An tÚdarás um Bóithre Náisiúnta
National Roads Authority

Project Appraisal Guidelines

Unit 6.2 Guidance on using COBA

July 2011

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Guidance on Using COBA

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1 Introduction

1.1. This PAG Unit provides information on the processes required to undertake a COBA assessment. It deals with data collection, the inputs from the traffic model, and the parameter values that should be used for assessments at the different phases of a road scheme.

1.2. This PAG Unit also addresses the structure of the COBA input and how the data file may be prepared and edited for input to the COBA programme.

1.3. After completion of a COBA assessment, it is necessary to submit a full report to the National Roads Authority (NRA), the content of which is outlined in *PAG Unit 6.12: CBA Report*. The steps to be undertaken in completing an audit of the COBA print out and the requirements for Handover, Review & Closeout are also explained in *PAG Unit 6.12: CBA Report*.

1.4. A specific version of the COBA software has been developed by Transport Research Laboratory (TRL) for use on road schemes in the Republic of Ireland. A report prepared by the TRL documenting the development of the Irish COBA is included as *PAG Unit 6.3: TRL COBA Report.*

2 Data Requirements

General

2.1. COBA has the flexibility for a number of input parameters to be modified by the user to better reflect local conditions. However, the use of standard values and relationships is central to the COBA concept and, at the early stages of scheme assessment, this avoids the need for time consuming and costly data collection exercises.

2.2. The decision to use local or national default values depends on the phase of the scheme assessment. At Route Selection, local values may be used where available, although national values are normally acceptable. However at Design Stage, local data should be input where it is both reliable and significantly different from national COBA values.

2.3. This Section sets out the different categories of data required, how such data should be compiled and whether local or national data are more appropriate for the CBA process.

Data Categories

2.4. Data input into COBA can be classified into three categories, according to the source, as illustrated in Table 6.2.1:

- Data that is always local;
- Data that should be local if values are reliable and differ significantly from national values; and
- Data that should always be national.

Table 6.2.1: Summary of Data Required for COBA

Always Local	Local or National	Always National
Scheme costs	Seasonality index	Values of time
Link geometric characteristics	E-Factor	Accident costs
Junction geometric characteristics	M-Factor	Economic growth
Link flows	Traffic mix proportions	Vehicle operating cost parameters
Junction turning proportions	Flow groups	Taxation
	Accident rates and casualty proportions	Traffic growth profiles
	Speed-flow curves	Discount Rate
	Vehicle occupancy	Consumer Price Index

		Relative Price Factor
		Carbon Costs

2.5. The data input can, in essence, be grouped under six key headings as follows:

- Scheme costs;
- Link geometry;
- Junction data;
- Traffic data;
- Accident data; and
- Economic values.

Scheme Costs

2.6. The scheme cost is made up from the following elements:

- Construction costs;
- Land and property costs;
- Preparation costs (planning and design);
- Supervision costs; and
- Maintenance costs.

2.7. Scheme costs can be entered into COBA using two different input keys

- **KEY054 –** user inputs Construction and Land Cost estimates and COBA calculates the equivalent costs in the present value year for construction, land, preparation and supervision and allocates them to the correct year; or
- **KEY055 –** allows the user to enter total scheme costs according to a manually calculated profile of expenditure.

2.8. Both keys allow the user to specify the sector incurring the cost (i.e. Central or Local Government) and any contributions from private developers.

2.9. In each case, costs are entered into COBA exclusive of indirect taxation, i.e. in the factor cost unit of account. COBA uses indirect taxation rates held within the program to convert factor costs into market prices.

2.10. Costs are entered into COBA as undiscounted values. COBA uses information on the discount rate to derive discounted values.

2.11. KEY054 converts prices to the price base year using information provided by the user on the Consumer Price Index at the base year and the year in which the estimate was made. When using KEY055, costs are entered in price base year, i.e. after taking into account the effects of inflation.

2.12. It is an NRA requirement that KEY055 is used to enter costs. Detailed guidance on how to derive the profile of scheme costs for input into COBA KEY055 can be found in *PAG Unit 6.7: Preparation of Scheme Costs*.

Link Geometry

2.13. The geometric characteristics for the links and junctions included in the COBA network should be obtained from suitably scaled plans of the existing and proposed road network. These characteristics are supported by field measurements of those elements on the existing network that are to be included in the assessment.

2.14. The following data relating to links are required:

- Type of link – to allocate the speed-flow relationship, with links defined in accordance with the classifications in Table 6.2.4 (see Section 4);
- Speed limit;
- Length;
- Width – including widths of any hard shoulders, hard strips and verges;
- Hilliness;
- Bendiness;
- Number of major junctions or accesses per kilometre;
- Degree of development fronting the link; and
- Sight distances.

2.15. The list above is an outline of the information necessary. The complete set of information necessary for each link depends on the link type (e.g. rural, urban, suburban, dual or single carriageway etc.). Full details of the data requirements, including definitions and their derivation, are given in the UK DMRB Volume 13, Section 1, Chapter 5.

Junction Data

2.16. For junctions that are to be modelled explicitly, the level of detail to be collected depends on the type of junction; i.e. signal controlled, roundabout, signalised roundabout, merge or priority junction that is being modelled. An indication of the data requirements for each junction type is provided below:

- For all junction types, the junction will need to be defined as either rural or urban and whether the entry arms are single or dual-carriageway;
- For priority junctions, the major and minor arms and any stagger should be identified. The width of the carriageway for the various turning streams should be measured along with the geometry of any central reserves and sight distances;
- For roundabouts, the user must specify if the junction is grade separated or not, and specify the geometry of the entry arms and of the circulatory carriageway;
- For signal-controlled junctions, including signal-controlled roundabouts, the user will need data on the staging arrangement at the junction along with the geometry and gradient of the approach arms. Signal- controlled roundabouts also require data on the saturation flows for each approach arm, and the data for flared entry arms; and
- For merge junctions at grade-separated interchanges, the number of lanes downstream from the merge is required.

2.17. Full details of the data requirements for junctions are given in DMRB Volume 13, Section 1, Chapter 6.

2.18. Note that modelling junctions is not an explicit requirement in COBA models. Guidance on the inclusion of junction modelling is included in Section 3 of this PAG Unit.

Traffic Data

2.19. Traffic flow data, in the form of link flows and turning proportions are normally obtained from a traffic model, the complexity and extent of which will reflect the nature of the scheme. For further information on the development of traffic models, see *PAG Unit 5.2: Construction of Transport Models*.

2.20. For the traffic count data, long-term data (i.e. over a period of at least one-year) are required to establish local values for the following parameters:

- Seasonality index;
- E-factor;
- M-Factor; and
- Vehicle mix proportions.

2.21. Default values for these parameters, applicable to the assessment of road schemes, and the derivation of scheme specific parameter values for the above parameters are discussed in more detail in Section 4.

2.22. Journey time surveys allow validation of the base year COBA model by comparing modelled journey times with actual recordings. They also provide data for locally adjusting the maximum delay parameter at junctions.

Accident Data

2.23. Local data on the occurrence and severity of accidents should relate to a period when the conditions on the road have been broadly unchanged (for example, no abnormal changes in traffic flow, no changes in junction design or road geometry, etc.). Local data should ideally cover the five years previous to the COBA assessment but in all cases must cover a period of at least three years.

2.24. In addition, accident data should be checked to identify any particular anomalies where it is suspected that they do not accurately reflect the accident history of the link. Where such anomalies do exist, accident data may need to be processed or adjusted before inputting to the COBA data file. One such example is where road works led to a significant change in the accident rate over a period of one year during a five year period. In such a case it may be appropriate to manually interpolate data for that year, or to adopt default accident rates.

2.25. The number of accidents in each year is input, including zero for those links or years where no accidents occurred, and COBA will then internally produce a local accident rate (accidents per million vehicle kilometres) for each link.

2.26. If insufficient data are available to allow computation of local accident rates, then the default national default values should be used.

2.27. Only those accidents recorded by the Gardaí will be manifest in accident data, however the Gardaí are not always in attendance at the scene of accidents, especially when no injuries occur. The COBA program assumes that only one third of minor injury accidents and two thirds of serious injury accidents are reported, and applies factors to observed data within the COBA program to account for this.

