PEARS

Program for the Economic Assessment of Road Schemes
User Guidance
September 2014

Transport Scotland
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1 INTRODUCTION

1.1 Introduction & Background

1.1.1 PEARs (Program for the Economic Assessment of Road Schemes) is an economic assessment package that has been specifically designed for use with the output from traffic microsimulation models. The economic concepts in PEARs are consistent with the Fixed Trip Matrix methodologies of NESA (as detailed in DMRB Volume 15).

1.1.2 PEARs carries out trip-based assessments of changes in travel time costs and vehicle operating costs. The costs of a trip-based assessment are derived by aggregating the costs of each individually modelled vehicle on the network. By comparison, traditional link-based assessments (e.g. NESA) and matrix-based assessments (e.g. TUBA) rely on a single travel time and vehicle operating cost for each link or origin/destination movement representative of the whole modelled period and each vehicle classification modelled.

1.1.3 PEARs 09.1 onwards includes the calculation and valuation of carbon emissions based on the parameter values and guidance presented in TAG Unit 3.3.5, The Greenhouse Gases Sub-Objective. This is discussed further in Section 2.6.

1.1.4 PEARs 11.1 onwards includes a link to Transport Scotland’s emissions software AIRE (Analysis of Instantaneous Road Emissions).

1.1.5 PEARs 14.1 uses 2010 as the base year for calculations (previously 2002) includes Carbon Dioxide equivalent (CO2e) instead of Total Carbon 2010.

1.2 Accidents & Non-Traffic Related Maintenance

1.2.1 Like the DfT’s TUBA program, PEARs does not at present consider accidents and therefore a separate accident assessment is required (usually an ‘accident only’ COBALT or NESA assessment).

1.2.2 In addition, at present, PEARs does not consider non-traffic related maintenance. The costs and benefits associated with Non-Traffic Related Maintenance can generally be obtained from the accident only COBALT or NESA assessments.

1.3 Runtime Requirements

1.3.1 If you are using PEARs outside of the UK it is possible that the Regional Options on your PC will not be suitable. It is recommended that English (United Kingdom) format is used. In order for PEARs to run correctly it is critical that the decimal symbol and time format shown in Table 1.1 are used.

<table>
<thead>
<tr>
<th>Table 1.1: Regional Options which are critical for running PEARs</th>
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<tbody>
<tr>
<td>Decimal Symbol</td>
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<tr>
<td>Time Format</td>
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</tbody>
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1.4 Audit & Use of PEARs

1.4.1 PEARS has been developed by SIAS Limited (SIAS) and is currently maintained by Transport Scotland. Transport Scotland has had PEARS independently audited and its use is approved for the economic appraisal of trunk road scheme assessments where Fixed Trip Matrix microsimulation models have been applied.

1.4.2 Users outside Scotland should check with the appropriate Overseeing Organisation to ensure that it is appropriate and acceptable to use PEARS.

1.5 PEARs & Microsimulation Models

1.5.1 Although PEARs has been specifically designed such that it can be used directly with outputs from S-Paramics, it can be used with other microsimulation traffic models, providing the outputs from the models are in a suitable format for input to PEARs (which may require some element of interfacing).

1.5.2 The combination of microsimulation traffic modelling and PEARs provides a robust traffic and economic assessment tool in that the detailed aspects of traffic operation can be captured with greater accuracy. This includes:

- Detailed network definition (e.g. hilliness and bendiness derived from OS digital mapping data, traffic calming and other localised characteristics)

- A high level of flexibility in coding and modelling the operating characteristics of different vehicle types (e.g. light, medium and heavy vehicles, public service and slow moving vehicles)

- Accurate representation of the variation in traffic flows using time based profiles of travel demand by vehicle type and origin/destination (e.g. different traffic flow profiles can be used for different movements and/or directions)

- Detailed modelling of individual vehicles and the interaction between cars and slower moving vehicles at junctions, in platoons, and during overtaking manoeuvres (e.g. more robust outputs for economic appraisal including the assessment of downstream benefits)

1.6 Further Information

1.6.1 Appendix A: Definitions, at the rear of this User Guidance, contains a list of definitions which is intended to assist users of PEARs.

1.6.2 Further background documentation can also be found at the DfT’s Transport Analysis Guidance website www.gov.uk/transport-analysis-guidance-webtag and Transport Scotland’s website www.transportscotland.gov.uk.

1.7 Support

1.7.1 PEARs is supported by Transport Scotland. If users require any assistance or further information regarding PEARs, please email: LATIS@transportscotland.gsi.gov.uk.
2 ECONOMIC ASSESSMENT

2.1 Cost Benefit Analysis

2.1.1 The requirement for a traffic and economic assessment, or cost-benefit analysis, results from a need for all funding authorities to secure value for money from any investment expenditure. In the case of the transport sector, cost-benefit analysis provides a consistent methodology to compare the value for money of an individual scheme to other schemes within a funding authority’s overall transport programme.

2.1.2 Cost-benefit analysis is used to compare (in monetary terms) the benefits of a scheme (such as savings in travel times, vehicle operating costs, accidents, etc.) with the costs associated with constructing a scheme (i.e. capital cost, land costs, supervision costs, etc). If the benefits outweigh the costs, the scheme can be considered to provide ‘value for money’ and to be economically justified.

2.2 Method of Accounting

2.2.1 The method of accounting used in the appraisal of transport schemes has moved from one based on social costs and benefits to one based on Willingness to Pay. This method allows better identification of how different groups in society will be affected by the improvement scheme.

2.2.2 For example, a benefit to one person or social group could be perceived as a cost to another, so when collating the results, the transfer in payments between consumer, provider and government can sometimes be cancelled out.

2.2.3 In addition to the move to Willingness to Pay, the unit of account has changed from Factor Cost Prices (net of any indirect taxes) to Market Prices (gross of any indirect taxes).

2.2.4 Market Prices are those paid by consumers for services and goods on the open market. As they include taxation, they can be more easily perceived by consumers. It should be noted, however, that prices that do not include taxation (such as public transport fares) are still perceived by consumers in market prices.

2.2.5 A fuller discussion of Willingness to Pay, and the conversion between the Factor Cost and Market Price units of account, is given in TAG Unit A1.1, Cost Benefit Analysis (January 2014) and A1.3, User and Provider Impacts (January 2014).

All costs and benefits reported in PEARS are expressed in Market Price unit of account.

2.3 Framework for Assessment

2.3.1 In order to compare costs and benefits that occur at different times throughout the appraisal period, Discounting is employed to convert these values back to a Present Value Year, currently 2010.

2.3.2 Discounting is based on the principle that society in general prefers goods and services now rather than at some point in the future and values capital today more highly than capital tomorrow.
2.3.3 Any sum (S) can be reduced to its present value (PV) using the formula:

\[ PV = \frac{S}{(1+ r)^n} \]

Where:
- PV = the present value
- S = the sum
- r = the discount rate
- n = year in which the sum is received (when the money is spent)
- n = 0 is the present value year (2010)

2.3.4 For example, £1,000,000 spent in 2020 would be worth the equivalent of £708,919 in 2010, using a 3.5% discount rate.

The discount rates used in PEARs, together with the Present Value Year of 2010, are taken from HM Treasury’s Green Book *Appraisal and Evaluation in Central Government*.

