ArupTransport

Tyne and Wear Passenger Transport Authority

New Tyne Crossing

Proof of Evidence

Appendices

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Congestion Reference Flows

B. CONGESTION REFERENCE FLOWS

B1.1 The Congestion Reference Flow (CRF) (from the Design Manual for Roads and Bridges (DMRB) TD 46/97, Annex D method) was used for the definition of 'capacity'. The method explicitly recognises that 'capacity' is not an absolute measure, and it is therefore not now recommended practice to, for example, state that 'traffic flows in the Tyne Tunnel exceed capacity', or that 'capacity was exceeded in 1995'. The method relies on calculating an hourly flow level, derived from the geometric characteristics of the road, and the proportion of heavy vehicles in the peak period. The calculated hourly flow level is such that the following conditions, qualitatively expressed, would be evident to the driver:

- the road 'feels congested';
- minor incidents cause disproportionate delays;
- speeds drop well below 'acceptable' levels; and
- stop/start operation is commonplace.

B1.2 From this hourly level, daily flows are derived, using factors specific to the traffic pattern, such as the tidal nature of the flows, and the peak-hour factor. The daily flow level is called 'the CRF', and the CRF is expressed as an Annual Average Daily Traffic (AADT) value.

B1.3 The design manual describes Congestion Reference Flow as follows:

'The Congestion Reference Flow of a link is an estimate of the AADT flow is likely to be 'congested' in the peak periods of an average day. Congestion is defined as the situation when the hourly traffic demand exceeds the maximum sustainable hourly throughput of the link. At this point the effect on traffic is likely to be one or more of the following: flow breakdown with speeds varying considerably, average speeds drop significantly, the sustainable throughput is reduced and queues are likely to form.'

B1.4 Thus a link which experiences the traditional morning and evening commuter peaks and has AADT traffic levels equal to the CRF, is likely to be congested for approximately 250 hours per year in the weekday peaks in the peak direction (there being approximately 500 weekday peak hours in the year, half of which will have a higher than average demand flow). Table B1 shows the variables used in the calculation of the Congestion Reference Flow.

Table B1 Congestion Reference Flow (CRF) Calculation

CRF = CAPACITY * NL *WF *100/PKF *100/PKD * AADT/AAWT	
CAPACITY	Maximum Hourly Throughput
NL	Number of lanes per Direction
WF	Width Factor
PkF	Percentage of 2 way daily flow that occurs during the peak hour
PkD	Directional Split of the peak hour flow
AADT	Annual Average Daily Traffic
AAWT	Annual Average Weekday Traffic

B1.5 The CAPACITY variable refers to the maximum hourly lane throughput, and is calculated using the variables shown in Table B2, for new roads or roads that are not currently experiencing congestion. If a road is currently experiencing congestion then this value can be measured directly.

Table B2 CAPACITY Calculation

CAPACITY =(A-B*PK%H)		
CAPACITY	Maximum Hourly Throughput	
PK%H	Proportion of Heavy Vehicles in the Peak Hour	
A and B are parameters dependent on road standard		
	A	**B**
Single Carriageway	1380	15
Dual Carriageway	2100	20
Motorway	2300	25

B1.6 Table B2 shows that the maximum hourly throughput of a single carriageway, for example, is 1380 vehicles at the most, regardless of the proportion of heavy vehicles. An example of the how the CRF of the Tyne Tunnel is calculated is shown below:

- percentage of 2 way daily flow that occurs during the peak hour = 8.5%
- the directional split of the peak hour flow = 51.4%
- the ratio of Annual Average Daily Traffic to Annual Average Weekday Traffic = 0.91

B1.7 Table B3 shows the calculation below, yielding a CRF of approximately 25,000 vpd.

Table B3 Congestion Reference Flow Calculation for the Tyne Tunnel

CRF = CAPACITY * NL *WF *100/PKF *100/PKD * AADT/AAWT	
	Single Carriageway
CAPACITY	1380 – 15*4.4% = 1314
NL	1 lane per direction
WF	0.90 (Carriageway assumed to be 6.75 m wide)
PkF	8.5%
PkD	51.4%
AADT/AAWT	0.91
CRF	24,748

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APPENDIX C

Transport Economics Note

TRANSPORT ECONOMICS NOTE

Summary: This Transport Economics Note provides the latest values of time and vehicle operating costs recommended by the Department of the Environment, Transport and the Regions for use in economic appraisals of transport projects. This Note replaces the previous Highways Economics Note No. 2.

1. INTRODUCTION

General

1.1 This Transport Economics Note (TEN) provides the latest values of time and vehicle operating costs recommended by the Department of the Environment, Transport and the Regions (DETR) for use in economic appraisals of transport projects in England as well as the rest of Great Britain with the relevant Overseeing Organisation's permission. This note replaces the previous Highways Economics Note Number 2 (HEN2) dated November 1997.