Economic Values

2.28. The COBA user must make use of the most recent data on economic parameter values. Further information on the application of national parameter values is provided in Section 18 of *PAG Unit 6.1: Guidance on Conducting CBA*. Values are set out in *PAG Unit 6.11: National Parameter Values Sheet*.

2.29. National default values are applicable for all economic parameters regardless of the scheme assessment phase. These values are contained within the COBA program and must not be changed unless instructed to do so by the NRA.

3 Scoping a COBA Model

General

3.1. The COBA user is required to provide a description of the road network to cover both the existing situation and the proposed improvements. The basis of this will be a conventional traffic model, from which link flows for input into the COBA assessment will be obtained. In this Section the structure of the COBA model and its interface with a conventional traffic model is described. For more specific advice regarding traffic modelling, PAG Unit 5.0: Transport Modelling should be consulted.

Extent of Network

3.2. The COBA network should extend far enough from the improvement to include all links on which there is a substantial difference in the assigned traffic flows between the Do-Minimum and Do-Something networks. If the scheme is expected to result in a significant change in the flow level on a competing route, that route should be included in the network. This concept should be balanced by the consideration that, as the network spreads, benefits arising from the scheme in distant areas are inherently less plausible and more difficult to assess than local benefits. It is recommended that, as a general rule, the extent of the COBA network should be the same as the assignment network, to avoid possible bias from the omission of links. Even the smallest differences in the matrix of trips used on the assessment networks can affect the results.

3.3. The assignment network and the COBA network therefore need to be compatible in three respects:

(i) Detail of network;
(ii) Description of links and junctions; and
(iii) Incorporation of future changes to network.

Journey Time Information

3.4. The journey times from most traffic models will be inadequate for economic appraisal using COBA, since they represent short period models that do not differentiate between travel at different times and in different traffic conditions. For some schemes, especially inter-urban ones, the flow group and speed-flow analysis incorporated in COBA can be used to calculate journey times across different periods. The facility in COBA to print out journey speeds and times for each flow group in a specified year can be used to check that the two networks are broadly compatible.

3.5. In areas where traffic congestion exists or will exist during the appraisal period, it is important that the predictions of the traffic model are thoroughly validated. Methods of determining the accuracy of journey times and the number of journey time runs required to achieve a given level of accuracy are set out in Section 7 of this PAG Unit.

Modelling Junctions

3.6. An accurate replication of existing journey times through the network can be difficult if this relies on link transit times alone. In such cases, the inclusion of junctions will allow a more accurate reflection of traffic behaviour. As such, the requirement to model junctions in a COBA network will arise if the presence of junctions on the existing road significantly impacts on journey time through the network

3.7. COBA models all junctions in isolation, with all arrivals assumed to be random; no allowance is made for any junction interaction. Therefore, great care must be taken when modelling junctions in the same area of the network where the capacity of one junction controls the flow at another, either now or at some time in the future. If this occurs it may only be necessary to model the controlling junction. Double counting of delay must be avoided.

3.8. The concept of maximum delay has an important bearing on junction modelling in COBA. The form of the COBA junction delay formulae implies that, as the capacity of the junction is reached, delays increase very rapidly. However, COBA includes, as default, a maximum delay at junctions of 300 seconds for peak flow group types.

3.9. If journey time evidence warrants a local adjustment for any individual junction, the user may change the value for the peak group upwards or downwards (maximum 900 seconds). The maximum delay is attributed to all vehicles but on an arm-by-arm or stream-by-stream basis. Maximum delays for the non-peak flow groups are calculated as a proportion of the peak maximum delay, shown in Table 6.2.2.

Table 6.2.2: Maximum Delay by Flow Group

Flow Group Type	Proportion of Maximum Delay	Default Maximum Delay (seconds)
Type 1 (off Peak)	0.4	120
Type 2 (Adjacent to Peak)	0.6	180
Type 4 (Peak)	1.0	300

Accident Only and Delay Only Junctions

3.10. Delay-Only junctions are used to model user specified geometric delay at roundabouts or points in the network where the speed flow relationships do not apply. The specified delay is applied to all vehicle types and is constant over all flow groups.

3.11. An Accident-Only node may be used to model accidents at a node without modelling junction delays. This is important for urban junctions, where the delay is subsumed into the link speed/flow relationships. As national accident data is only available on a link and junction basis, Accident-Only nodes are not to be used without prior approval of the NRA.

4 National Parameter Values

4.1. COBA contains a series of default values for parameters relating to economic values (for example, time, accidents, vehicle operating costs and carbon costs), accidents (rates and severity), annual traffic flow patterns and vehicle composition (E and M-factors and flow groups). These parameters have been developed specifically for the assessment of road schemes in the Republic of Ireland.

4.2. This Section provides a general discussion on the various parameters, followed by a more detailed discussion of the approach to selecting parameters at the different phases of scheme development. All data is summarised in PAG Unit 6.11: National Parameter Values Sheet.

Economic Parameters

4.3. The economic input parameters are fixed and do not change by project phase. Some notes on these parameters are included below.

<u>Key Parameters</u>

4.4. The Present Value Year is that year for which costs and benefits are expressed. The Present Value Year for the appraisal of road schemes should be 2009.

4.5. A discount rate of 4% shall be adopted; this is in line with latest Department of Finance guidance. This rate should be applied across the 30 year appraisal period.

4.6. The Appraisal Period is the period over which costs and benefits are accounted. The appraisal period shall be 30 years, although an allowance is made for the accrual of additional costs and benefits after this period through the calculation of residual value.

4.7. Consumer Price Indices (CPI) are used to adjust prices to the price base year. Up to date information on the CPI can be obtained from the Central Statistics Office website (http://www.cso.ie). For example, to adjust a price from July 2010 to the present value year (for the purpose of this example, average 2009 prices) one would apply the following formula:

$$Cost\ in\ average\ base\ year\ prices = Latest\ Available\ Cost \times \frac{CPI_{2009}}{CPI_{July 2010}}$$

4.8. The Relative Price Factor (RPF) describes that process which adjusts construction costs to their long term average, effectively correcting for the sharp rise and fall of construction prices that occurs through economic cycles. This process is separate from adjustments based on the CPI. Current advice is for a value of unity to be adopted for the RPF at all project phases.

Maintenance Costs

4.9. Road maintenance costs have been developed for the following road classes:

- Standard 2-lane with hard shoulder;
- Wide 2-lane with hard shoulder;
- Type 3 Dual Carriageway (2+1);
- Type 2 Dual 2 Lane Carriageway; and
- Type 1, Standard and Wide Dual Carriageway/Motorway.

4.10. Maintenance costs are presented as a rate per kilometre per year. The maintenance type relating to each road class is included in Table 6.2.4.

Value of Time

4.11. Forecast growth in real gross national product (GNP) per person employed has been used to determine future changes in the real value of time. The same growth factor is applied for work, commuting and other non-work time, although the facility exists to use different factors.

Value of Accidents

4.12. Forecast growth in real GNP per person employed has also been used to determine future changes in the real value of accidents. The assumption is that the values of most elements of accident costs are proportional to national income.

Vehicle Operating Costs – Fuel

4.13. COBA calculates fuel costs using a function based on the average vehicle speed on each link. The function includes a number of constants known as the a, b, and c parameters. These vary by vehicle class to reproduce the different fuel operating cost characteristics of different vehicle types.

4.14. The COBA vehicle operating cost formula is of the form:

$$C = a + bV + cV^2$$

where:

- C = cost in cents per kilometre per vehicle;
- V = average link speed in km/h, and
- a, b and c are vehicle category parameters.

4.15. The a, b and c parameters are contained in COBA both in cents/km and litres/km at resource cost. Conversion between the two is simply a case of factoring the parameters by the resource cost of fuel (cents per litre).

Vehicle Operating Costs – Non-Fuel

4.16. Non-fuel vehicle operating costs include oil, tyres, maintenance and mileage. Only items that vary with the use of the vehicle are measured and parameters are presented by vehicle class. Non-fuel costs are calculated using the equation:

$$C = a_1 + b_1/V$$

where:

- C= cost in cents per kilometre per vehicle;
- V= average link speed in km/h, and
- a_1 and b_1 are vehicle category parameters.