2.3.5 The model *Base* year is likely to be the year in which the traffic surveys were conducted. The forecast years will typically be the *Opening Year* and a *Forecast Year(s)*. The opening year will be the first year that consumers can expect to accrue benefits from the scheme, e.g. the year in which the scheme is opened to traffic. The forecast year(s) will be typically 10 or 15 years after opening.

As a minimum, PEARs requires the user to input an opening year and a forecast year, however, the appraisal can be improved through the inclusion of intermediate modelled years, typically every 5 years from the model Base year.

2.3.6 Users should refer to the Overseeing Organisation’s guidance on economic assessment when selecting the appropriate Traffic Growth. Local growth, or growth based on national forecasts, is generally used. In Scotland for trunk road schemes, Transport Scotland’s advice is to consider using the Transport Model for Scotland (TMfS) as the principle source of growth forecasts; or alternatively Scottish Trip End Program (STEP); or National Road Traffic Forecasts (NRTF97). Where NRTF97 forecasts are used, users should note that these assume zero traffic growth post 2031.

2.3.7 Users should note that PEARs contains no information on traffic growth. Any traffic growth is applied within the traffic models, the outputs of which are input to PEARs.

2.3.8 The Period of Appraisal will typically be 60 years to cover the period of useful life of the asset and to capture the streams of costs and benefits accrued during the life of a project. While it is possible that, if fully maintained throughout its life, the period of usefulness of the project may extend well beyond 60 years and, technically, such projects may be seen to have an infinite life, a 60 year appraisal period is considered pragmatic, given the risk and uncertainty of estimating costs and benefits any further into the future.

The default appraisal period in PEARs is 60 years.

2.3.9 A fuller discussion of the framework for calculation of Measures of Economic Worth is given in *TAG Unit A1.1, Cost Benefit Analysis (January 2014)*.
2.4 Demand & Annualisation

2.4.1 In theory, every hour of a year should be simulated to provide input to the economic assessment. In practice, however, this is unrealistic, so PEARS allows users to input discrete time periods and aggregate them to provide data for the year.

2.4.2 For example, for inter-urban corridors where traffic patterns are likely to be significantly affected by a design scheme, a 24hr simulation is recommended. Traffic demand can be accurately replicated using traffic flow profiles, by vehicle class and O-D movement. Where comprehensive automatic traffic count (ATC) data exists (preferably in 5min bins/intervals to assist with the profiling), different day types can be modelled:

- Weekday
- Saturday
- Sunday

2.4.3 Given the different day types, multiplication factors to annualise the data would be 253, 52, and 59 respectively (assuming the 7 bank holidays resemble Sundays and ignoring Christmas Day completely), totalling 364 days (8,736hr).

2.4.4 At the other extreme, an urban junction may be presumed only to accrue significant benefits during peak periods. In this case, it may be reasonable for two 3hr periods only to be modelled, each with a multiplication factor of 253, giving a total of 1,518 annual hours.

2.4.5 In between, there could be any number of combinations of day types including seasonal variations and time periods, each aggregated to provide the number of annual hours to be modelled.

2.4.6 PEARS offers the user flexibility in how the discrete time periods are aggregated. Although it is recommended that a full year is assembled (e.g. 8,736hr), the assessment period can vary depending on the objectives and requirements of the overall appraisal.

A requirement of PEARS is that the time periods for the Do-Minimum or Reference Case and the Do-Something (Design) options must be identical.

2.4.7 When undertaking time period runs within the microsimulation traffic model, users are advised to collect measurements over an extended period to allow sufficient extra time at the end of the period to ensure that all journeys that started within the required time period have reached their destination. Failure to do so may potentially have significant impacts on the economic appraisal.

2.4.8 Micro-simulation models tend to only output completed trips. PEARS uses the start time of trips in the trips-ALL and busdelay CSV files to assess how various economics (such as Value of Time) are applied. As a result, careful consideration must be given to the trips attributed to a time schema within PEARS to ensure that all trips on the traffic model network within the modelled period are appropriately represented in the economics.
2.5 User Costs & Benefits

2.5.1 *User Costs* incurred by the road user are defined as including travel time, vehicle operating and accident costs. While PEARs is used to quantify the changes in travel time and vehicle operating costs, changes in accident costs are calculated externally using COBALT or NESA (in Scotland) (*DMRB Volume 15*). Any changes in travel time, vehicle operating or accidents costs during construction and routine maintenance are calculated externally.

2.5.2 Generally, the most significant user benefit likely to accrue from a road improvement scheme is that of changes in Travel Time. Savings in travel time are disaggregated into three distinct groups: Work (in employer’s time); Commuting (travel to and from normal place of work); and Other (travel for other non-work purposes).

2.5.3 Travel in the course of Working time is valued at its cost to the employer of the travelling employee. This assumes that all travel in the course of Working time is carried out in the employer’s time rather than in the employee’s time. Commuting is for journeys made to and from the normal place of work and Other includes all purposes of travel except travel in the course of work and commuting. Commuting and Other time are valued at the cost perceived by the consumer.

2.5.4 PEARs adopts the same journey purposes as NESA (in Scotland) and TUBA, which can be categorised as either Working or Non-Working. All goods vehicles and their occupants are appraised in Working time only.

2.5.5 Values of time and vehicle occupancy, plus changes in these over time, are detailed further in the TAG data book.

2.5.6 The benefits accrued to traffic also include potential savings in Vehicle Operating Costs (VOC). The change in VOC over the length of a journey will depend on changes in both the distance travelled by vehicles and the average speed over the journey. The change in overall VOC can be either negative or positive depending on the changes in vehicle speeds and distance travelled.

2.5.7 Vehicle Operating Costs are a function of use, which are disaggregated into fuel and non-fuel elements and include: fuel, oil, tyres, maintenance, depreciation, size of vehicle fleets. Other running costs such as vehicle excise duty, insurance and garaging are not included.

2.5.8 The resource cost of fuel consumption in PEARs is currently estimated by vehicle type using a function of the form (*TAG data book: A 1.3.8, January 2014*):

\[ L = a/v + b + c.v + d.v^2 \]

Where:
- \( L \) = cost in pence per kilometre per vehicle
- \( v \) = average vehicle speed in kilometres per hour
- \( a, b, c \) & \( d \) are fuel parameters for each vehicle type

2.5.9 This function reflects a higher operating cost at lower speeds, reflecting the effects of stop start conditions.
2.5.10 The formulae for calculating fuel consumption outlined above, are based on different parameters for different vehicle types (using a single calculation for the entire journey). PEARS can replicate the same calculation, but can also calculate fuel use based on an aggregation of the fuel used in each microscopic time step in the simulation for each individual vehicle. As this approach takes into account the increased use of fuel in stop-start motoring, and the variation in journey time for each vehicle, it is inherently more accurate than a simple calculation based on mean overall journey time.

2.5.11 The use of the fuel accumulation method in PEARS requires outputs from the microsimulation model to be in litres (i.e. within the trips-ALL and busdelay CSV files).

The use of the fuel accumulation method in PEARS is only valid if an appropriate pollution and fuel-use model was used during the simulation.

2.5.12 The non-fuel elements of the marginal resource cost are combined in a formula of the form (TAG data book: A 1.3.14, January 2014):

\[ C = a^1 + b^1 / V \]

Where:
- \( C \) = cost in pence per kilometre per vehicle
- \( V \) = average vehicle speed in kilometres per hour
- \( a^1, b^1 \) are non-fuel parameters for each vehicle type

2.5.13 The marginal resource costs of oil, tyres, mileage and maintenance related depreciation are assumed to be fixed costs per kilometre and appear in the \( a^1 \) term. The \( b^1 \) term in the non-fuel costs represents changes in the productivity of commercial vehicles and cars in working time, all goods vehicles and service buses.