1.2 The values presented in this note are suitable for use in COBA [1], TUBA [2] and QUADRO[3] computer programs, although this list is not exhaustive. Further advice relating to their application may be obtained from the DETR.

1.3 TEN aims, as far as possible, to cover all modes of transport. However in certain parts of the note, notably vehicle occupancies and vehicle operating costs, a lack of available data means that all modes have not been covered.

1.4 Replacement of HEN2 was also necessary to allow implementation of the recommendations contained in latest research for DETR[4]. The main recommendations being that the method of cost-benefit analysis be changed from one based on social costs and benefits to one based on willingness to pay, and that the results of economic appraisals should be expressed in the market price unit of account.

Methods of Cost Benefit Analysis

1.5 Cost benefit analysis aims to take account of all the ways in which a project affects people, irrespective of whether those effects are registered in conventional financial accounts. There are two different methods of cost-benefit analysis (calculus of social costs and benefits, and calculus of willingness to pay). Both lead to the same valuation of net social benefit, but they differ in their presentation of results.

1.6 The method of social costs and benefits seeks to measure the value to society as a whole of the resources used by, and the benefits created by, a project. It does not take account of transfer payments (payments made by one individual or organisation to another) and therefore the impacts on different groups in society are not identified.

1.7 The willingness to pay method aims to arrive at a measure of the costs and benefits experienced by each person or organisation as a result of a project. Presenting results in this way means that there are often items which appear as benefits for one person or organisation and costs for another.

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1 COBA is a cost-benefit analysis computer program designed by DETR used for the economic appraisal of road schemes only.

2 Transport User Benefit Appraisal (TUBA) is a computer program developed by DETR to undertake an economic appraisal for a multi-modal transport project.

3 QUADRO is a computer program developed by DETR for estimating the cost of queues and delays at roadworks.

4 "Developing a Consistent Cost-Benefit Framework for Multi-Modal Transport Appraisal", by Robert Sugden, Economics Research Centre, University of East Anglia, January 1999.

Units of Account

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

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

1.10 Costs can be converted to (or from) market prices by multiplying (or dividing) by the indirect tax correction factor, (1+t), where t is 20.9% - the average rate of indirect taxation in the economy in 1998.

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

2. VALUES OF TIME

2.1 This chapter provides the latest values of time recommended by the DETR for use in economic appraisals of transport projects. All items are expressed in average 1998 values and prices. The forecast rates of increase in the values of time are consistent with those used in Transport 2010: The 10 Year Plan.

Values of Working Time per Person

2.2 Working time values, given in Table 2/1 part (a), apply only to journeys made in the course of work. This excludes commuting journeys. The perceived value of working time is the value as perceived by the employer. Businesses perceive costs in the factor cost unit of account and therefore the perceived cost and the resource cost are the same for values of working time. The resource cost is calculated as being equal to the gross wage rate plus non-wage labour costs such as national insurance, pensions and other costs which vary with worker hours. The 36.5% mark-up for non-wage labour costs used in the previous note (HEN2) has been revised down to 24.1%, a figure derived using more recent data from the 1992 Labour Cost Survey.

2.3 Values for car drivers and passengers; rail, bus, underground and taxi passengers; walkers; cyclists; and motorcyclists were derived from the 1996/98 National Travel Survey (NTS). Values for the occupational groups (bus, OGV, taxi and train drivers, LGV occupant, and all workers) were obtained from the 1998 New Earnings Survey. In the case of staged journeys, the value of working time for the main mode should be used, where the main mode refers to the mode used for the longest amount of journey time.

Vehicle Occupant	Resource Cost	Perceived Cost	Market Price
(a) Working Time			
Car driver	1744	1744	2109
Car passenger	1369	1369	1656
LGV occupant (driver or passenger)	731	731	884
OGV occupant	731	731	884
PSV driver	668	667	807
PSV passenger	1109	1109	1341
Taxi Driver	798	798	965
Taxi passenger	2374	2374	2870
Rail passenger	2517	2517	3043
Underground passenger	2115	2115	2558
Train Driver (including underground)	1498	1498	1811
Walker	2401	2401	2903
Cyclist	1198	1198	1449
Motorcyclist	941	941	1137
Average of all workers	1157	1157	1399
(b) Non-Working Time			
Standard appraisal value	374	452	452

Table 2/1: Values of Time per Person (pence per hour, average 1998 prices and values)

2.4 In certain circumstances it may be appropriate to make the simple assumption of a common value of time for all travellers in working time, in which case the average of all workers value (calculated from the average earnings of all industries in Great Britain) given in Table 2/1 should be used. Where this approach is adopted, sensitivity tests should be carried out, using values disaggregated by modal group.

2.5 For modelling purposes, it may be necessary to consider the distribution of the values of time with respect to income. If further information is required, please contact HETA Division, DETR.

