Diesel Car	58.255	7.812	-0.06996	0.000550
Electric Car	0.000	1.819	0.00000	0.000000
Average Car	95.308	6.378	-0.03336	0.000383
Petrol LGV	201.951	8.337	-0.09660	0.001305
Diesel LGV	138.802	7.689	-0.05748	0.001066
Average LGV	142.222	7.724	-0.05960	0.001079

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Fuel Costs, Fuel Duty and VAT rates are shown in Table 9.19, which is provided in the Economy Spreadsheet which supports this section of the STAG Technical Database. The data presented in Table 9.19 has been taken from the Department for Transport's WebTAG data book A1.3.7).

Table 9.20 now removed. Refer to table 9.19 for costs from 2031.

The resource cost of fuel VOCs is net of indirect taxation. The market price is gross of indirect taxation and is therefore the sum of the resource cost and fuel duty, plus VAT (market price= [resource cost + fuel duty] x [1+VAT]). In work time the perceived cost of fuel VOCs is the cost perceived by businesses. Businesses are generally viewed as perceiving costs in the factor cost unit of account as most business costs are free of indirect taxation because they can claim it back. However, businesses cannot reclaim fuel duty and therefore the perceived cost of fuel VOCs in work time is equal to the resource cost plus fuel duty. In non-work time, the perceived cost of fuel VOCs is the cost as perceived by the individual consumer. Consumers perceive costs in the market price unit of account and therefore the perceived value of fuel VOCs in non-working time is equal to the market price.

Values for fuel duty and VAT in Table 9.19 take account of all changes announced in the 2012 Budget Report (HMT March 2012). These are:

- A 3.02p per litre increase in fuel duty from 57.95p per litre to 60.97p per litre on 1 August 2012
- Increases in line with RPI on 1 April each year from 2013 onwards.

The actual price of a unit of electricity may vary according to the type of electricity used (domestic, commercial or industrial) which in itself will depend on where electric cars are recharged. We would expect much of the electricity for electric cars to be charged at the domestic rate. At the same time, the rail industry pays a much lower price for electricity than domestic users.

Beyond 2030, the electricity prices for both car and rail are assumed to vary according to the change in carbon cost only. For petrol and diesel beyond 2030, both the resource and duty prices are forecast to grow at a rate of 0.195% per year.

Information on the rates of fuel duty to be applied in the calculation of rail fuel operating costs can be found in Section 9.5.22 Rail Operating Costs.

Table 9.21 shows the forecast proportion of the car and LGV fleet using petrol, diesel or mains electricity used to calculate average car and LGV values. Values for years between 2005 and 2029 that are not shown in the table should be estimated using linear interpolation between the two closest years. Values for 2031 onwards should be assumed to be held at 2030 levels. With electric cars still in the early stages of development, and uncertainty over the rate of progression in battery technology (a key barrier to progress) there is necessarily a large margin of error around any forecast take up of electric vehicles. As such this projection should be seen as one of a range of potential development pathways and any particular sensitivity to the pathway given out here noted in the analysis.

Table 9.21: Proportion of cars and LGV vehicle kms using petrol, diesel or electricity (%) (Source: WebTAG data book Table A1.3.9)

Year	Cars			LGVs		OGV1		OGV2		PSV	
	Petrol	Diesel	Electric	Petrol	Diesel	Diesel	Electric	Diesel	Electric	Diesel	Electric
2004	73.28	26.72	0.00	11.07	88.93	100.00	0.00	100.00	0.00	100.00	0.00
2010	59.27	40.73	0.00	5.86	94.14						
2015	47.97	51.87	0.16	3.64	96.36						
2020	43.70	55.33	0.96	1.89	98.11						
2025	44.41	53.05	2.54	1.04	98.96						
2030	44.46	50.23	5.31	0.79	99.21						

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

9.5.19 Rates of Change in Fuel VOCs

There are two causes of changes in fuel VOC over time: improvements in vehicle efficiency and changes in the cost of fuel. For cars, changes in fuel VOCs also reflect changes in the proportion of traffic using either petrol, diesel or mains electricity.

Vehicle efficiency assumptions are illustrated in Table 9.22. These figures show changes in fuel consumption and therefore negative figures indicate an improvement in vehicle efficiency.