2.5.14 Vehicle Operating Costs, fuel and non-fuel costs and changes in cost over time are detailed further in TAG Unit A1.3, User and Provider Impacts (January 2014).

All user costs and benefits in PEARS are discounted to 2010 prices and values.

2.6 Emissions Benefits

2.6.1 PEARS includes the calculation and valuation of carbon emissions (PEARS09.1 onwards).

2.6.2 The calculation of carbon emissions is considered to be the key indicator in assessing the impacts of transport options on climate change. The valuation of carbon emissions considers the additional global damage arising from an additional tonne of carbon being emitted.

2.6.3 Carbon emissions are estimated per litre of fuel burnt and as such are calculated from the amount of fuel consumed. The change in fuel consumption will depend on changes in both the distance travelled and vehicle speeds. The change in carbon emissions can be either negative or positive depending on the changes in vehicle speeds and distance travelled.
2.6.4 Carbon dioxide emissions per litre of fuel burnt and the non-traded values of carbon per tonne of CO2e, plus changes in these over time, are detailed further in TAG data book: A 3.3 and A 3.4 (January 2014).

2.6.5 PEARS includes the calculation and valuation of low, central and high non-traded values of carbon (PEARS11.1 onwards).

2.7 Scheme Costs

2.7.1 Cost-benefit analysis compares the user benefits of an improvement scheme with its costs. Scheme costs principally include:

- Construction
- Land
- Property costs
- Preparation, design and supervision costs

2.7.2 Scheme costs should generally be input to PEARS in current day prices together with the appropriate Consumer Price Index, e.g. 128.1, April 2014 (Source: Office for National Statistics). In specifying the scheme costs, a rate of spend needs to be defined to establish when the money will be spent.

All of the costs should be exclusive of Value Added Tax.

2.7.3 One of the fundamental considerations of the assessment process is that of Optimism Bias. Optimism Bias is the term used to reflect a tendency for the true capital cost, operational cost or works duration of schemes in the public sector to be underestimated thereby overestimating the benefits of the scheme.

2.7.4 Consequently, there is a need, particularly at the initial stages of the assessment, to provide more realistic cost estimates. To this end, the appraisal process now includes the requirement to apply an uplift to the capital costs of the works and an extension to the project programme. Optimism Bias will generally be higher at the early stages of an assessment when details of any proposed scheme, and the associated risks, will generally be less well defined and lower at the later stages of assessment when the details of the proposed scheme and associated risks are better defined.

Optimism Bias must be applied to all scheme assessments. Optimism Bias is not a sensitivity test.

2.7.5 For Transport Scotland trunk road schemes, the levels of Optimism Bias generally applied are outlined in Table 2.1. Users should confirm the levels of Optimism Bias to be applied at each stage of a scheme’s assessment with their Overseeing Organisation. Further general advice regarding Optimism Bias can be found in TAG Unit A1.2, Scheme Costs (January 2014).
Table 2.1: Optimism Bias Adjustment Factors Approved by Transport Scotland for Different Stages of Assessment of Trunk Road Schemes

<table>
<thead>
<tr>
<th>Stage / Factors</th>
<th>Preliminary Assessment / DMRB Stage 1</th>
<th>Route Option Assessment / Pre-Feasibility DMRB Stage 2</th>
<th>Preferred Scheme Assessment / Pre-Order Publication DMRB Stage 3</th>
<th>Pre-Tender Assessment / Order Publication</th>
<th>Post-Tender Assessment / Works Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Factor (Roads)</td>
<td>44%*</td>
<td>25%</td>
<td>15%*</td>
<td>15%</td>
<td>3%*</td>
</tr>
<tr>
<td>Works' Duration Factor (Roads)</td>
<td>20%*</td>
<td>10%</td>
<td>10%*</td>
<td>5%</td>
<td>1%*</td>
</tr>
<tr>
<td>Cost Factor (Fixed Links)</td>
<td>66%*</td>
<td>44%</td>
<td>23%*</td>
<td>23%</td>
<td>6%*</td>
</tr>
<tr>
<td>Works' Duration Factor (Fixed Links)</td>
<td>25%*</td>
<td>Agree with TS</td>
<td>Agree with TS</td>
<td>Agree with TS</td>
<td>3%*</td>
</tr>
</tbody>
</table>

Sources: *Flyvbjerg (2004) & Mott MacDonald (2002), otherwise Transport Scotland

2.7.6 As in any Cost Benefit Analysis, the economic assessment of road schemes is based on the assessment of future costs and future benefits. One of the features of the progressive analysis of schemes is that the economic assessment is undertaken at each stage based on the return on future investments. This means that scheme costs incurred prior to the current economic assessment which are already spent and cannot be recovered (whether or not the scheme goes ahead) should be excluded from the overall scheme costs input to the economic assessment. Such costs are referred to as Sunk Costs.

2.8 Accidents & Non-Traffic Related Maintenance

2.8.1 PEARs, like TUBA does not at present consider accidents, so a separate accident assessment is required (usually an accident only COBALT or NESA assessment). An accident only COBALT or NESA assessment will also provide details regarding the costs or benefits associated with non-traffic related maintenance, which is typically considered as part of an economic appraisal.

2.8.2 In addition, travel time, vehicle operating and accident costs during construction and routine maintenance should be assessed separately.

2.8.3 Any accident, non-traffic related maintenance costs or benefits need to be manually input to the Transport Economic Efficiency (TEE) tables output by PEARs (see Section 2.11) and the various economic outputs manually updated, e.g. PVC, PVB, NPV, and BCR.
2.9 Economic Outputs

2.9.1 The economic performance of a scheme can be presented in a number of ways. Each compares the value of the benefits accrued to the value of the costs expended.

2.9.2 The Net Present Value (NPV) of a scheme (in 2010 prices and values) is the discounted sum of all the future benefits less the discounted sum of all the future costs. The NPV is given by the formula:

\[ \text{NPV} = \text{PVB} - \text{PVC} \]

Where:
- **PVB** = Present Value of Benefits (inc. any Indirect Tax Revenues)
- **PVC** = Present Value of Costs

2.9.3 If the scheme returns a positive NPV, the scheme can be said to provide value for money and can be considered to be economically justified.

2.9.4 The Benefit/Cost Ratio (BCR) of a scheme is the discounted sum of all the future benefits divided by the discounted sum of all the future costs. The BCR is generally given by the formula:

\[ \text{BCR} = \frac{\text{PVB}}{\text{PVC}} \]

Where:
- **PVB** = Present Value of Benefits (inc. any Indirect Tax Revenues)
- **PVC** = Present Value of Costs

2.9.5 Again, if the scheme returns a BCR greater than 1.00, the scheme can be said to provide value for money on economic grounds.

2.10 Impacts of Indirect Tax Revenues

2.10.1 Indirect Tax Revenues (ITRs) are classified as Wider Public Finances. When calculating the BCR the Wider Public Finances contribute to the scheme benefits (*TAG Unit A2.1, Wider Impacts, January 2014)*.