Value of Time Growth

4.17. In future years the real value of time will change as productivity increases. Factors have been developed to take into account these changes such that they can be accounted for through the appraisal period.

Value of Accident Growth

4.18. Factors are also derived to define the growth in the valuation of accidents. These are deemed to be similar to value of time increases.

Vehicle Operating Cost Growth

4.19. Small changes are expected in fuel price and fuel consumption. No change in non-fuel operating costs are expected.

Indirect Tax Rates

4.20. COBA requires inputs on average tax on final consumption, tax on fuel (final consumption) and tax on fuel (intermediate consumption). This allows input costs to be converted from resource costs to market costs, and hence allows an assessment of the cost and benefit stream for different market segments.

Future Changes in Indirect Tax Rates

4.21. Any change in taxation levels is proposed by Government, and the implications of such tax changes on various segments of society are considered independently from the CBA process. The CBA should therefore assume that tax rates remain static throughout the assessment period.

Emission Costs

4.22. The COBA program takes account of emissions of the following gases:

- Carbon Dioxide (CO_2);

- Nitrous Oxide (N_2O);
- Volatile Organic Compounds (VOC);
- Nitrogen Oxides (NO_X); and
- Particulate Matter (PM), both urban and rural.

4.23. Emissions are considered in terms of the change in the equivalent tonnes released as a result of implementing a road scheme. Emissions are estimated from fuel consumption in the Do-Minimum and the Do-Something options. The change in tonnes emitted and the monetary value given to the change is calculated in COBA.

4.24. Emissions costs (greenhouse and non-greenhouse gases) change with respect to time and these changes are included within the COBA program. Current Department of Finance guidance indicates that each tonne of CO2 equivalent should be costed at €39 from 2015 onwards. This is based on expected value of carbon emanating from the European Emissions Trading Scheme. However, over time as trading schemes become more comprehensive, it is likely that the values emanating from them will approach those arising from abatement costs and the value of €39 will be too low.

4.25. Based on the anticipated value of abatement costs in 2060 as determined by the UK Department of Transport, the value of €39 per tonne would need to grow at a rate of 4 per cent per annum in real terms over the period to 2060 to reflect the rise in abatement cost values. An adjustment factor or 4 per cent per annum should therefore be applied to post 2015 values.

Traffic Input Parameters

<u>Seasonality Index</u>

4.26. The Seasonality Index is an important descriptor of annual traffic flow patterns. It is defined as the ratio of the average August weekday (Monday to Friday) flow to the average weekday flow in the neutral months of April, May, June, September and October (excluding periods affected by bank holidays). Long-term automatic traffic counter data is required to derive local values. A good estimate can be arrived at by comparing the weekday traffic flows from a three-week continuous count in August with one from late May/June or October.

<u>E-Factor</u>

4.27. The E-factor converts flows entered into the program as 12-hour values into the 16-hour equivalent. Local relationships between the 12-hour and 16-hour flows can be derived from long-term automatic traffic counts. It is preferable that AADT flows are manually calculated from traffic model outputs using a relationship based on observed local data representing a full year.

M-Factor

4.28. The M-factor converts flows entered into the program as 16-hour values into an Annual All Vehicle Flow (AAVF). A local M-factor can be derived that relates the average weekday 16-hour count in the month specified to the annual all vehicle flow. Long-term automatic traffic counter data will be required to do this. It is preferable that AADT flows are manually calculated from traffic model outputs using a relationship based on observed local data representing a full year.

Link and Junction Combined Accident Rates and Casualty Proportions

4.29. COBA provides default data for the frequency, severity and the number of casualties resulting from accidents associated with different road types.

4.30. If default accident values are to be replaced with local values, the COBA user must demonstrate that the local severity split is significantly different in statistical terms from the default national averages, and not a result of one or two particularly bad accidents, the effect of which will be evened out by less extreme accidents as time goes by. Adjustments are made automatically within the COBA program to account for accident under-reporting. As a result, the number of minor accidents is automatically multiplied by 3 and the number of serious accidents by 1.5.

4.31. Where no local data are available and for the Do-Something scheme components, the default national parameter values should be used.

Accident Reduction Factors

4.32. COBA takes into account the existing long-term declining trend in accident rates and severity. The program uses a ‘β-factor’ to model the reducing number of accidents in each assessment year and also to model the reduction in the average number of casualties, by severity split, resulting from each accident.

4.33. The change in accident rates and number of severities per accident is explained by the relationship:

$$A_N = A_0 \times \beta^N$$

Where:

- A_N = the accident rate or number of casualties per accident N years after base year;
- A_0 = the accident rate or number of casualties per accident in the base year; and
- β_N = change coefficient raised to the power N.

4.34. For the assessment of road schemes β-factors have been developed to take into account Irish policy on the reduction of road traffic accidents. Default β-factors contained within the COBA program are provided in PAG Unit 6.11: National Parameter Value Sheet.

4.35. The β-factors are applied for any year between 1998 and 2016. Between 2017 and 2026, and between 2027 and 2036 the reduction factors are assumed to be one half and one quarter respectively of the 1998 to 2016 reduction. For example, if the coefficient β is 0.9, then it is 0.95 for the period 2017 to 2026 (or [1+β]/2), and 0.975 for the period 2027 to 2036. Zero change is assumed post 2036.

4.36. There is no facility to change how β varies with respect to time as this is embedded within the COBA program.

Vehicle Category Proportions

4.37. Based on the flow groups in Table 6.2.5 default national values have been derived for the vehicle category proportions in each of the flow groups, for each network classification. Category proportions have also been derived for vehicles falling into each of the three time modes.

AADT Adjustment Factors

4.38. Provided for conversion of 12-hour or 16-hour traffic flows to AADT. Note however that it is preferable that AADT flows are manually calculated from traffic model outputs using a relationship based on observed local data representing a full year.

Vehicle Category Correction Factors

4.39. Factors are provided for cases where flows are entered as 12-hour or 16-hour counts. It is preferable that AADT flows are manually calculated from traffic model outputs using a relationship based on observed local data representing a full year.

Vehicle Category Proportion Correction Factors

4.40. Correction factors were calculated using the formula

Vehicle proportion correction factor = Flow group proportion/annual proportion

4.41. Note that annual proportions are only determined for flow groups 2 to 4 and 7 to 9 and for vehicle types 2 and 5. Vehicle flows for cars and for flow groups 1 and 6 are calculated within COBA by means of a balancing procedure. The results are shown below.

Vehicle Occupancy

4.42. National default values for the average number of people occupying a vehicle of a given category and time mode (work, commuting and other) have been developed from roadside interview data.

4.43. The default values also give occupancy rates for three of the eight flow groups, described in Table 6.2.5; i.e. Flow Groups 2, 3 and 4. For Flow Group 1, which relates to the overnight off-peak traffic, and Flow Groups 6 – 9, which relate to weekend traffic, the UK default value has been taken (adjusted to account for the average occupancy of working cars in Flow Groups 2 – 4), since the source roadside interview data only covered the 12-hour period from 07:00 to 18:45.

Vehicle Proportions by Time Mode and Flow Group

4.44. Default values are provided for the allocation of AADT to the various flow groups. Local values should only be used with specific consent from the NRA.

5 Preparing Scheme-Specific COBA Input

Network Classification

5.1. Three network classifications have been adopted for the assessment of road schemes, as described in Table 6.2.3. Users of COBA should select the network classification that best describes the scheme being assessed. Note - the UK abbreviations for network classifications are still used.

Table 6.2.3: Network Classification

Network Classification	COBA INPUT
Motorway	MWY
National Primary – excluding motorway	TNB
National Secondary	PNB

Road Class

5.2. COBA uses a number of Road Classes to describe the nature of each link throughout the network. The road class determines the type of data that is to be input for each link, and therefore is a key parameter to be selected for each link. Up to 20 road classes are definable in COBA, with each representing a certain road description as contained within the DMRB. Road classes are summarised in Table 6.2.4.