Values of Non-Working Time per Person

2.6 The value for non-working time, given in Table 2/1 part (b), applies to all non-work journey purposes, including travel to and from work, by all modes. It is based on research conducted by the Department of Transport, reported in 1985, and published as *The Value of Travel Time Savings.* The derivation of the Standard Appraisal Value from the research findings was explained in the consultation document *Values for Travel Time Savings and Accident Prevention*, (Department of Transport, 1987). The value given in that document was obtained using weights in vehicle travel time taken from the 1978/79 NTS, the latest then available. The use of such weights means that the value is converted from a behavioural value[5] into an equity value. The value given in this note was derived using similar data from the 1985/86 NTS as weights and therefore the standard appraisal value in Table 2/1 represents the equity value of non-work time. The 1985 value was converted to a 1998 value by uprating in proportion to changes in average employee earnings[6] and then converted into the factor cost unit of account by dividing by the 1985 indirect tax correction factor.

2.7 The value of non-working time spent waiting for public transport, walking and cycling is double the standard appraisal value.

2.8 The perceived value of non-working time is the value as perceived by the individual traveller. Individual consumers perceive costs in the market price unit of account and therefore the perceived cost and the market price are the same for the non-working value of time.

2.9 Past research[7] carried out for the Department showed that the value of time savings reported by those road users surveyed was influenced by the context in which the savings or losses occur. A number of values were reported which differed, for example, according to the amount of time saved, whether the change related to increases or reductions in travel time, the duration of the trip, its purpose etc. Further research[8] is currently being carried out in these areas.

Vehicle Occupancies

2.10 Vehicle occupancy figures for cars are shown in Table 2/2. These figures were derived from the 1996/98 NTS and show the sum of driver occupancy (which is always 1) and passenger occupancy. Occupancies in the top half of Table 2/2 are per vehicle kilometre and those in the bottom half are per trip.

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5 The behavioural value of non-working time for any individual is measured by his or her willingness to pay (WTP) for reductions in travel time.

6 Average earnings of full time adult employees including overtime but excluding absences are obtained from Table 5.6 of *Labour Market Trends*, published by the Office for National Statistics.

7 "The Value of Travel Time on UK Roads", Hague Consulting Group and Accent Marketing and Research.

8 "Revising the Values of Work and Non-Working Time used for Transport Appraisal and Modelling", Institute for Transport Studies, University of Leeds.

Vehicle Type And Journey Purpose	Weekday					Weekend Average	All Week Average
	7am-10am	10am-4pm	4pm-7pm	7pm-7am	Average		
	Occupancy per Vehicle Kilometre Travelled						
Work Car	1.26	1.19	1.18	1.24	1.21	1.28	1.22
Non-work Car	1.38	1.61	1.46	1.47	1.49	1.88	1.60
Average Car	1.36	1.51	1.42	1.44	1.44	1.79	1.54
	Occupancy per trip						
Work Car	1.26	1.19	1.18	1.22	1.20	1.27	1.21
Non-work Car	1.46	1.63	1.53	1.55	1.55	1.87	1.63
Average Car	1.44	1.58	1.50	1.54	1.52	1.86	1.60

Table 2/2: Car Occupancies in 1998

2.11 Occupancies for all other vehicles are shown in Table 2/3. These figures also show the sum of driver and passenger occupancy. Occupancies for different times of the day are only available for cars. For LGVs, different occupancy figures are available for a weekday and the weekend. For all other vehicles, only all week average occupancy figures are available. These should be used for all time periods. Values for heavy and light rail are not included as it is assumed that, if a public transport project is being appraised, a project specific public transport model will be used which will give appropriate details of passenger occupancy. Average PSV occupancy figures are given, as these are required for highways scheme appraisal.

Vehicle Type and Journey Purpose	Occupancy per Vehicle Kilometre Travelled		
	Weekday	Weekend	All Week Average
LGV			
Work (freight)	1.20	1.26	1.20
Non-work (private)	1.46	2.03	1.59
Average LGV	1.23	1.35	1.25
OGV1			
Work	1.00	1.00	1.00
OGV2			
Work	1.00	1.00	1.00
PSV			
Occupants in Work	1.10	1.10	1.10
Occupants in Non-work	12.10	12.10	12.10

Table 2/3: Vehicle Occupancies in 1998

2.12 Table 2/4 shows the predicted decline in car passenger occupancies. These figures are consistent with the DETR's National Road Traffic Forecasts. The occupancy of all other vehicle types should be assumed to remain unchanged over time.