2.10.2 In the context of transport appraisals, the main source of ITR is fuel which is subject to high rates of tax. Any change in the amount of fuel consumed affects the amount of ITR.

2.10.3 Changes in the amount of fuel consumed can be brought about in a number of ways, for example:

- Speeds – vehicle fuel consumption is generally parabolic in nature, i.e. high consumption at low or high speeds and lower consumption in between, i.e. 40 – 60mph
- Changes in vehicle distance travelled, i.e. changes in vehicle kilometres
- Switching trips from cars to public transport
2.10.4 Switching trips from cars to public transport has a further impact on ITRs, as not only is there a change in the amount of fuel consumed but public transport services also have lower rates of taxation, i.e. fares are zero-rated for VAT. The impacts of any changes in public transport fare revenues are not however considered in a PEARs assessment. In a fixed trip matrix PEARs assessment, any changes in Indirect Tax Revenues are based on changes in vehicle speeds or vehicle kilometres between a Reference Case and Design options, hence changes in the amounts of fuel consumed.

2.10.5 In PEARs14.1, any changes in ITRs are reported in the Public Accounts section of the TEE table in accordance with Treasury advice and contribute towards the Wider Public Finances. In the TEE table, any reduction in ITRs results in an increase in the overall PVB of a scheme; conversely any increase in ITRs results in a reduction in the overall PVB of a scheme.

The Transport Economic Efficiency tables in PEARs reflect those presented by the Treasury.
2.11 Transport Economic Efficiency (TEE) Tables

2.11.1 The results of the PEARS assessment are combined externally with results from the accident and maintenance assessments and input to the TEE tables in support of the scheme. An example of the TEE tables output by PEARS are shown in Figure 2.1, Figure 2.2, and Figure 2.3.

Figure 2.1: Example of TEE Table 15A

Table 15A: Economic Efficiency of the Road System (Market Prices)

<table>
<thead>
<tr>
<th>Schema Title</th>
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<td>NET NON-BUSINESS BENEFITS: COMMUTING</td>
<td>11</td>
</tr>
<tr>
<td>NET NON-BUSINESS BENEFITS: OTHER</td>
<td>12</td>
</tr>
<tr>
<td>NET NON-BUSINESS BENEFITS - SUB TOTAL</td>
<td>13</td>
</tr>
<tr>
<td>BUSINESS USER BENEFITS</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Business Vehicle Operating Costs</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Subtotal</td>
<td>21</td>
</tr>
<tr>
<td>Private Sector Provider Impacts</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Private Sector Vehicle Operating Costs</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>26</td>
</tr>
<tr>
<td>Subtotal</td>
<td>27</td>
</tr>
<tr>
<td>Other Business Impacts</td>
<td>28</td>
</tr>
<tr>
<td>NET BUSINESS IMPACT</td>
<td>29</td>
</tr>
<tr>
<td>TOTAL PRESENT VALUES OF TEE IMPACTS</td>
<td>30</td>
</tr>
</tbody>
</table>

* Impact calculated external to PEARS & manually input by User. Any manual inputs will require the manual reconciliation of the Sub Totals / Impacts etc as well as the NPV & BCR etc. in Table 15C.

This analysis is based on Central traffic growth.
Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are in units of £1,000,000 pounds sterling and are discounted to 2010.
Evaluation period 60 years. Scenario opening year 2011.
Current year 2014.

Date printed: 09 September 2014  SIAS Limited  Page 1 of 1
Reference data: Date January 2014  Version: 1.14
### Figure 2.2: Example of TEE Table 15B

#### Table 15B: Public Accounts

<table>
<thead>
<tr>
<th>Scheme Title</th>
<th>Reference</th>
<th>Cal'c / Source</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IMPACT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Government Funding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue (*)</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment Costs (*)</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Costs (*)</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Traffic (Group 1) (*)</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Related (Group 2) (*)</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developer &amp; Other Contributions (*)</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grant Subsidy Payment (*)</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Impact</strong></td>
<td>39</td>
<td>Sum(32 to 38)</td>
<td></td>
</tr>
<tr>
<td><strong>Central Government Funding: Transport</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue (*)</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment Costs</td>
<td>41</td>
<td>£59.35</td>
<td></td>
</tr>
<tr>
<td>Operating Costs (*)</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Traffic (Group 1) (*)</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Related (Group 2) (*)</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developer &amp; Other Contributions (*)</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grant Subsidy Payment (*)</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Impact</strong></td>
<td>47</td>
<td>Sum(30 to 46)</td>
<td>£59.35</td>
</tr>
<tr>
<td><strong>Central Government Funding: Non-Transport</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect Tax Revenues</td>
<td>48</td>
<td>£1.23</td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Broad Transport Budget</strong></td>
<td>49</td>
<td>39+47</td>
<td>£59.35</td>
</tr>
<tr>
<td><strong>Wider Public Finances</strong></td>
<td>50</td>
<td>48</td>
<td>£1.23</td>
</tr>
</tbody>
</table>

* Impact calculated external to PEARs & manually input by User. Any manual inputs will require the manual recalculation of the Net Impacts. Totals etc. as well as the NPC & BOS etc. in Table 15C.

This analysis is based on Central traffic growth.

Benefits appear as positive numbers, while costs appear as negative numbers.

All entries are in units of £1,000,000 pounds sterling and are discounted to 2010.

Evaluation period 60 years. Scheme opening year 2018.

Current year 2014.
2.12 Further Information

2.12.1 Further information on the underlying principles of economic assessment can be found in *DMRB Volume 15 and TAG Unit A1.1, A1.2 and A1.3.*
3 APPLICATION OF PEARS

3.1 Background

3.1.1 As outlined in Section 1, PEARS can be used with various traffic microsimulation models, providing the outputs from the models are in a suitable format for inputting to PEARS.

3.1.2 The layout of PEARS and the various screens presented, guide the user through the various stages of pulling together the data inputs required to carry out an economic assessment. These include how to:

- Input the scheme title, description, costs and spend profile
- Build an evaluation time schema and link it to the appropriate microsimulation model outputs
- Perform the assessment and generate the reports
- Save the PEARS configuration data for future assessments

Note: The configuration of the assessment set up in these stages can be amended at any time, and the overall configuration saved and re-used.

3.1.3 The initial PEARS splash screen appears before going into the Scheme tab. Navigation through PEARS is achieved either by selecting the appropriate tab, clicking the Previous or Next buttons on each tab, or by selecting the step from the Step menu.

3.2 Defining the Scheme

3.2.1 The Scheme tab, as shown in , allows the user to give the assessment a title and description and to specify the scheme costs and cost profile over a period of up to 5 years:

- Scheme title  General title
- Scheme description  General description and growth scenario
- Scheme costs  Including Optimism Bias
- CPI  Consumer Price Index at the date of the scheme cost estimate (www.statistics.gov.uk)
- Cost/spend profile  Including any Optimism Bias (TAG Unit A1.2, Scheme Costs, January 2014)
Figure 3.1: PEARs Scheme Tab
3.3 Traffic Model Inputs to PEARS

3.3.1 Selecting the Modelling tab, as shown in , allows the user to create a time schema linking the future year traffic model runs to the assessment period.

3.3.2 The user can specify how the various discrete modelled periods or time frames are annualised. Each discrete modelled period can be given a different annualisation factor to extrapolate it to the required period (Section 2.4). Time frames must end on or before midnight. If modelled periods span midnight then two time frames should be created; one before midnight and one after midnight.