Accident Types

5.3. For the Route Selection phase, link and junction accidents have been combined to produce default values for accident rates, severity splits and costs, which are all attributed to links. Six accident rates, based on road type, have been considered, and their relationship to the road classes is shown in Table 6.2.4. It should be noted that accident type numbers are not the same as the road class numbers used to define the speed-flow relationships.

5.4. Accident data provided for each accident type has been split according to the speed limit structure for roads. For National Roads (including National Motorways) and non-national roads in non-built up areas, accident data relating to speed limits of 80 km/h or greater are applicable; whereas for built up areas, data relating to speed limits not exceeding 60 km/h should be used. Unlike the UK procedure, no distinction has been made concerning the standard of the road, i.e. old or modern.

Maintenance Type

5.5. Each link will have a maintenance type, which relates to the type of link defined. Maintenance costs can distinguish between wide and standard single carriageways, motorways and dual carriageways, which can be standard Type 1, Type 2, or 2+1. A total of six maintenance types have been defined, which relate to the road classes as outlined in Table 6.2.4.

Table 6.2.4: COBA road classes, accident and maintenance type summary

Road Description	COBA Road Class	COBA Accident Type	COBA Maintenance Type
Rural Reduced Single (7.0m) Carriageway S2*	1	4	1
Rural Standard Single (7.3m) Carriageway S2*	1	4	1
Rural Wide Single (10.0m) Carriageway S2*	1	4	1
Type 1 Rural Dual Carriageway (Standard)*	2	10	2
Type 1 Rural All Purpose Dual Carriageway (Wide)*	2	10	2
Type 2 Rural Dual Carriageway*	3	10	2
Rural All Purpose Dual 3 or more lane carriageway	4	10	3
2x2 Motorway (Standard 7.0m)*	5	1	4
2x2 Motorway (Wide 7.5m)*	5	1	4
3x3 Motorway	6	1	5
4x4 Motorway	7	3	6
Urban All Purpose Dual Carriageway (Central)*	8	10	2
Urban All Purpose Dual Carriageway (Non Central)*	9	10	2
Urban All Purpose Single Carriageway (Central)	8	4	1
Urban All Purpose Single Carriageway (Non Central	9	4	1
Small town All Purpose Dual Carriageway	10	10	2
Small town All Purpose Single Carriageway	10	4	1
Suburban All Purpose Dual Carriageway	11	10	2
Suburban All Purpose Single Carriageway	12	4	1
2+1 Road – (with central safety barrier)* *	13	11	2
2+1 Road - (without central safety barrier) * *	14	5	1
User Defined – all vehicle relationship	15-16		

User Defined – light/heavy vehicle relationship	17-20		

* Cross Section consistent with those in NRA TD 27

Traffic Flows

5.6. Ideally, traffic flows should be input as Annual Average Daily Traffic (AADT) values, extracted from an appropriate traffic model (see Section 3). If flows are entered as 12 or 16-hour values then the default values for the E and M-factors will be used by the program to convert these to Annual All Vehicle Flows (AAVF). The use of AADT as COBA input is the preferred approach.

5.7. Note that special attention must be paid to the calculation of AADT from short period traffic models. Any error in the AADT calculation from traffic modelling output will lead to inaccurate COBA outputs.

Speed Flow Curves

5.8. A combination of UK default and locally derived speed-flow curves have been applied to road classes. For Type 2 and Type 3 Dual Carriageways, speed flow curves have been developed by the NRA and are included in the Irish version of COBA. UK default values have been used for all other road types.

5.9. Different speed-flow predictions will be made by allocating a link to the appropriate road class of Table 6.2.4. Further details on the nature of the speed-flows defined for each road class can be found by reference to DMRB Volume 13, Section 1 Part 5, Chapters 1 to 9 (Speed on Links).

5.10. It is noted that the speed flow curves used in COBA differ from those used in the National Traffic Model, which adopts speed flow relationships from the US Bureau of Public Roads. It is important that speed flow curves from these two different sources are not mixed in any traffic or COBA models.

5.11. The definitions of the road classes highlighted by a "*" in Table 6.2.4 are consistent with those in NRA TD 27, which sets out the dimensional requirements for road cross-sections for new National Roads. Type 2 Dual Carriageways are as defined in documentation available from the NRA.

5.12. The remaining road classes complete the range of classes that are likely to be required in the COBA assessment, and include those necessary to represent existing links. These are consistent with the definitions provided in the UK DMRB Volume 13.

5.13. The following explanatory notes are provided on the different road classes. Where speed limits are quoted these relate to the new speed limit structure recommended by the Working Group on the Review of Speed Limits. These limits are effective since January 2005:

(i) Rural single carriageway and dual carriageway roads are normally subject to a speed limit of either 100km/h for National Roads or 80km/h for Non-National Roads. This includes all road classes 1 to 3. Motorways (Class 5 and 6) are generally subject to a speed limit of 120km/h.
(ii) Classes 8 and 9 are used for roads in built up areas subject to speed limits of 50 km/h (31 mph). The distinction is made between central and non-central urban areas, with central areas defined as those including the main shops, offices and central railway stations, with a high density of land use and frequent multi-storey development consistent with a 'central business district' (CBD). Streets containing commercial or industrial development but not of a high density CBD nature should not be included within the central area. Non-central areas comprise the remainder of the urban area.
(iii) Suburban roads, classes 11 and 12, apply to the major suburban routes in towns and cities where the speed limit is generally 60 km/h.
(iv) The main urban speed flow relationships do not apply to towns with populations of less than 70,000, for villages or for rural roads with short stretches of development. In such cases the small town road class (Class 10) should be used.

User-Defined Speed-Flow Relationships

5.14. The facility exists for the user to define special speed-flow relationships. They should only be used in special circumstances where the normal ranges of speed-flow relationships do not apply. There are two types of user defined speed-flow relationships:

(i) Special Road Classes 15-16: The user may define the relationships by the use of six speeds equated to specific flow levels. The relationships apply to both light and heavy vehicles and are independent of link geometric parameters; and
(ii) Road Classes 17-20: Here the user can define the basic constants to generate relationships similar to the form used for the rural road classes. Light and heavy vehicles can be modelled separately.

Traffic Growth

5.15. Traffic growth rates should be extracted from the transport models as aggregate growth rates for the relevant vehicle categories as set out in PAG Unit 5.3: Traffic Forecasting. The calculation of the traffic growth rates is based on the growth in total vehicle kilometres between the opening year, design year and forecast year traffic models. This should be converted into an annualised growth rate (assuming linear growth) for the purpose of the COBA model.

5.16. Traffic growth rates should be applied to projected opening year traffic flows to derive forecast demand through the appraisal period. They are therefore applied to the opening year scheme data (as extracted from traffic models) in the COBA input file.

Traffic Flow Groups

5.17. To take into account the variations in the level of traffic flow and vehicle composition, the 8,760 hours of the year are divided into different proportions (numbers of hours) called flow groups. Each flow group represents a different level of flow. The peak period flow group contains those hours throughout the year that are defined as 'peak hours' (Flow Groups 4 and 9) and defines the proportion of annual traffic travelling during those hours. Other flow groups represent the 'adjacent to peak' (Flow Groups 3 and 8) and 'off peak' (Flow Groups 1, 2, 6 and 7) periods.

5.18. When undertaking CBA of National Road Schemes in Ireland, eight flow groups are to be used – 4 Flows Groups each for the weekday and weekend hours.

5.19. Each Flow Group Number should also be further defined by a Flow Group Type. Relevant Flow Group Types are Type 1 (Off Peak), Type 2 (Adjacent to Peak) and Type 3 (Peak).

5.20. For modelling purposes the flow in each hour of a given flow group is considered to be at a constant proportion of the annual average hourly traffic (AAHT). This proportion is defined as the flow group multiplier or 'd', the value of which is shown in the table. The structure of flow groups for use in the appraisal of road schemes is outlined in Table 6.2.5.