Vehicle Type And Journey Purpose	Change in Car Passenger Occupancy (% pa) up to 2036						
	Weekday					Weekend Average	All Week Average
	7am-10am	10am-4pm	4pm-7pm	7pm-7am	Average		
Work Car	-0.48	-0.40	-0.62	-0.50	-0.44	-0.48	-0.45
Non-work Car	-0.67	-0.65	-0.53	-0.47	-0.59	-0.52	-0.66

Table 2/4: Annual Percentage Change in Car Passenger Occupancies

Journey Purpose Splits

2.13 Data from the 1996/98 NTS has been used to produce journey purpose splits for work and non-work trips for the five standard appraisal time periods. These purpose splits, shown in Table 2/5, are necessary in order to calculate values of time per vehicle for the average vehicle. Journey purpose splits are assumed to remain constant over time.

Vehicle Type And Journey Purpose	Weekday					Weekend Average	All Week Average
	7am-10am	10am-4pm	4pm-7pm	7pm-7am	Average		
	Percentage of Vehicle Time						
Car							
Work	21.1	23.8	14.2	12.3	18.8	3.8	15.1
Non-work	78.9	76.2	85.8	87.7	81.2	96.2	84.9
LGV							
Work (freight)	88.0	88.0	88.0	88.0	88.0	88.0	88.0
Non-work (private)	12.0	12.0	12.0	12.0	12.0	12.0	12.0
OGV1							
Work	100.0	100.0	100.0	100.0	100.0	100.0	100.0
OGV2							
Work	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Percentage of Occupant's Time						
PSV							
Work	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Non-work	99.2	99.2	99.2	99.2	99.2	99.2	99.2
Light Rail							
Work	5.0	11.0	6.0	7.0	7.0	1.0	6.0
Non-work	95.0	89.0	94.0	93.0	93.0	99.0	94.0
Heavy Rail							
Work	5.0	11.0	6.0	7.0	7.0	1.0	6.0
Non-work	95.0	89.0	94.0	93.0	93.0	99.0	94.0

Table 2/5: Proportion of Trips Made in Work and Non-Work Time

Values of Time per Vehicle

2.14 The values of time per vehicle given in Table 2/6 were calculated by multiplication of the appropriate figures from Tables 2/1, 2/2 and 2/3. Average car, average LGV and average PSV values also use the journey purpose split data from Table 2/5 as weights. For clarity, only the perceived cost values are given here.

Vehicle Type And Journey Purpose	Perceived Value (pence per hour)						
	Weekday					Weekend Average	All Week Average
	7am 10am	10am- 4pm	4pm- 7pm	7pm- 7am	Average		
Car							
Work	2100	2004	1991	2073	2031	2128	2045
Non-work	624	728	660	664	673	850	723
Average Car	935	1032	849	837	928	899	923
LGV							
Work (freight)	877	877	877	877	877	921	877
Non-work (private)	660	660	660	660	660	918	719
Average LGV	851	851	851	851	851	921	858
OGV1							
Working	731	731	731	731	731	731	731
OGV2							
Working	731	731	731	731	731	731	731
PSV							
- Work (driver and working passengers)	778	778	778	778	778	778	778
- Non-Work (non-work passengers)	5469	5469	5469	5469	5469	5469	5469

Table 2/6: Perceived Values of Time per Vehicle in 1998

Annual Rates of Growth in the Value of Time

2.15 The real value of average employee earnings is assumed to reflect the growth in the real value of both working time and non-working time. This grew by 3.41% per annum between 1998 and 1999. Beyond 1999 it is assumed that the real value of time will grow in line with the forecast of real GDP per head. Forecasts for GDP are produced by H. M. Treasury and forecasts for population growth produced by DETR. Forecast growth in the real value of time is shown in Table 2/7.

Range of Years	GDP Growth (%pa)	Population Growth (%pa)	Growth in Value of Time (%pa)
1998-1999	Not required	Not required	3.41 (actual)
1999-2000	1.75	0.430	1.31
2000-2005	2.50	0.306	2.19
2005-2050	2.25	0.216	2.03

Table 2/7: Forecast Growth in the Real Value of Time

3. VEHICLE OPERATING COSTS

3.1 This chapter provides the latest vehicle operating cost (VOC) values recommended by the DETR for use in economic appraisals of transport projects. VOCs are separated into fuel VOCs and non-fuel VOCs and are discussed separately within the chapter . All parameters are expressed in average 1998 values and prices. Forecast rates of increases in VOCs are consistent with those used in Transport 2010: The 10 Year Plan.

Vehicle Operating Costs - Fuel

3.2 Fuel consumption is estimated using a function of the form:

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

Where L = consumption, expressed in litres per kilometre.
V = average link speed in kilometres per hour,
a, b and c are parameters defined for each vehicle category.

3.3 The parameters needed to calculate the fuel consumption element of VOC are given in Table 3/1. These parameters can be converted into pence per kilometre by multiplying by the cost of fuel. All vehicles, except cars, are assumed to be diesel driven and therefore parameters for these vehicles should be multiplied by the cost of diesel. The cost of fuel is shown in Table 3/2. These figures are for the third quarter of the year and are provided by the DTI. Figures for petrol are weighted to take account of the consumption split between unleaded and leaded[9] petrol. Figures for cars represent the average car "on the road" and are therefore a weighted average of the petrol and diesel figures where the weights used are the proportions of the car fleet using petrol and diesel, shown in Table 3/3.