Table 9.22: Forecast Assumed Vehicle Fuel Efficiency Improvements (Source: WebTAG data book Table A1.3.10)

Year	Change in Vehicle Efficiency (% pa)							
	Petrol Car	Diesel Car	Electric Car	Petrol LGV	Diesel LGV	OGV1	OGV2	PSV
2006 - 2007	-0.42 (actual)	-0.49 (actual)		-0.01 (actual)	0.00 (actual)	-1.23 (actual)	-1.23 (actual)	0.00 (actual)
2007 - 2008	-1.05 (actual)	-1.07 (actual)		-0.01 (actual)	0.00 (actual)	-1.23 (actual)	-1.23 (actual)	0.00 (actual)
2008 - 2009	-1.78 (actual)	-0.92 (actual)		-1.35 (actual)	-1.23 (actual)	-1.23 (actual)	-1.23 (actual)	0.00 (actual)
2009 - 2010	-1.43 (actual)	-1.63 (actual)		-0.34 (actual)	-1.80 (actual)	-1.23 (actual)	-1.23 (actual)	0.00 (actual)
2010 - 2015	-1.81	-2.23	0.10	-0.11	-2.71	0.00	0.00	0.00
2015 - 2020	-3.32	-2.22	-0.02	-2.35	-2.35	0.00	0.00	0.00
2020 - 2025	-3.16	-2.02	-0.12	-2.85	-1.65	0.00	0.00	0.00
2025 - 2030	-1.56	-1.19	0.00	-2.40	-0.74	0.00	0.00	0.00
2030 - 2035	-0.57	-0.52	0.08	-0.54	-0.22	0.00	0.00	0.00

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database. The spreadsheet also contains Table 9.22a: Cumulative Change in Assumed Vehicle Fuel Efficiency Improvements.

As with consumption values noted earlier, values for an average car are no longer provided as petrol, diesel and electric cars do not have common units. Table 9.23 shows how the parameters to calculate fuel/energy cost per kilometre changes through time for an average car and an average LGV.

Table 9.23: Average Vehicle Fuel/Energy Cost Formulae Parameter Values (2010 prices) (Source: WebTAG data book Tables A1.3.12 and A1.3.13)

	Parameters			
Vehicle Category	**a**	**b**	**c**	**d**
Average Car, excluding VAT (for travel in course of work)				
2010	75.068	4.874	-0.024	0.000
2015	69.227	5.160	-0.031	0.00032
2020	60.772	4.850	-0.031	0.00031
2025	53.750	4.320	-0.027	0.00027
2030	49.736	3.997	-0.024	0.00024
Average LGV, excluding VAT (for travel in course of work)				
2010	108.974	5.908	-0.046	0.001
2015	110.337	6.028	-0.046	0.00084
2020	103.683	5.700	-0.043	0.00079
2025	96.820	5.342	-0.040	0.00074
2030	94.993	5.247	-0.039	0.00073
Average Car, including VAT (for travel in course of other purposes)				
2010	88.205	5.727	-0.029	0.000
2015	83.027	6.191	-0.037	0.000
2020	72.926	5.817	-0.037	0.000
2025	64.500	5.175	-0.033	0.000
2030	59.683	4.779	-0.029	0.000
Average LGV, including VAT (for travel in course of other purposes)				
2010	128.044	6.942	-0.054	0.00097
2015	132.405	7.233	-0.055	0.00101
2020	124.420	6.840	-0.052	0.00095
2025	116.184	6.410	-0.048	0.00089
2030	113.992	6.297	-0.047	0.00087

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

9.5.20 Vehicle Operating Costs (Non-Fuel)

Non-fuel-related costs include the costs of oil, tires, maintenance and repairs, depreciation and capital saving for vehicles in working time.

Non-fuel VOCs are calculated using the following formula;

$$C = a1 + \frac{b1}{V},$$

Where;
C = cost in pence per kilometre travelled,
V = average link speed in kilometres per hour,
a1 = a parameter for distance related costs defined for each vehicle category,
b1 = a parameter for vehicle capital saving defined for each vehicle category (only relevant to working vehicles).