Table 6.2.5: Default Flow Group Structure

Network Classification	Flow Group Number*	Number of Hours in Flow Group	Flow Group Hours	Flow Group Type: [1 = Ordinary Flow Group (off-peak); 2 = Adjacent to Peak Flow group 3 = Peak Flow Group]	FLOW/ AAHT 'd'
Motorway (MWY)	1	2,540	1 – 2,540	1	0.311
	2	2,680	2,541 – 5,220	1	1.372
	3	522	5,221 – 5,742	2	1.845
	4	522	5,743 – 6,264	3	2.170
	6	1,300	6,265 – 7,564	1	0.220
	7	780	7,565 – 8,344	1	1.471
	8	208	8,345 – 8,552	2	1.714
	9	208	8,553 – 8,760	3	1.961
National Primary (TNB)	1	2,650	1 – 2,650	1	0.282
	2	2,570	2,651 – 5,220	1	1.408
	3	522	5,221 – 5,742	2	1.972
	4	522	5,743 – 6,264	3	2.304
	6	1,290	6,265 – 7,554	1	0.205
	7	790	7,555 – 8,344	1	1.397
	8	208	8,345 – 8,552	2	1.779
	9	208	8,553 – 8,760	3	2.032
National Secondary (PNB)	1	2,660	1 – 2,660	1	0.259
	2	2,560	2,661 – 5,220	1	1.403
	3	522	5,221 – 5,742	2	1.986
	4	522	5,743 – 6,264	3	2.424
	6	1,300	6,265 – 7,564	1	0.281
	7	780	7,565 – 8,344	1	1.258
	8	208	8,345 – 8,552	2	1.826
	9	208	8,553 – 8,760	3	2.178

* The default flow group structure contains no Flow Group Numbers 5 or 10. Flow Groups 1-4 represent weekday hours while Flow Groups 6-9 represent weekend hours.

5.21. For locally derived data, classified traffic data from count sites in the vicinity of the scheme will need to be collected and should ideally contain data for each of the 8,760 hours of a year. Where this is not possible, due to missing data, some degree of infilling is permissible; for example, using data relating to the average from similar days, or hours within the same month. The complete year's data should be arranged in ascending order, i.e. the largest total flow would be ranked at number 8,760 and the smallest flow ranked number 1. The average vehicle proportions relating to the yearly hours given in Table 6.2.5 should be calculated (where 1 relates to the hour with the smallest total traffic and 8,760 the hour with the largest total traffic).

5.22. Changes to default values should only be undertaken with specific consent of the NRA.

Vehicle Category Proportions

5.23. For locally derived values, the proportion of each vehicle category should be computed based on the weighted average over the entire network, taking into account the lengths of the various links and the total flow on them throughout the year (i.e. vehicle kilometres) and should be representative of the proposed scheme.

5.24. Local values for the proportions of cars and light goods vehicles in work, commuting and other time may be derived from roadside interview data where sufficient information is available. Vehicle proportions by time mode must be disaggregated by flow group. Since interview data will normally cover a 12-hour weekday period between 07:00 and 19:00, vehicle proportions by time mode can only be developed for Flow Groups 2, 3 and 4. Default values should be used for the remaining Flow Groups, as presented in PAG Unit 6.11: National Parameter Value Sheet.

Accidents

5.25. Where local accident data are available and are considered to be reliable, these can be used in preference to the national default accident rates and casualty proportions. Such data on the occurrence and severity of accidents should relate to a period when the conditions on the road have been broadly unchanged (for example, no abnormal changes in traffic flow, no changes in junction design or road geometry, etc.). Ideally, local data should cover the five years previous to the COBA assessment and must cover a period of at least three years. The user can either calculate the observed accident rate in terms of the number of accidents per million vehicle kilometres (mvkm), or alternatively input accident numbers from which the program will calculate a local link accident rate. In the latter case, the number of accidents in each year must be input, including zero for those links or years where no accidents occurred, and COBA will then internally produce a local accident rate (for each link). This rate should be calculated as the average personal injury accident rate per million vehicle kilometres over the 5 year period.

PIA/mvkm = (X1+X2+X3+X4+X5)/Y

where X1 is the total number of PIA in year 1, and Y is the total traffic flow on the link over this period expressed in million vehicle kilometres

5.26. It is recommended that the local accident rates be input as ‘combined’ link and junction rates.

Summary

5.27. In Table 6.2.6, the approach that should be taken for each parameter is summarised for the different stages of the life of a scheme. Parameters are either based on the national default values or locally derived data. In a few instances, the existing UK default values have been retained since there are insufficient data at present to determine Irish parameters. Where it is indicated that the national default values are to be adopted, the user must not change the values already contained within the COBA program.

5.28. For each parameter, the COBA KEY number is provided: this corresponds directly with the record on the COBA input deck.

Table 6.2.7: Summary Approach to Parameter Coding

PARAMETER	COBA KEY	PHASE 2 - ROUTE SELECTION	PHASE 3 DESIGN /PHASE 5 ADVANCE WORKS & CONSTRUCTION DOCUMENTS	PHASE 7 HANDOVER, REVIEW & CLOSEOUT	COMMENTS
Present value year / appraisal period	003	NATIONAL	NATIONAL	NATIONAL	
Traffic proportions	006	NATIONAL	LOCAL	LOCAL	
Vehicle mix groups	007	NATIONAL	LOCAL	LOCAL	
Seasonality index	008	NATIONAL	LOCAL	LOCAL	
E-factor	008	NATIONAL	LOCAL	LOCAL	
M-factor	008	NATIONAL	LOCAL	LOCAL	
Growth of traffic	009	NATIONAL	NATIONAL	NATIONAL	
Tax Rates	013	NATIONAL	NATIONAL	NATIONAL	
Tax rate changes	014	NATIONAL	NATIONAL	NATIONAL	.
Discount rate	015	NATIONAL	NATIONAL	NATIONAL	
Vehicle operating cost	016	NATIONAL	NATIONAL	NATIONAL	
Accident costs	017	NATIONAL	NATIONAL	NATIONAL	
Annual compound growth rates	019	NATIONAL	NATIONAL	NATIONAL	
Annual compound growth for fuel and non-fuel	020	NATIONAL	NATIONAL	NATIONAL	
Values of time per person	021	NATIONAL	NATIONAL	NATIONAL	
Accident rates, severity splits for link / junction combined	023	NATIONAL	LOCAL	LOCAL	

Accident reduction factors (β-factors)	023	NATIONAL	NATIONAL	NATIONAL	
Maintenance costs	024	NATIONAL	NATIONAL	NATIONAL	
Accident proportions	028	NATIONAL	LOCAL	LOCAL	
Adjustment factors A(I)	029	NATIONAL	NATIONAL	NATIONAL	
Flow group multipliers	030	NATIONAL	NATIONAL	NATIONAL	
Flow groups - composition correction factors	031	NATIONAL	LOCAL	LOCAL	
Annual % change in vehicle occupancy	032	DEFAULT	DEFAULT	DEFAULT	Until directed otherwise the UK parameter values are used.
Occupancy of vehicle / category / time mode	033	NATIONAL / DEFAULT	LOCAL / DEFAULT	LOCAL / DEFAULT	At Route Selection phase, National Default values are used for Flow Groups 2 – 4 and 7 - 9, with adjusted* UK default values for Flow Groups 1 and 6. At Design phase local values can be derived for Flow Groups 2 – 4 and 7 - 9, but adjusted* UK default values are still to be used for Flow Groups 1 and 6.
Proportions of vehicles in each time mode	034	NATIONAL / DEFAULT	LOCAL / DEFAULT	LOCAL / DEFAULT	At Route Selection phase National Default values are used for Flow Groups 2 – 4 and 7 - 9, with adjusted* UK default values for Flow Groups 1 and 6. At Design phase local values can be derived for Flow Groups 2 – 4 and 7 - 9, but adjusted* UK default values

					are still to be used for Flow Groups 1 and 6. Note when inputting proportions for vehicle category 1 (normally cars), the flow group to which the proportions relate must be specified. Data for all the flow groups used must be input.
Annual changes to proportions in each time mode for a particular vehicle category	037	DEFAULT	DEFAULT	DEFAULT	Until directed otherwise, the UK parameter values are to be used.
Scheme costs	055	LOCAL	LOCAL	LOCAL	At Route Selection, Option Comparison Estimate to be used. At Design, the cost estimate should be the weighted average of the Target Cost 1 and Total Scheme Budget. If the Target Cost 2 estimate produced at main contract award phase exceeds the Target Cost 1 estimate, the CBA must be updated accordingly. The final outturn cost is to be used for the purpose of Handover, Review & Closeout CBA

* For details of adjustments refer to *PAG Unit 6.3: TRL COBA Report*

6 The COBA Input File

Format of Data Entry

<u>Characters</u>

6.1. Data are entered in the COBA input deck using individual ‘KEY’ records. Data items may be divided into three groups:

- Alphanumeric (A): Contains any alphabetic, numeric or other character valid to the computer.
- Real (R): Contains a number with a decimal point. If a decimal point is omitted, COBA will assume its position is either on the right hand edge of the box for numbers intrinsically greater than unity (for example flows), or at the left hand edge for numbers intrinsically less than unity. This is indicated on the coding sheets by the presence of a dot on one edge of the box. Blanks (spaces) are treated as zeroes.
- Integer (I): Contains a number without a decimal point. Again, all blanks in the box are interpreted as zeroes.