Vehicle Category	Parameter		
	a	b	c
Petrol Car	0.1780	-0.00299	0.00002050
Diesel Car	0.1315	-0.00214	0.00001332
Average Car	0.1689	-0.00282	0.00001910
LGV	0.2026	-0.00328	0.00002630
OGV1	0.4649	-0.00751	0.00005454
OGV2	0.9529	-0.01479	0.00010083
PSV	0.7244	-0.01135	0.00007157

Table 3/1: Fuel VOC Formulae Parameter Values (litres per km 1998)

9 Lead Replacement Petrol (LRP) after 2000.

Year	Resource Cost (pence per litre)			Duty (pence per litre)			V.A.T (%)		
	Petrol	Diesel	Av. Car	Petrol	Diesel	Av. Car	Petrol	Diesel	Av. Car
1998	12.2	11.8	12.1	45.3	45.0	45.3	17.5	17.5	17.5
1999	14.1	16.1	14.5	47.6	46.5	47.4	17.5	17.5	17.5
2000	20.0	20.1	20.0	46.8	46.1	46.8	17.5	17.5	17.5

Table 3/2: Fuel Costs, Fuel Duty and VAT Rates 1998-2000 (1998 prices)

Year	Proportion of Car Fleet using Petrol or Diesel (%)	
	Petrol	Diesel
1998	80.5 (actual)	19.5 (actual)
1999	79.0 (actual)	21.0 (actual)
2000	77.7 (actual)	22.3 (actual)
2001	76.5	23.5
2002	75.4	24.6
2003	74.5	25.5
2004	73.7	26.3
2005	73.1	26.9
2006	72.6	27.4
2007	72.2	27.8
2008	71.9	28.1
2009	71.6	28.4
2010	71.3	28.7
	decreasing to	increasing to
2031	70.4	29.6

Table 3/3: Proportion of Car Fleet Using Petrol and Diesel

3.4 The resource cost of fuel VOCs is net of indirect taxation. The market price is gross of indirect taxation and is therefore the sum of the resource cost and fuel duty, plus VAT of 17.5% (that is, market price = [resource cost + fuel duty] x 1.175). In work time the perceived cost of fuel VOCs is the cost perceived by businesses. Businesses are generally viewed as perceiving costs in the factor cost unit of account as most business costs are free of indirect taxation because they can claim it back. However, businesses cannot reclaim fuel duty and therefore the perceived value of fuel VOCs in work time is equal to the resource cost plus fuel duty. In non-work time, the perceived cost of fuel VOCs is the cost as perceived by the individual consumer. Consumers perceive costs in the market prices unit of account and therefore the perceived value of fuel VOCs in non-working time is equal to the market price.

Rates of Change in Fuel VOCs

3.5 There are two causes of changes in fuel VOC over time: improvements in vehicle efficiency and changes in the cost of fuel. For cars, changes in fuel VOCs also reflect changes in the proportion of the vehicle fleet using either petrol or diesel (see Table 3/3).

3.6 Vehicle efficiency assumptions are shown in Table 3/4. These figures show changes in fuel consumption and therefore negative figures indicate an improvement in vehicle efficiency.

Vehicle Category	Change in Vehicle Efficiency					
	1998-2010		2011-2031		2032-2050	
	(%)	(% pa)	(%)	(% pa)	(%)	(% pa)
Petrol Car	-21.9	-2.04	-9.7	-0.51	0	0
Diesel Car	-21.5	-2.00	-6.9	-0.36	0	0
Average Car	-21.8	-2.03	-8.9	-0.46	0	0
LGV	-15.0	-1.35	0	0	0	0
OGV1	-12.5	-1.11	0	0	0	0
OGV2	-15.0	-1.35	0	0	0	0
PSV	0	0	0	0	0	0

Table 3/4: Assumed Vehicle Fuel Efficiency Improvements

3.7 Changes in the cost of fuel, shown in Table 3/5, represent the change in the resource cost per litre of fuel. Figures for 1998-2000 are actual. Figures beyond 2000 take account of changes in oil price forecasts from the DTI.

3.8 Fuel duty is assumed to remain constant in real terms beyond 2000 and VAT is assumed to remain at 17.5%.

Range Of Years	Increase in the Resource Cost of Fuel (% pa)		
	Petrol	Diesel	Average Car
1998-1999	15.5 (actual)	36.4 (actual)	19.7 (actual)
1999-2000	42.1 (actual)	24.9 (actual)	38.1 (actual)
2000-2001	-25.9	-25.6	-25.8
2001-2002	-18.3	-18.0	-18.2
2003-2050	0.0	0.0	0.0

Table 3/5: Annual Rates of Change in the Resource Cost of Fuel

Vehicle Operating Costs – Non-Fuel

3.9 The non-fuel elements of VOC are combined in a formula of the form;

$$C = a^1 + b^1/V,$$

where C = cost in pence per kilometre travelled,
V = average link speed in kilometres per hour,
a^1 is a parameter for distance related costs defined for each vehicle category, and
b^1 is a parameter for vehicle capital saving defined for each vehicle category. This parameter is only relevant to working vehicles.