3.3.3 The individual Reference Case and Design traffic models are linked to the schema by selecting the appropriate modelled Year, clicking Add, selecting the appropriate modelled time period and then browsing to the corresponding traffic model using the Model button.

3.3.4 Two files called nodes and version are required in the model directory. The contents of the nodes file is irrelevant, but it is important that the nodes file does not have a file extension. The version file contains information about the version of S-Paramics which the models were run in. The version file requires one line with the following format: version 20xx.y (e.g. version 2014.1). Users who have not run their models in S-Paramics should ensure they create a version file with this format. The user can select the traffic model by double clicking on the nodes file which will appear in the browser. The selected model and available log runs then appear in the window.
3.3.5 The directory structure should be as follows:

- Model Directory
- Log
- run 001
- run 002, etc.

3.3.6 Users may select or deselect individual model runs using the tick boxes. The information boxes will indicate if a model has been assigned, and the number of runs associated with it. An assessment cannot be carried out until all the required data is selected. The version file is required in each run folder. This will happen automatically if using S-Paramics.

3.3.7 In order to be read into PEARS, each microsimulation model run must collect data on vehicle trips and data on bus delays. The layout of the trips data and bus delay data must be as per the S-Paramics trips-ALL CSV file and busdelay CSV file. Figure 3.3 shows the layout of the S-Paramics trips-ALL CSV file, and Figure 3.4 shows the layout of the S-Paramics busdelay CSV file.

3.3.8 Figure 3.5 shows an example of a time schema where the time frames reflect discrete modelled periods.
3.3.9 Figure 3.6 indicates that three modelled years have been used in the schema and shows the Reference Case time periods for 2020 and 2023.

![Figure 3.6: Reference Case Time Periods](image)

PEARS interpolates the costs associated with the Reference Case and the Design options between modelled years and extrapolates linearly before the first modelled year and after the last modelled year. The one exception to this is the calculation of carbon emissions where PEARS takes into account guidance that carbon emissions (per litre of fuel burnt) remain constant from 2020 *(TAG data book: A 3.3, January 2014)*. A sufficient number of modelled years are required to provide a reasonable representation of costs during the evaluation period.

3.4 Assessment Characteristics

3.4.1 When the user is confident that all modelled periods have been included, clicking on the Assessment tab allows the user to specify a number of items, including:

- **Opening year**: The first year when benefits start to be accrued (opened to traffic)
- **Appraisal period**, for example, 60 years
- **Interpolation method**
- **Fuel use calculation**
- **Last growth year (in costs)**, see Section 4.12

3.4.2 Interpolation of the benefits may be:

- **Linear**
  The costs are interpolated linearly between the assessment years
- **Percentage**
  The costs are assumed to rise each year by a constant percentage, as follows:

\[
\text{Cost (n+1)} = \text{Cost n} \times (1 + X)
\]

*Where:*

- \( n = \text{year in which the increase in cost is to be applied} \)
- \( X = \text{increase in costs between year n & year n+1 (expressed as \%/100)} \)

The one exception to this is the calculation of carbon emissions where PEARS takes into account guidance that carbon emissions (per litre of fuel burnt) remain constant from 2020 *(TAG data book: A 3.3, January 2014).*
3.4.3 The fuel use for each trip may be derived either by:

- An estimate over the entire journey (average speed) – refer to Section 2.5.8
- The accumulation of the fuel used in each microsimulation time step for each vehicle
- The fuel calculated from Transport Scotland’s emissions software AIRE (Analysis of Instantaneous Road Emissions)

The use of the fuel accumulation method is only valid if an appropriate pollution and fuel-use model was available and used during the traffic simulation.

3.4.4 An example of the Assessment tab is given in Figure 3.7.

![Figure 3.7: PEARS Assessment Tab](image)

3.5 Run the Assessment

3.5.1 With all the parameters input, the assessment is carried out by clicking the Carry Out Economic Assessment of Road Scheme button, in the centre of the Assessment tab – see Figure 3.7.

3.5.2 PEARS will then read in the trip data from the respective CSV files, convert these to monetary values and summate the costs and benefits by consumer, provider and government. The progress of the assessment is shown in the Status window.
3.6 Reporting

3.6.1 Once the assessment has been carried out, PEARS automatically switches to the Reports tab, in which the standard TEE outputs are reproduced:

- Table 15A: Economic Efficiency of the Road System
- Table 15B: Public Accounts
- Table 15C: Analysis of Monetised Costs and Benefits

3.6.2 The outputs can be reported for the Full Assessment or as First Year Rate of Return values. An example of the Reports tab is shown in Figure 3.8.

![Figure 3.8: PEARS Reports Tab](image)

3.6.3 TEE Tables 15A, 15B, and 15C can be printed using the Print button at the bottom of the main PEARS dialog window. The user has the choice of printing the current page, all pages or specific pages. If the option to print specific pages is selected then options to print detailed occupancies, values and economic parameters underpinning the calculations are offered.
3.6.4 An example of the PEARS Report Generation dialog window is given in Figure 3.9.

![Figure 3.9: PEARS Report Generation Dialog Window](image)

3.7 Calculations

3.7.1 A more detailed analysis of the components of the assessment can also be obtained graphically using the **Workings** button at the bottom of the main PEARS dialogue window and selecting the **Analysis** sub-tab, as shown in Figure 3.10.

![Figure 3.10: PEARS Scheme Workings - Analysis Sub-Tab](image)
3.7.2 These graphs may be customised in appearance with 2D and 3D options, and annotated with a title and legend. They can be copied to the Microsoft Windows clipboard for inclusion in Microsoft Office documents, either as a table of text values or as an image, according to the Paste/Paste Special options of the receiving application.

3.8 Save the Assessment

3.8.1 The completed PEARS assessment can be saved in .PSF format for use at a later date. The other File Menu Options include:

- Create a New assessment
- Open an existing assessment
- Save an assessment
- Save assessment as a new file

3.8.2 These functions are duplicated at the bottom of the PEARS dialog window, see Figure 3.11 for example.

3.9 Change the Reference Values

3.9.1 It is possible to adjust the default settings, reference values and coefficients within PEARS, however, this assumes that users have sufficient statistically robust data to warrant any such adjustments. Changing the default settings will potentially result in the loss of a standard means of comparing schemes and should be undertaken only after due consideration of the implications and with the prior approval of the relevant Overseeing Organisation.

3.9.2 The reference values can be changed via the Reference Values tab as shown in Figure 3.11. Changes can only be made after clicking Allow Reference Value Changes from the Settings Menu. Default values can be restored by clicking the Defaults button.

3.9.3 If any of the default settings, reference values or coefficients within PEARS have been adjusted, this it must be declared and documented in any subsequent reporting.