6.2. It should be noted that if a data field, which should contain a number, contains any non-numeric character, (except a decimal point or minus sign where appropriate), COBA will halt immediately with a computer system error. This is outside the control of the COBA program.

<u>Limits on Data</u>

6.3. Most numeric data are required to be within certain limits. These limits are principally to guard against mistyping of data in the wrong columns. If the data item is discovered to be outside the limits shown in the description of that data item an error message is printed; for example:

“This data item MUST NOT LIE OUTSIDE THE RANGE x TO y”.

6.4. Errors result in the Project being truncated to a data check only.

6.5. Some data items have two sets of limits, in which case the error limits are shown with the warning limits in brackets. If the item is inside the error limits but outside the warning limits, a warning message is printed; for example:

“WARNING - data item is LARGER THAN x”.

6.6. The warning limits are chiefly determined by the range of values of observations made during the research on which COBA is based. The program will continue to run to completion despite these warnings. Nevertheless, the user should review all such warnings for each output provided, as they may point to coding errors.

Reclassification Repeat Inhibitor, RRI

6.7. In COBA there is a distinction between those improvements which would be made whether or not the Do-Something were to be implemented (defined as the Do-Minimum), and those which are alternatives to implementing the Do-Something.

6.8. Normally all reclassifications that occur in the Do-Minimum are repeated in each Do-Something in the year in which they take effect in the Do-Minimum.

6.9. For each particular Do-Minimum mid-scheme data change, (that is, flow changes, link or junction classification changes, or accident rate changes), it is possible to prevent the repeat in each Do-Something by entering an 'X' in column 5. This 'X' is referred to as the Reclassification Repeat Inhibitor, RRI. Obviously, the RRI is meaningful only in a reclassification that occurs in the Do-Minimum. In all other circumstances, it is ignored.

Link and Node Names

6.10. To a certain extent, link and node names are a matter of common sense. The values permissible are numbers between 1 and 9999. Further limitations are imposed in particular sections, for example:

- For a link or node to be classified or de-classified, or for its flow or accident data to be specified, it must obviously be 'in the network';
- For a link or node to be declassified, it must first be classified;
- Connectivity between links and nodes must be preserved. In flow data if the 'towards node' is specified for a one-way link, it is obviously nonsensical if link and node are not connected in the network. Similarly, during junction data, the link on a subsequent record must refer to a link actually attached to the node being classified;
- The list of the arms of a classified junction must correspond exactly to the network description of that node; and
- The number of nodes that may be classified will generally be smaller than the number of network nodes because of storage space limitations.
- To facilitate easy navigation through the link-node diagram, the link naming convention should relate insofar as is practical to the adjacent node number. For example, node 5 will have links 51, 52 and 53 connected to it. Node 38 will have links 381, 382 and 383 connected to it. The link connecting node 46 and 52 may be called either node 461 or 521. See Section 3.3 of *PAG Unit 6.12: CBA Report* for further elaboration.

Key Records

6.11. The COBA deck, defining a particular 'Project' is made up of a series of KEY 'records', which can be grouped together into the following headings:

- Control records;
- Basic data;
- Network data;

- Scheme data: declassification;
- Scheme data: costs;
- Scheme data: link flows;
- Scheme data: link classifications;
- Scheme data: node classifications;
- Scheme data: accidents; and
- Final control records.

6.12. Classification is the term used when a link or node is described by geometric parameters in order that the costs of negotiating the link or node can be calculated. Declassification is the process whereby the link or node can be retained in the network but the user costs will no longer be calculated.

6.13. Following an overview of the format of the data entered into the COBA deck, this section provides a summary of the contents of each of the above KEY categories. However, a detailed description of how to code individual KEY 'records' in COBA is found in DMRB Volume 13, Section 1, Part 7.

Control Records

6.14. Control records are used to highlight the data sections from each other, e.g. from the basic records to the network data.

Basic Data

6.15. Basic Data are those data records that apply to the whole of the project; for example, the years for which the Project is to be evaluated.

6.16. The order in which Basic Data records are entered is important since some items interact with others. In general, entering records in the order of their free-format keys will be successful, although the following guidelines should be noted:

- Mandatory records: KEYs 001, 003, 004 and 005 are mandatory records and should be input in that order. If any of these records are omitted, then the program run will be reduced to a Data Check Only. If the Print Phases required are to be specified, then KEY 002 should be input in numerical order within the mandatory records.
- Scheme years: COBA allows users to redefine the present value year on the same record as the first and last scheme years (KEY 003 - mandatory). The program will therefore not accept a Basic Data record of any type that specifies a year unless the scheme years record has already been accepted. Thus, since the KEY 003 record is mandatory (and is almost the first record of a file), the program will only fail in this way if the record itself is unrecognised.
- Vehicle categories: Most COBA runs will be performed using the default set of vehicle categories. If any item of Basic Data is entered which specifies a vehicle category by number, COBA will assume this number refers to the sequence of the default set. Thereafter the vehicle categories cannot be redefined. The following Basic Data types relate to vehicle categories:
    - Traffic proportions;

- Local growth factors;
- Adjustment factors;
- Occupancy and change in occupancy of category;
- Proportion of category in time mode; and
- Increment to vehicle mode split.

6.17. The essential point is that if vehicle categories are to be redefined, this must be done before the traffic proportions for the project are specified.

Network Data

6.18. Network data are those records that define the structure of the Do-Minimum network and how it changes with each scheme, or at reclassification years.

Scheme Data: Declassification

6.19. Declassification is the process whereby the link or node can be retained in the network but the user costs will no longer be calculated.

Scheme Data: Costs

6.20. By convention, COBA costs are input for the whole Scheme at the very beginning of the Scheme Data. Because of this, Scheme Costs will not be accepted in the reclassification section. Values for scheme capital costs, traffic related maintenance capital costs and delays during construction and maintenance works may be input in present value year terms in the correct year on KEY 055.

6.21. It is an NRA requirement that KEY055 is used to enter costs. Detailed guidance on how to derive the profile of scheme costs for input into COBA KEY055 can be found in *PAG Unit 6.7: Preparation of Scheme Costs*.

Scheme Data: Link Flows

6.22. A single record is used to input link traffic flows, either as total vehicles or by vehicle mix group. It is on this record that one-way links and their direction of flow are defined.

Scheme Data: Link Classifications

6.23. These records are used to define the characteristics of all the links in the network for which user cost calculations are required. Each link is defined by a separate record, which allows the user to define the speed-flow relationship applicable to the link, geometrical quantities such as lane widths, accident type and speed limits.

Scheme Data: Node Classifications

6.24. Those junctions that are classified are defined. Junction type, geometric parameters, operational parameters (e.g. signal stages), delays and turning flows are entered.

Scheme Data: Accidents

6.25. Accident data must be the last data type entered into any Scheme Data section. These data records are used to define observed accident rates or numbers, to overwrite the default values held within the program. Links may have accident rates only if they are classified.

Final Control Records

6.26. Control records define the end of scheme data, the end of the project data (when more than one scheme) and the end of the program run.