3.10 The parameters needed to calculate the non-fuel vehicle operating costs are given in Table 3/6. These parameters are in pence per kilometre at 1998 prices.

Vehicle Category	Resource Cost Parameters		Perceived Cost Parameters	
	a^1	b^1	a^1	b^1
Work Car	3.760	102.92	3.760	102.92
Non-Work Car	2.911	-	3.520	-
Average Car	3.040	15.54	3.556	15.54
Work LGV	4.336	43.50	4.336	43.50
Non-Work LGV	4.336	-	5.240	-
Average LGV	4.336	38.28	4.444	38.28
OGV1	8.828	133.74	8.828	133.74
OGV2	9.859	270.92	9.859	270.92
PSV	18.287	306.60	18.287	306.60

Table 3/6: Non-Fuel VOC Formulae Parameter Values (pence per km, 1998 prices)

3.11 Non-fuel VOC parameters for work and non-work cars and private LGVs have been derived in accordance with previous methods outlined in "Review of Vehicle Operating Costs in COBA" EEA Division, DoT. 1990-91. Non-fuel parameters for all other vehicles have been updated from HEN2 by the ratio of average 1998 and 1994 RPIs. The elements making up non-fuel vehicle operating costs include oil, tyres, maintenance, depreciation and vehicle capital saving (only for vehicles in working time).

3.12 The resource cost of non-fuel VOCs is net of indirect taxa tion and the market price is gross of indirect taxation. The perceived cost of non-fuel VOCs differs for work and non-work time. In work time, the perceived cost is the cost perceived by businesses and is therefore equal to the resource cost. In non-work time, the perceived cost is the cost perceived by the consumer and is therefore equal to the market price.

3.13 The perceived cost of non-fuel LGV operating costs differ in work and non-work time by the indirect tax correction factor (described in paragraph 1.10). However, the difference between non-fuel car operating costs is not explained entirely by the indirect tax correction factor as account is also taken of the difference in the composition of vehicle fleet in work and non-work time. In work time, a large proportion of total mileage is by cars with large engine sizes and these cars have higher non-fuel VOCs.

Rates of Change in Non-Fuel VOCs

3.14 Non-fuel VOCs are assumed to remain constant in real terms over the forecast period. This assumption is made because the main elements which make up non-fuel VOCs are subject to less volatility than fuel VOCs.

APPENDIX D

Extract from COBA 11 Manual

PART 2

THE VALUATION OF COSTS AND BENEFITS

Contents

Chapter

3. THE VALUATION OF ACCIDENTS

3.1 The benefits from a reduction in the number and severity of accidents constitute an important element in the appraisal of trunk road schemes. It is necessary to put a money value on accident savings so that they are given an appropriate valuation relative to that given to construction costs and to time and vehicle operating cost savings. Standard values are produced for use in valuing the savings of accidents resulting from road improvements and road safety measures. The values used in COBA are derived on the same basis as given in Highways Economics Note No. 1 September 1999 (1998 prices and values). The latest version of HEN1 is available from RS Division, DTLR. Table 3/1 details the components of accident costs which in addition to the 'casualty' cost include the costs associated with damage to property, insurance administration, police time and an allowance for damage only accidents.

COST PER CASUALTY, £	
Fatal casualty	1,047,240
Serious casualty	117,670
Slight casualty	9,070

COST PER ACCIDENT, £				
	Insurance Administration	**Damage to Property**		
		Urban	Rural	Motorway
Fatal accident	193	5007	8494	10804
Serious accident	120	2684	3872	9218
Slight accident	73	1584	2566	4663
Damage only	34	1133	1692	1626
		Police Cost		
		Urban	Rural	Motorway
Fatal accident		1226	1162	1701
Serious accident		103	287	268
Slight accident		37	37	37
Damage only		2	2	2
Number of Damage Only Accidents per pia		17.7	7.8	7.6

Table 3/1: Components of Accident Costs (1998 values and prices)

3.2 To determine overall accident costs, details of the average accident severity split (that is, the number of fatal, serious and slight casualties per accident) and the proportion of fatal/serious/slight accidents are required. Information on the severity split by links and junctions type is given in Part 2 Chapter 4 for links and Chapter 5 for junctions. Note that accidents are classified according to the most seriously injured casualty and that for accident coding purposes 'rural' roads are defined as those with a speed limit of more than 40 mph (64 kph). Those with speed limits of 40 mph or below are defined as 'urban' roads.