Currently parameter a1 takes the same value for petrol and diesel vehicles. For electric vehicles, the evidence is very weak, but suggests that the costs are lower because there are fewer moving parts that are likely to wear out with mileage. There is currently no evidence to confirm whether the a1 parameter differs by trip purpose for electric cars. There is also no evidence regarding the b1 parameter for electric cars in-work. For the present it will be assumed that the vehicle capital saving for electric cars will be the same as for petrol/diesel cars.

Table 9.24 presents the required parameters to calculate the non-fuel vehicle operating costs.

Table 9.24: Non-Fuel Resource VOCs, 2010 (2010 prices and values) (Source WebTAG data book Table A1.3.14)

Vehicle Category		Parameter Values	
		a1 p / km	b1 p / hr
Car	Work Petrol	4.966	135.946
	Work Diesel	4.966	135.946
	Work Electric	1.157	135.946
	Non-Work Petrol	3.846	0.000
	Non-Work Diesel	3.846	0.000
	Non-Work Electric	1.157	0.000
LGV	Work	7.213	47.113
	Non-Work	7.213	0.000
	Average	7.213	41.458
OGV1	Work	6.714	263.817
OGV2	Work	13.061	508.525
PSV	Work	30.461	694.547

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

Non-fuel VOCs are assumed to remain constant in real terms over the forecast period; however parameters for an average car vary through time (owing to changes in the proportion of electric vehicles) and are given in Table 9.25.

Table 9.25: Forecast Non-Fuel Resource VOCs (2010 prices) (Source WebTAG data book Table A1.3.15)

Year	**Work Car**		**Non-Work Car**		**Average Car**	
	a1 pence/km	b1 pence/hr	a1 pence/km	b1 pence/hr	a1 pence/km	b1 pence/hr
2010	4.966	135.946	3.846	0.000	3.992	17.809
2015	4.960	135.946	3.842	0.000	3.988	17.809
2020	4.929	135.946	3.820	0.000	3.965	17.809
2025	4.869	135.946	3.778	0.000	3.921	17.809
2030	4.764	135.946	3.703	0.000	3.842	17.809

This table is also provided in the Economy Spreadsheet which supports this section of the STAG Technical Database.

9.5.21 Bus Operating Costs

In a standard appraisal of a road scheme buses should be treated as part of the traffic flow, and the operating cost formulae (described above) are applied, using the appropriate parameter values for PSVs. In a multi-modal study, however, different options may result not only in faster or slower running times for existing bus services, but in the need for more or different levels and patterns of bus service provision. In these cases, the impact of options on the costs of bus service provision have to be considered in more detail.

9.5.22 Rail Operating Costs

Information on rail operating costs can be obtained through discussion with Transport Scotland.

9.5.23 Rail Appraisal – Road Network Effects

Transport Scotland recommend that impacts on the wider transport network are assessed with a multi-modal transport model. However, it recognises that in some cases the cost of developing such a model cannot be justified as being in keeping with the principle of proportionality in STAG appraisal. In such cases suitable approximations of the impact on the road network should be applied and identified separately in the TEE table.

In many cases, approximate values can be obtained through taking skims of existing road network models for the local area. The Department for Transport has also provided estimates for the impact of marginal changes to car flows on the road network based on data from the NTM. Practitioners should make use of the methods and values set out in Unit A5.4 of WebTAG where local models of the road network are unavailable.

It should be noted that, consistent with STAG guidance under the Environment Criterion, monetised values for journey ambience, local air pollution, or noise should not be included in the AST.

9.6 Reporting

It is important that practitioners provide clear and concise details of the impacts which are calculated during Part 2 Appraisal under the Economy Criterion in the STAG Report. For the TEE analysis, a statement of key appraisal parameters should be made and the key components of the present value of benefits should be presented and described – Travel time, User charges, Vehicle Operating Costs and Quality/Reliability benefits (where appropriate). This should be complemented by the presentation and discussion of the distribution of journey time (dis-) benefits by size, the product of the analysis outlined in section 9.2.2.1.

A tabular presentation of results is expected in the Part 2 AST with supporting information provided to outline the basis for the quantitative impacts calculated. Calculated WEBS and EALI benefits should be presented clearly in the same Part 2 AST supplemented by spatial analysis of the impacts of a scheme where possible (most likely, using GIS). Where no WEB or EALI impacts are expected this should be stated clearly.