Data Preparation and Editing

6.27. There are several methods a user can adopt to prepare the COBA input data file:

- An experienced user may prefer to edit an existing COBA input file;
- Entering data in the strict format defined in the COBA input coding sheets. These require the user to enter each character of the input data into specific, right-justified columns; or
- Using the program CSCREEN to edit an existing COBA input file or create a new file in the COBA data format on screen. Some data checking is undertaken as the file is created.

6.28. Edits to the data file can be done through a simple text editor. The file should be in plain ASCII format (i.e. containing no special characters and each line terminating with a carriage return). Suitable text editors include the NotePad or WordPad program included with Windows software.

6.29. More sophisticated word processors may be used but the user must ensure that files are saved as a plain text/text only file.

6.30. A default COBA input file is provided in *PAG Unit 6.4: Default COBA Input File*. This file should be used as the starting point for coding. It contains all the default parameter values discussed in previous Sections.

7 COBA Model Validation

Journey Time Validation Techniques

7.1. Often local journey time measurements over the road network will have been made for the traffic modelling stage of scheme assessment. It is necessary to check observed journey times with those on the assignment networks and those computed by COBA. This comparison may bring to light specific instances where the COBA Do-Minimum journey times no not adequately reflect observed values, or those reported from the traffic models. (Note: COBA journey times for each flow group are printed out for a specified year in Phase 8 of the COBA output).

7.2. Generally, journey times are only required on roads where there is likely to be competition as a result of a network intervention. Given that the scheme benefits are based largely on network journey time changes, it is necessary that the journey times in COBA are accurately reflected on links where changes in traffic flow are expected.

7.3. Journey time measurements carried out for COBA should be used to estimate average speeds only; it is not possible to determine the speed/flow slope to any reasonable degree of confidence from a small-scale survey. The journey time survey should be geared towards estimating observed journey time on the whole of the bypassed section of route; individual estimates of speed on each link are not required. In general, the longer the section of route that is being bypassed, the lower should be the variability of observed journey times. Fewer observations should be needed to estimate the journey time over a longer section of route to a given level of accuracy.

7.4. The most important consideration for local journey time surveys is that the journey times should be representative of conditions throughout the year. A large number of runs carried out on one day will usually be worth less than fewer runs spread over several days. Generally, measurements should be taken to cover both the peak and off-peak hours of the day.

7.5. The moving observer method is the most widely used method of carrying out journey time measurements. Alternatively, registration number surveys should be considered as an alternative to the moving observer method – these have the advantage of providing high sample rates. The NRA is open to alternative means of collecting journey time information, once it can be demonstrated that the proposed approach is representative.

7.6. The results of the journey time survey should be sent with the COBA Appraisal Report and should include information on the number of runs carried out in each time period with an estimate of their accuracy and details of the level of traffic flow at the time. The survey results should be compared with the COBA modelled times and flows in each flow group. If observed and modelled journey times are not in reasonable agreement, then the speed/flow relationship that has been used for a particular link should be reconsidered, and possibly a local relationship defined.

7.7. For full guidance on undertaking journey time surveys, and comparing with the model output, reference should be made to DMRB Volume 13, Section 1, Part 5, Chapter 10 (Local Journey Time Measurements). *PAG Unit 5.2: Construction of Transport Models* should be referred to for guidance on appropriate validation criteria for journey times.

Junction Validation

7.8. Where junctions are explicitly modelled and COBA junction delay benefits are a significant element of scheme benefits, the magnitude of the junction delay benefits should be verified by considering the following:

- Do-Minimum improvements or, where Do-Something delays are large, Do-Something junction optimisation. Small changes in the coding of junction layouts can sometimes yield significant changes in junction delay costs;
- Comparison of COBA and measured journey times, for example, where junctions interact. In practice, it is more common for local maximum average delays to be less than 300 seconds rather than more; and
- Explicit modelling of critical junctions outside COBA. In exceptional cases, the COBA user may wish to consider whether in-depth analysis of a critical junction is necessary.

7.9. A particular problem with calibrating maximum delays using timed runs is that it is impossible to calibrate future scenarios. For example, a junction may be coded at 300 seconds maximum delay on the basis of present journey time evidence, but may give rise to longer delays in the future due to traffic growth. This may be tested using more sophisticated junction modelling techniques as found in congested assignment packages that explicitly model local diversionary reassignment. Advice from the Strategic Planning Unit should be sought in such circumstances.

8 COBA Output and Interpretation

General

8.1. Historically, the COBA program has accepted input and worked in resource costs; this is still the case with the Irish version of the software. However, the calculus currently being used is the Willingness To Pay (WTP) methodology with the program converting costs and benefits to market prices using appropriate tax correction factors.

8.2. Following the COBA run, appraisal results are summarised at the end of the COBA output file. The information describes the Economic Efficiency of the Transport System and is expressed in Market Prices. This output is provided in the form of a number of tables, each providing separate measures of output. The interpretation of such output, and the processes behind the calculation of the performance indices is described in this Section.

8.3. It is important to note that COBA is only able to allocate the elements of the appraisal that the program calculates. There may be other significant costs and benefits that should be included in the decision making process.

Sensitivity Testing

8.4. No COBA result is exact: a risk exists that project costs and benefits might deviate from their expected values. Any investment decision, whether public or private sector, is bound to be subject to uncertainty. Decisions regarding long-lived investments with distant forecast horizons, such as national road proposals, are subject to a high degree of uncertainty. However, it is important for decision makers to have some idea about how robust the results may be in order to know what weight to attach to them. It is, therefore, necessary to consider a range of possible outcomes.

8.5. One approach is to set bounds on the uncertainty by carrying out tests on key variables to identify those variables to which the results are particularly sensitive. These are the variables on which the decision makers' judgment should focus.

Local Variables

8.6. At design, locally derived parameter values should be used where local data is both reliable and significantly different from national values. However, it can be useful for the user to carry out sensitivity tests on these variables, especially where they are both uncertain in the local context and likely to affect the COBA result significantly.

8.7. It is recommended that any sensitivity test using local values should use the national values as a benchmark. This is to ascertain the importance of local variations and to allow comparison of schemes on a similar basis.

Forecasting Inputs

8.8. Errors introduced by economic forecasting inputs are known to have a significant impact on NPV results, in particular the impact of Gross Domestic Product and possibly fuel price assumptions on traffic forecasts and the associated values of time, accidents and vehicle operating costs used in COBA. It is therefore necessary to present COBA results based on high, medium and low traffic growth scenarios. This should be done for all CBAs.

Scheme Costs

8.9. There is a great deal of uncertainty concerning the final capital costs of road schemes. This degree of uncertainty tends to reduce at later stages of the project's development, when outturn costs can be estimated with more confidence. Sensitivity tests should, therefore, be undertaken to assess the impact of changes in construction costs and land and property costs on the overall NPV of a scheme (see PAG Unit 6.1: Guidance on Conducting COBA for more detail). In particular the testing should look at the impact of changing construction costs and the level of change required to alter the viability of a scheme.

Other Considerations

8.10. It may well be the case that a sensitivity test highlights variation in the NPV, but that the sign of the NPV and ranking of options remains unchanged. This would clearly increase the weight that can be put on the economic results.

Interpretation of COBA Output

8.11. The most significant tables of the COBA output occur in Phase 16. These are:

Table 14, Phase 16 – 'Conversion of Travel Costs to Market Prices by Vehicle Category'

8.12. This table (see Table 6.2.7) shows the calculations necessary to convert the time and vehicle operating cost changes calculated in resource costs to market prices. The individual components given in Tables 9A to 9F of the COBA output file are presented under the Transport Economic Efficiency (TEE) categories and converted to market prices by the appropriate tax correction factors.

Table 15A, Phase 16 – 'Economic Efficiency of the Road System in Market Prices (TEE Table)'

8.13. Table 15A in the COBA output is an adaptation of the TEE Table. COBA takes the input values for the construction delays and maintenance delay savings (expressed as resource costs), converts to market prices and allocates between 'consumers' and 'business' in proportion to the consumer and business user (Time and VOC) benefits of the scheme under normal operating conditions.

8.14. Table 6.2.8 shows how the elements of the TEE Table calculated by COBA are referenced from Table 14 and combined with the delays during construction and maintenance delay savings to produce the 'Net Consumer User Benefit' and 'Net Business Impact'.