Users must not adjust any of the default reference values or coefficients within PEARS without first consulting the relevant Overseeing Organisation.
### Figure 3.11: PEARS Reference Values Tab

<table>
<thead>
<tr>
<th>Vehicle Category</th>
<th>Parameter A</th>
<th>Parameter B</th>
<th>Parameter C</th>
<th>Parameter D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car</td>
<td>0.0640205981</td>
<td>-0.00480333</td>
<td>-0.000464163</td>
<td>0.00000301748</td>
</tr>
<tr>
<td>Diesel Car</td>
<td>0.43704841</td>
<td>0.004816498</td>
<td>-0.00052408</td>
<td>0.00000191209</td>
</tr>
<tr>
<td>Petrol SUV</td>
<td>1.05363326</td>
<td>0.004235219</td>
<td>-0.00074481</td>
<td>0.0000110552</td>
</tr>
<tr>
<td>Diesel UGV</td>
<td>1.045266333</td>
<td>0.007690419</td>
<td>-0.000432956</td>
<td>0.0000080062</td>
</tr>
<tr>
<td>Diesel LGV</td>
<td>1.47738474</td>
<td>0.245817298</td>
<td>-0.000572813</td>
<td>0.000006638</td>
</tr>
<tr>
<td>DoV</td>
<td>3.39592246</td>
<td>0.394370825</td>
<td>-0.000462865</td>
<td>0.0000055224</td>
</tr>
<tr>
<td>PSV</td>
<td>4.115603124</td>
<td>0.306464813</td>
<td>-0.000462865</td>
<td>0.0000055224</td>
</tr>
</tbody>
</table>
4 FURTHER INFORMATION

4.1 Introduction

4.1.1 This section provides further information on a number of areas of PEARS, namely:

- PEARS Naming Convention
- Using Updated Versions of PEARS
- Vehicle Categories & Base Vehicle Types
- Vehicle Type Descriptions
- Journey Purpose Splits
- Occupancy
- Traffic Growth
- Zero Traffic Growth Post 2031
- Trip Matrix Totals
- Current Year
- Last Growth Year (in Costs/Benefits)
- AIRE (Analysis of Instantaneous Road Emissions)
- Accidents and Non-Traffic Related Maintenance
- Analysis of Delays and Costs During Construction & Maintenance
- Confidence in Results
- Reporting Results

4.2 PEARS Naming Convention

4.2.1 Each version of PEARS released by SIAS will be named in accordance with the version of the TAG data book on which the majority of the reference values, etc. are based. For example, this version of PEARS, which is based on the TAG data book (January 2014), is being released as version PEARS14.1. SIAS considers the “.1” is necessary to allow for any further updates which may be required.

4.2.2 It is worth noting that the TAG data book will not necessarily follow the exact release dates as future updates to each are introduced. For example, it is possible that the reference values, etc. contained in the TAG data book could remain unchanged while the carbon emissions per vehicle type and/or the monetary value of these emissions, etc. are updated. Users should check that the version of the program they are using is appropriate to their study/assessment.

4.3 Using Updated Versions of PEARS

4.3.1 If PEARS is used on an existing project which has been run using an earlier version of the software, the following warning will appear:

This project was created using different reference data than is installed on this system. The assessment techniques and data required may
have changed. The results have therefore been removed from the project. The assessment will need to be run again. ALL reference data will be upgraded to the data on this system. This change is not permanent until you Save the project.

4.3.2 To update an assessment to the latest reference data users should select “OK”. Users should note that once the latest reference data has been saved it is permanent and cannot be reversed or undone.

4.4 Vehicle Categories & Base Vehicle Types

4.4.1 The following vehicle categories can be included in PEARS:

- Cars
- LGVs
- OGV1
- OGV2
- Private Buses
- Service Buses

4.4.2 For each of the vehicle categories detailed, PEARS assumes Base Vehicle Types as outlined in Table 4.1.

<table>
<thead>
<tr>
<th>Vehicle Category</th>
<th>Base Vehicle Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>1</td>
</tr>
<tr>
<td>LGV</td>
<td>14</td>
</tr>
<tr>
<td>OGV1</td>
<td>15</td>
</tr>
<tr>
<td>OGV2</td>
<td>16</td>
</tr>
<tr>
<td>Private Bus/Coach</td>
<td>17</td>
</tr>
<tr>
<td>Service Bus</td>
<td>As per the Routes in the Bus Delay File</td>
</tr>
</tbody>
</table>

4.4.3 As previously outlined, PEARS requires each microsimulation model run to provide data on vehicle trips and data on bus journeys. The trips data and bus journey data must conform to the format of the S-Paramics trips-ALL CSV file and busdelay CSV file.

4.4.4 The trips-ALL CSV file contains entries for both Vehicle Types and the Base Vehicle Types. The Vehicle Types are specific to the vehicle categories included within the microsimulation model (and are ignored by PEARS), while the Base Vehicle Types are specific to PEARS and correspond to the vehicle categories outlined in Table 4.1. Prior to running PEARS users must ensure that their modelled vehicle types/vehicle categories correspond with the appropriate Base Vehicle Types outlined in Table 4.1 (not necessary if running S-Paramics).
4.4.5 Information on Service Buses is read in from the busdelay CSV file. PEARs recognises that all the trips in the busdelay CSV file are Service Buses and therefore there is no equivalent Base Vehicle Type. Any trip data relating to Service Buses which is included in the trips-ALL CSV file will not be read by PEARs. The trips-ALL CSV file does however take into account Private Buses/Coaches as Base Vehicle Type 17.

4.4.6 In order to assess the economic impact of the Service Buses alone, an empty trips-ALL CSV file is required to accompany the busdelay CSV file.

4.5 Vehicle Type Descriptions

4.5.1 Users should note that although microsimulation programs such as S-Paramics can contain and output vehicle type descriptions such as ‘Car – home to work’ or ‘Car – non-home based leisure short’, PEARs ignores the individual trip purpose and applies the trip purpose proportions by vehicle type set out in the TAG data book to the total trips in each vehicle category.

4.5.2 It is not strictly necessary to specify trip purpose in the microsimulation model as the purpose proportions are applied to the total trips.

4.6 Journey Purpose Splits

4.6.1 In the current version of PEARs, Journey Purpose Splits, e.g. car-work, car commuting, LGV work, LGV non-work, etc., are applied as per the TAG data book to each Base Vehicle Type included within the model. In the majority of applications of PEARs this approach is entirely appropriate, the exception being where users have split the matrices assigned within their microsimulation models into specific vehicle classes/journey purposes.

4.6.2 The journey purpose splits for Car, LGV, OGV1, and OGV2 are based on the percentage of distance travelled by vehicle whereas the journey purpose values for Service Buses are based on the percentage of distance travelled by occupants.

If users have split the matrices assigned within their microsimulation models into specific vehicle classes/journey purposes, the current version of PEARs will ignore and overwrite them.

4.7 Occupancy

4.7.1 It should be noted that the Business Occupancy values in the ‘Reference Values’ section of PEARs for Coaches and Service Buses are for bus passengers only and do not include a driver. The driver is included in the calculation, but not in the ‘Occupancy’ table.

4.8 Traffic Growth

4.8.1 Users should keep a record of the traffic growth being applied to a particular test to assist with any future reporting and analysis. Users have the option of including a note within the ‘Traffic Growth’ box on the PEARs Scheme tab (see ).

Users should note that PEARs does not include any specific information on different levels of traffic growth and takes all such information from the traffic model outputs,
i.e. the trips-ALL CSV files. Any text entry or reference relating to traffic growth input to PEARs is for information only and has absolutely no effect upon the PEARs calculations or results.

4.9 Zero Traffic Growth

4.9.1 As traffic growth can only be defined by entries in the trips-ALL CSV files, to define zero traffic growth from a specific year, say 2032, it is necessary to include trips-ALL CSV files with the same number of trips in two assessment years, i.e. 2032 and 2033, from which costs can be calculated and extrapolated for the remainder of the evaluation period.