3.3 Details of the average proportion of fatal/serious/slight accidents on links is given in Table 3/2 and at junctions in Table 3/3. The proportions are based on 1996 – 1998 data. Accident rates and severity have been reducing over recent years and this trend is expected to continue into the future; see paragraph 4.5 and Table 4/3 in Chapter 4. The forecasting of the proportion of fatal/serious/slight accidents is based on a similar methodology. First, the fatal and serious proportion is forecast by applying the 'accident rate change coefficient' given in Table 4/1 in Chapter 4. The sum of these is subtracted from unity to determine slight proportion.

LINK ONLY ACCIDENT PROPORTIONS (1997 Base)							
ACCIDENT TYPE	ROAD TYPE	ACCIDENT PROPORTIONS					
	Casualty Severity	Fatal (f)		Serious (se)		Slight (sl)	
1 – 3	Motorways	0.021		0.126		0.853	
	Speed Limit	30/40 mph			> 40 mph		
	Casualty Severity	f	se	sl	f	se	sl
4 – 8	S2 A Roads	0.017	0.166	0.817	0.049	0.242	0.709
9	Other S2 Roads	0.010	0.164	0.826	0.028	0.217	0.756
10 - 15	Dual Carriageways	0.017	0.165	0.818	0.032	0.183	0.785
LINK AND JUNCTION COMBINED ACCIDENT PROPORTIONS (1997 Base)							
	Casualty Severity	Fatal (f)		Serious (se)		Slight (sl)	
1 – 3	Motorways	0.021		0.126		0.853	
	Speed Limit	30/40 mph			> 40 mph		
	Casualty Severity	f	se	sl	f	se	sl
4 - 8	S2 A Roads	0.010	0.142	0.848	0.038	0.222	0.740
9	Other S2 Roads	0.007	0.139	0.854	0.024	0.204	0.772
10 - 15	Dual Carriageways	0.011	0.136	0.852	0.031	0.174	0.795

Table 3/2: Proportions of Fatal, Serious and Slight Accidents on Links (Average 1997)

PROPORTIONS OF ACCIDENTS AT JUNCTIONS (1997 Base)						
Speed Limit	**30/40 mph**			**> 40 mph**		
Casualty Severity	**f**	**se**	**sl**	**f**	**se**	**sl**
3 Arm Priority	0.0074	0.1377	0.8549	0.0242	0.1919	0.7839
4 and 5 arm Priority	0.0059	0.1334	0.8608	0.0268	0.2177	0.7554
3 Arm Traffic Signals	0.0064	0.1150	0.8786	0.0142	0.1302	0.8556
4 and 5 Arm Traffic Signals	0.0060	0.1248	0.8692	0.0127	0.1273	0.8600
Roundabouts	0.0025	0.0851	0.9123	0.0038	0.0897	0.9065
Signalised Roundabouts	0.0024	0.0610	0.9362	0.0020	0.0517	0.9463

Table 3/3: Proportions of Fatal, Serious and Slight Accidents at Junctions (Average 1997)

3.4 The average accident costs used in COBA will normally be appropriate even where local accident rates differ from the average. In some circumstances the severity split may differ with a consequent change in average accident costs, but this is likely to be significant in few cases. The Overseeing Organisation should be consulted if it is considered necessary to use local severity splits. General policy is to discourage the use of a local severity split unless it can be shown that exceptional conditions genuinely arise which are unlikely to be corrected by modest remedial works.

3.5 In order to accept a local severity split the user must:

i) demonstrate that the severity split is significantly different in statistical terms from the COBA value, and also that this does not result from one or two particularly bad accidents, the effect of which will be evened out by less extreme accidents as time goes by. Data covering all available accident history, with a minimum of five years must be supplied;

ii) arrange an Accident Investigation and Prevention Study by the Local Authority to identify the causes of the safety problem and recommend remedial safety measures. Where this study concludes that modest remedial works are unlikely to correct the problem then a local severity split may be used. However where modest remedial works are recommended, the cost of these works should be included in the "do minimum" and the revised COBA severity split used.

3.6 Statistics of damage only accidents are not generally available because they are not comprehensively reported by the police. On the basis of some survey information, these are taken in COBA to occur at the rates given in Table 3/1. The accident costs given in Part 2 Chapter 4 and Chapter 5 include an allowance for damage only accidents at these rates.

3.7 For the purposes of appraisal it is necessary to form a view on how costs will vary over future years. The value of most elements of accident costs are proportional to national income, and for this reason it is assumed that values change in line with GDP per head. The actual and forecast changes in GDP per head are given in Table 3/4.