Table 15B, Phase 16 – 'Public Accounts'

8.15. This Table (see Table 6.2.9) shows the summary of Public Accounts and summarises the funding of the project. This table fulfils the requirement for an "exchequer cash flow analysis".

Table 15C, Phase 16 – 'Analysis of Monetised Costs and Benefits'

8.16. Table15C (shown in Table 6.2.10) of the COBA output summarises the monetised costs and benefits as calculated by COBA. This effectively represents the scheme summary, and is the key output from the CBA assessment.

Table 6.2.7: Conversion of travel costs to market prices by vehicle category (Table 14, Phase 16 of the COBA Output)

From Table	VEHICLE CATEGORY	TIME		TOTAL TIME	OPERATING FUEL		OPERATING OTHER		TOTAL OPER. COSTS
		WORK	COMM/OTHER		WORK	COMM/ OTHER	WORK	COMM/ OTHER	
	<u>Personal</u>								
9A	**<u>Travel</u>**	-							
9B	Car								
	Private LGV	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
	TOTAL	<u>Σ × t</u>	<u>Σ × t</u>	<u>Σ(row)</u>	<u>see note vi</u>	<u>$\Sigma \times t_F$</u>	<u>Σ × t</u>	<u>$\Sigma \times t_N$</u>	<u>Σ(row)</u>
	Adjustment	Σ= **AA**	Σ= **BB**	Σ	Σ= **CC**	Σ= **DD**	Σ= **EE**	Σ= **FF**	Σ
	MARKET								
9E	PRICE								
		<u>Σ × t</u>	<u>Σ × t</u>	<u>Σ(row)</u>					
	PSV	Σ= **GG**	Σ= **HH**	Σ=	-	-	-	-	-
	Adjustment								
	MARKET								
	PRICE								
	<u>Freight</u>								
9B	Freight LGV								
9C	OGV1								
9D	OGV2								
	TOTAL	Σ		Σ	Σ		Σ		Σ
	Adjustment	<u>Σ × t</u>		<u>Σ(row)</u>	<u>see note vi</u>		<u>Σ × t</u>		<u>Σ(row)</u>
	MARKET	Σ= **II**	-	Σ		-	Σ= **KK**	-	Σ
	PRICE				Σ= **JJ**				
	<u>Private</u>								
9E	**<u>Sector</u>**								
	PSV	<u>Σ × t</u>		<u>Σ(row)</u>	<u>see note vi</u>		<u>Σ × t</u>		<u>Σ(row)</u>
	Adjustment	Σ=**LL**	-	Σ		-	Σ= **NN**	-	Σ
	MARKET				Σ= **MM**				
	PRICE								
	Totals	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ

THIS ANALYSIS IS BASED ON ………………… TRAFFIC GROWTH
AND ………………… ECONOMIC GROWTH
COSTS ARE IN (PV Year) PRICES IN MULTIPLES OF A THOUSAND EURO AND ARE DISCOUNTED TO (PV Year)
EVALUATION PERIOD (evaluation period) YEARS FIRST SCHEME YEAR …… CURRENT YEAR ……
DISCOUNT RATE (discount rate) PERCENT FOR (years) YEARS THEREAFTER (discount rate) for (years)
THEREAFTER (discount rate) PERCENT

Notes:

(i) ‘t’ is the average rate of indirect tax on final consumption in the economy;

(ii) ‘t_F’ is the rate of indirect tax on fuel as a final consumption good;

(iii) ‘$t_{F∍}$’ is the rate of indirect tax on fuel as an intermediate consumption good;

(iv) ‘t_N’ is the rate of indirect tax on non-fuel vehicle operating costs as a final consumption good;

(v) ‘$t_{N∍}$’ is the rate of indirect tax on non-fuel vehicle operating costs as an intermediate consumption good;

(vi) The adjustment for Working Operating Fuel is Σ Total x (1 + $t_{N∍}$) × (1 + t) - Σ Total

Table 6.2.8: Economic efficiency of the road system in market prices (Table 15A, Phase 16 of the COBA Output)

IMPACT	TABLE REF	TOTAL	CARS & PRIVATE LGVs	GOODS VEHS & BUS. LGVs	BUS AND COACH
CONSUMER USER BENEFITS					
User Benefits					
Travel Time		=Σ (row)	BB	-	HH
Vehicle operating costs		=Σ (row)	DD + FF	-	-
Travel time and vehicle operating costs					
During construction		See note (i)		-	
During maintenance		See note (i)		-	
NET CONSUMER USER BENEFITS	(1)	=Σ (column)	Σ	-	Σ
BUSINESS USERS					
User Benefits					
Travel Time		=Σ (row)	AA	II	GG + LL
Vehicle operating costs		=Σ (row)	CC + EE	JJ + KK	-
Travel time and vehicle operating costs					
During construction		See note (i)			
During maintenance		See note (i)			
Subtotal	(2)				
Private Sector Provider Impacts					
Operating Costs	(3)				MM + NN
Other Business Impacts					
Developer and Other Contributions	(4)	=Σ (row)			
NET BUSINESS IMPACT	(5) = (2)+ (3)+ (4)	Σ	Σ	Σ	Σ
TOTAL Present Value of Transport Economic Efficiency Benefits	(6) = (1) + (5)	Σ			

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EVALUATION PERIOD (evaluation period) YEARS FIRST SCHEME YEAR …… CURRENT YEAR ……
DISCOUNT RATE (discount rate) PERCENT FOR (years) YEARS THEREAFTER (discount rate) for (years)
THEREAFTER (discount rate) PERCENT

Notes:

(i) COBA takes the input values for the Construction Delays and Maintenance delay Savings, converts to market prices (multiplies by 1 + t) and allocates between 'Consumers' and 'Business' in proportion to the Consumer and business User (Time and VOC) benefits of the scheme under normal operating conditions.

Table 6.2.9: Public accounts (table 15B, phase 16 of the COBA output)

IMPACT	TABLE REF	TOTALS
LOCAL GOVERNMENT FUNDING		
Operating Costs		(1+ t) × (Maintenance Expenditure Savings)
Investment Costs		(1 + t) × (Scheme Costs less Maintenance Capital Cost Savings)
Developer and Other Contributions		
NET IMPACT	(7)	
CENTRAL GOVERNMENT FUNDING		
Operating Costs		(1+ t) × (Maintenance Expenditure Savings)
Investment Costs		(1 + t) × (Scheme Costs less Maintenance Capital Cost Savings)
Developer and Other Contributions		
NET IMPACT	(8)	
Present Value of Costs (PVC)	(9)	

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EVALUATION PERIOD (evaluation period) YEARS FIRST SCHEME YEAR …… CURRENT YEAR ……
DISCOUNT RATE (discount rate) PERCENT FOR (years) YEARS THEREAFTER (discount rate) for (years)
THEREAFTER (discount rate) PERCENT

Notes:

(i) Costs entered into COBA are in Resource Cost terms;
(ii) ‘t’ is the average rate of indirect taxation in the economy

Table 6.2.10: Analysis of monetised costs and benefits (table 15C, phase 16 of the COBA output)

IMPACT	TABLE REF	TOTALS
TEE Benefits		
Consumer User Benefits	(1)	
Business Benefits	(2)	
Private Sector Provider Impacts	(3)	
Accident Benefits	(10)	
Emission Benefits	(11)	
Indirect Tax benefit	(12)	
Residual Value	(13)	
Present Value of Benefits (PVB)	(14)	Σ
Government Funding		
Present value of Costs **(PVC)**	(9)	
Overall Impact		
Net Present Value **(NPV)**	(14) – (9)	
Benefit to Cost Ratio **(BCR)**	(14) / (9)	

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COSTS ARE IN (PV Year) PRICES IN MULTIPLES OF A THOUSAND EURO AND ARE DISCOUNTED TO (PV Year)
EVALUATION PERIOD (evaluation period) YEARS FIRST SCHEME YEAR …… CURRENT YEAR ……
DISCOUNT RATE (discount rate) PERCENT FOR (years) YEARS THEREAFTER (discount rate) for (years)
THEREAFTER (discount rate) PERCENT

Note: There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above **does NOT provide** a complete measure of value for money and should not be used as the sole basis for decisions