4.10 Trip Matrix Totals

4.10.1 As outlined, the current economic concepts in PEARs are consistent with the Fixed Trip Matrix methodologies of NESA (as detailed in DMRB Volume 15).

4.10.2 At present PEARs does not ‘flag’ any warnings if the Do-Minimum/Reference Case matrices and the Do-Something/Design matrices are different, as would be the case if a Variable Trip Matrix assessment was being carried out.

PEARS users are advised to always check the matrix totals, via the SumTrips column within the Scheme Workings, Run & V Class sub-tab (see Figure 3.10) in their Do-Minimum/Reference Case and Do-Something/Design scenarios to ensure these are consistent with a Fixed Trip Matrix assessment.

4.11 Current Year

4.11.1 The Current Year is required to determine when the discount rate changes take place. The discount rates used in PEARs reflect those in the Treasury Green Book, e.g. 3.5% for years 0 to 30 from the Current Year, reducing to 3.0% for years 31 to 75 and 2.5% for all remaining years.

4.11.2 In programs such as NESA, the Current Year is generally set by the release date of the software. The Current Year in PEARs should generally correspond with the Current Year which is being applied in the current version of COBALT or NESA to ensure consistency with any external accident and non-traffic related maintenance analyses using these programs. If users are in any doubt about what Current Year they should be using, they should contact the appropriate Overseeing Organisation.

Users should note that the Current Year on the Reference Values tab (see Figure 3.11), is set by the Overseeing Organisation and does NOT equate to the Opening Year or the Reference Case matrix year.

4.12 Last Growth Year (in Costs/Benefits)

4.12.1 The Last Growth Year on the Assessment tab (see Figure 3.5) is used to cap all undiscounted economic costs and benefits (including VoT and VOC). It does NOT relate to the last year of traffic growth.

4.12.2 If, for example, the Last Growth Year is set to 2040, every year thereafter will have the same benefit as 2040 before discounting, however, if the Last Growth Year is set to, say, 2035 and a modelled year has been specified for 2040,
the undiscounted benefits in every year after 2035 will be the same as 2035 with the exception of 2040, which will retain the benefits, etc. as calculated for that modelled year.

Users should note that the Last Growth Year relates to the last growth year of costs, etc. and does NOT relate to the last year of traffic growth – which needs to be defined by entries in the trips-ALL CSV files (as discussed in 4.8 and 4.9).

4.12.3 The Last Growth Year is an optional input which can be set by users as required, however, as the Last Growth Year should generally be set to after the end of the appraisal period, the default value of 2110 is generally appropriate as this will ensure it will not effect the economic calculations unless deliberately changed by the user.

Users must ensure that the Last Growth Year is set to a year following the last modelled year.

4.13 AIRE (Analysis of Road Emissions)

4.13.1 AIRE is an ancillary software module specifically designed to post-process the outputs from traffic microsimulation models and calculate vehicle emissions. AIRE can be used to process the detailed, vehicle by vehicle outputs produced by microsimulation models for each simulated time step and provides disaggregated and detailed emissions estimates.

4.13.2 PEARS can use the disaggregated and detailed emissions estimates from AIRE to more accurately calculate carbon emissions and fuel consumption. This is achieved by selecting the AIRE Fuel method on the Assessment tab before carrying out the economic assessment.

Users should ensure that AIRE has been used on all of the models included in the PEARS assessment.

4.14 Accidents and Non-Traffic Related Maintenance

4.14.1 Like the TUBA program, PEARS does not currently include the assessment of accident costs and benefits and an independent accident assessment is therefore required – usually an accident only COBALT or NESA assessment. An accident only COBALT or NESA assessment will also provide details regarding the costs or benefits associated with non-traffic related maintenance.

The economic results from any independent COBALT or NESA assessment must be manually input to the Transport Economic Efficiency Tables (outwith PEARS) and the various economic indicators, i.e. PVB, NPV, BCR, etc., manually updated.

4.15 Analysis of Delays and Costs During Construction & Maintenance

4.15.1 The analysis of delays and costs during construction and maintenance usually require to be assessed separately.

Any construction or maintenance related costs and benefits from an independent assessment need to be manually included in the Transport Economic Efficiency
Tables (outwith PEARS) and the various economic indicators, i.e. PVB, NPV, BCR, etc. manually updated.

4.16 Confidence in Results

4.16.1 PEARS uses outputs from a microsimulation model. Unlike conventional deterministic or equilibrium models, the outputs from a microsimulation model do not converge to a single solution, but vary each time the model is run (depending on the random number seed used in each run). It is important that provision is made for the degree of uncertainty in the microsimulation models through undertaking a number of model runs for each scenario. In most circumstances, five runs may be considered as the minimum, although this will be dependent on time/budget implications and any other constraints of the modelling exercise to be undertaken.

4.17 Reporting Results

4.17.1 PEARS is intended to be a generic piece of software which can be used throughout the UK and overseas, providing the relevant Overseeing Organisation has given approval. It is not possible within the outputs from PEARS to automatically cover all the various reporting requirements specified by different Overseeing Organisations. Users are required to independently report the PEARS outputs and to supplement these with any necessary information specifically required by the appropriate Overseeing Organisation.

4.17.2 PEARS has been developed such that the whole setup of the project/run can be reported on (i.e. every single tab). It is, however, ultimately up to the user to make use of this facility. PEARS does not output any information about the (traffic) models themselves, given it has no knowledge of the models, only of the output from the models (i.e. the trips-ALL and busdelay CSV files) and how the user has chosen to use that output.

4.17.3 Summary details regarding the models used, inputs, etc. should always be presented in the associated Economic Appraisal Report (Ref. SH1/97, DMRB Vol. 5), which should include (for example):

- Matrix totals in the Reference Case and the Design schemes (which should be identical in a Fixed Trip Matrix assessment)
- Time frames
- Annualisation factors applied
- Years assessed
- Opening Year
- Traffic Growth applied
- Traffic volumes along key links
- Degree of confidence in the microsimulation model and some qualification of the uncertainty in the economic outputs
APPENDIX A: Definitions
**Definitions**

The following list of definitions is intended to assist users of PEARS. The list is not fully comprehensive and users are therefore directed to:

- Design Manuals For Roads & Bridges (DMRB) – in particular Volumes 15, 13, 14, 12, and 5 (www.standardsforhighways.co.uk/dmrb/index.htm)
- The Department for Transport’s Transport Appraisal Guidance (www.webtag.org.uk)
- Scottish Transport Appraisal Guidance (www.scot-tag.org.uk)

<table>
<thead>
<tr>
<th><strong>Appraisal Period</strong></th>
<th>The <em>Appraisal Period</em> for the economic assessment of trunk road schemes - generally taken as 60 years. (See DMRB Vol. 15, Part 3 for further information.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Case/Base Situation</strong></td>
<td>The <em>Base Case</em> or <em>Base Situation</em> generally refers to the calibrated Base model, i.e. the model which represents the network conditions when the traffic flow data, etc. used to calibrate and validate the Base model was collected. (See DMRB Vol. 15, Part 5 for further information.)</td>
</tr>
<tr>
<td><strong>Benefit Cost Ratio to Funding Authority (BCRFA)</strong></td>
<td>No longer applicable as Indirect Tax Revenues are now classified as Wider Public Finances and contribute towards the scheme benefits (See TAG Unit A2.1, Wider Impacts. January 2014)</td>
</tr>
</tbody>
</table>
| **Benefit Cost Ratio to Government (BCR)** | The *Benefit Cost Ratio* is the Present Value Benefits divided by the Present Value Costs including any Indirect Tax Revenues. It is given by the formula:  

\[
BCR = \frac{PVB_{\text{Inc. ITR}}}{PVC}
\]

The BCR is discussed fully in the PEARS documentation. (See also DMRB Vol. 15, Part 3 for general advice on BCR.) |
<p>| <strong>Calibration</strong> | <em>Calibration</em> is the process of adjusting the parameters used in the various mathematical relationships in the (traffic) model to reflect the data as well as is necessary to satisfy the model objectives (Ref. DMRB Vol. 12). |
| <strong>Calibration Base</strong> | The validated base year model is often referred to as the <em>Calibration Base</em>. (See DMRB Vol. 12 for further information) |
| <strong>Construction Delays</strong> | <em>Construction Delays</em> are delays which are experienced by users during the construction of an improvement scheme. The discounted results must be incorporated into the Transport Economic Efficiency tables and the economic indicators manually updated. |</p>
<table>
<thead>
<tr>
<th><strong>Consumer Price Index (CPI)</strong></th>
<th>The <em>Consumer Price Index</em> is prepared by the Office for National Statistics. The CPI is used to measure general inflation and to convert user costs/benefits to a different price base. See <a href="http://www.statistics.gov.uk">www.statistics.gov.uk</a> for further information.</th>
</tr>
</thead>
</table>
### Fixed Trip Matrix (FTM)

A *Fixed Trip Matrix* assessment assumes the same number and distribution of trips are assigned to the Do-Minimum and Do-Something networks and that the only behavioural response to an improvement is reassignment, i.e. traffic travelling from A to B may use a new route. The economic concepts in PEARs are consistent with a FTM methodology. See *DMRB* Vol. 15, Part 3 for further information.

### Indirect Tax Revenue (ITR)

*Indirect Tax Revenue* is classified as Wider Public Finance and contributes to scheme benefits. In the context of transport appraisals, the main source of ITR is fuel which is subject to high rates of tax. Any change in the amount of fuel consumed affects the amount of ITR. ITRs are included within the Public Accounts as part of the Present Value Benefits. Discussed further in the PEARs documentation. (See *TAG Unit A2.1, Wider Impacts, January 2014* for further information)

### Maintenance Delays

*Maintenance Delays* are the delays experienced by users during the maintenance of an improvement scheme or the maintenance of the existing network (i.e. the Do-Minimum). The discounted results must be incorporated into the Transport Economic Efficiency tables and the economic indicators manually updated.

### Net Present Value (NPV)

The *Net Present Value* of a scheme is the Present Value Benefits minus the Present Value Costs (including any Indirect Tax Revenues).

Discussed fully in the PEARs documentation. See also *DMRB* Vol. 15 Part 3.

### Optimism Bias

*Optimism Bias* is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters (See *TAG Unit A1.2, Scheme Costs, January 2014* for further information). In trunk road scheme appraisals this generally refers to appraisers being overly optimistic about a scheme’s cost and the time taken to construct. The *Treasury Green Book* advises that, where a discount rate of 3.5% or less is used, Optimism Bias must be applied in terms of an increase in a scheme’s total scheme cost and increase in a scheme’s projected works’ duration. The levels of Optimism Bias to be applied at the different stages of a scheme assessment should be agreed with the appropriate Overseeing Organisation. The application of Optimism Bias is NOT a sensitivity test. (See *TAG Unit A1.2, Scheme Costs, January 2014* for further information.)
| **Present Value of Benefits (PVB)** | The *Present Value of Benefits* are the monetised benefits attributable to a scheme, discounted to the present value year at the appropriate discount rate (as defined by the Treasury). Monetised benefits may arise from: improvements in travel time/reductions in junction delays; reductions in vehicle operating costs; reductions in accidents/improvements; changes in user costs during construction and maintenance. Further details of each of the components which make up PVB can be found in *DMRB* Vol. 15, Part 6. |
| **Present Value of Costs (PVC)** | The *Present Value of Costs* represent the summary of the differences (between the Do-Something & the Do-Minimum) in Investment Costs, Operating Costs, Maintenance Costs, any Developer or Other Contributions, and any Indirect Tax Revenues, discounted to the present value year at the appropriate discount rate (as defined by the Treasury). Further details of each of the components which make up the PVC can be found in *DMRB* Vol. 15, Part 6. |
| **Present Value Year** | The *Present Value Year* is the year in which all benefits and costs are expressed. In principle any year can be taken but 2002 is currently used in all economic assessment programs used by Transport Scotland. See also *DMRB* Vol. 15, Part 3. |
| **Price Base Year or (Price Base Date)** | The *Price Base Year* (or *Price Base Date*) is the common year all prices are expressed in. In PEARs the Price Base Year is 2010. Conversions to the Price Base Year are normally carried out using the Retail Price Index (RPI). See *DMRB* Vol. 15, Part 3 for further information. |
| **Reference Case (RC)** | The *Reference Case*, generally represents the Do-Minimum plus the addition of non-controversial but non-committed elements e.g. proposals that are believed by the planner to be almost certain to gain statutory approval and for which funding is very likely to be made available (Ref. STAG Chapter 4). |
| **Scottish Transport Appraisal Guidance (STAG)** | The *Scottish Transport Appraisal Guidance* is a document to aid transport planners and decision makers in the development of transport policies, plans, programmes and projects throughout Scotland. STAG provides a comprehensive source of advice on all aspects of the planning process from the earliest stages of planning, through appraisal and implementation to ex-post evaluation. See www.scot-tag.org.uk for full details of STAG. |
| **Sunk Costs** | *Sunk Costs* are costs which have been spent or committed prior to the current economic assessment/scheme appraisal and which cannot be recovered (whether or not the scheme goes ahead). They should be excluded from the overall scheme costs input to the current economic assessment. Discussed further in the PEARs documentation and see also *TAG Unit A1.2, Scheme Costs, January 2014* for further information. |
Traffic Growth/Forecasts  

*Traffic Growth (or Traffic Forecasts)* is the growth or increase in traffic levels which are expected to occur during the appraisal of a scheme/improvement. Traffic growth is linked to changes in land use, income and government policies.

Validation  

*Validation* is the process of comparing the (traffic) model outputs against independent observed data not used in the model development process.  
(See *DMRB* Vol. 12 for further information)

Variable Trip Matrix (VTM)  

A *Variable Trip Matrix* assessment assumes a different number and/or distribution of trips are assigned to the Do-Minimum and Do-Something networks. Differences arise due to an improvement resulting in: redistribution – where origins or destinations change; generation – where new trips take place; modal transfer – where trips to the same destination are made by a different mode of transport; and changes to departure time – where trips are made at a different time of the day. At present PEARS does not consider VTM assessments. See *DMRB* Vol. 12 for further information.

Vehicle Operating Costs (VOC)  

*Vehicle Operating Costs* are dependent upon the distance travelled by vehicles and their average speed. In economic terms, VOC benefits can be either negative or positive depending on the balance of changes in distance travelled and speeds (DS v DM). VOCs are generally split between Fuel VOCs and Non-Fuel VOCs. (See *DMRB* Vol. 15, Part 6 for a fuller explanation).