Range of Years	Economic Forecasts Low and High Growth (% pa)
1998 – 1999 (actual)	3.00
1999 – 2000	1.31
2000 – 2005	2.19
2005 - 2050	2.03

Table 3/4: Assumed Compound Annual Rates of Growth of Accident Values (%)

3.8 The total cost of accidents on a road network is calculated by multiplying the number of accidents predicted to occur on the network by the cost per accident. As explained above, the cost per accident varies by type and area of road. The number of accidents on a given length of road is expressed as an accident rate, defined as so many 'Personal Injury Accidents per million vehicle kilometres', so that doubling either the length or the traffic flow on the road will double the number of accidents. Apart from length and flow level, in COBA there are two determinants of the number of accidents: the number and type of junctions and the type of links.

3.9 COBA incorporates a method of separating out the effects of links and junctions on accidents. Where junctions are coded for delay calculation, these should be coded for accident calculation. In addition, where there are junctions which are subsumed in links for speed calculations (in particular in urban areas), but which are likely to be associated with accidents, these should be coded as 'accident-only' nodes. Finally, where either a very large link-only network is used and 'accident-only' nodes are difficult to identify, or local data on existing accidents are difficult to split between links and junctions, combined 'link and junction' accident rates can be attributed to links. The treatment of accidents on links and junctions is described in detail in the following two Chapters.

4. THE VALUATION OF ACCIDENTS ON LINKS

4.1 The COBA user has to decide whether to code junction accidents separately from link accidents. 'Combined' accident rates and costs attribute all accidents to links. The 'link-only' rates and costs exclude junction accidents (that is, those occurring within 20 metres of a junction) and so both default and local 'link-only' accident rates are lower than the 'combined' rates for a particular link. Accidents at junctions are then modelled separately (see Part 2 Chapter 5). The preferred method of evaluating accidents is to separate link and junction accidents, using local accident data to define the 'Do-Minimum' rates and the default rates for new links and junctions in the 'Do-Something'. However, 'Combined' accident rates and costs should be selected in COBA when:

i) local data for the 'Do-Minimum' are not available;
ii) local data have already been collected in 'combined' form and resources to disaggregate the data are not available; or,
iii) a large network is being used and 'accident-only' nodes would be difficult to identify.

4.2 Accident rates and severities have been falling steadily over time and the trend is expected to continue in the future. The Government has also announced National Casualty Reduction targets and the methodology and parameters in COBA are consistent with those targets.

4.3 Local data can be obtained from the appropriate police or local authority and should relate to a period when 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 normally cover the five years previous to the COBA assessment and must cover at least three years. 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 (accidents per million vehicle kilometres) for each link.

4.4 For existing links where local accident data are not available and for new links, the program will use the default accident rates shown in Table 4/1, they are based on data from 1996 - 1998. There are fifteen accident types relating to the type of road which are further subdivided by speed limit. In the following tables many cells in the table are at present identical; when available data permit separate rates to be calculated users will be advised. The "Modern", "Older" and "Other" link descriptions used in the tables are defined as :

"Modern" roads designed and built to geometric standards relevant post 1980,
"Older" the majority of the major road network which was not built to recent standards. For single carriageways this description refers to 'A' roads only, and
"Other" 'B', 'C' and 'unclassified' single carriageway links.

4.5 The declining trend in accident rates was examined in TRL Report 382 and at a more disaggregate level in later work undertaken for the DETR. It was found that the changes in accident rates and the number of severities per accident are 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;

β^N = change coefficient raised to the power N (the number of years after the base year).

4.6 The values for the accident rate change coefficient β incorporated in the COBA program for the different link accident types are given in Table 4/1. They are the same for 'Link Only' and 'Link and Junction Combined' analyses and should be applied from any year from 1995 until year 2010. Between 2011 and

2020 and 2021 and 2030 the accident rate change is assumed to be one half and one quarter respectively of the 1995 to 2010 reduction. For example, if the coefficient β is 0.9 for 1995 to 2010 then it is 0.95 for 2011 to 2020 (or [1 + β]/2). Zero change is assumed post 2030.

LINK ONLY (1997 Base)

ACCIDENT TYPE	ROAD TYPE	Accident Rate (Pia/mvkm)	β
1	D2 Motorway	0.107	1.001
2	D3 Motorway	0.096	1.001
3	D4 Motorway	0.096	1.001

ACCIDENT TYPE	ROAD TYPE	30/40 mph Pia/mvkm	30/40 mph β	50/60/70 mph Pia/mvkm	50/60/70 mph β
4	Modern S2 Roads	0.229	0.984	0.144	0.973
5	Modern S2 Roads with HS	0.229	0.984	0.114	0.973
6	Modern WS2 Roads	0.229	0.984	0.093	0.973
7	Modern WS2 Roads with HS	0.229	0.984	0.085	0.973
8	Older S2 A Roads	0.229	0.984	0.165	0.973
9	Other S2 Roads	0.273	0.983	0.299	0.998
10	Modern D2 Roads	0.214	0.984	0.104	0.973
11	Modern D2 Roads with HS	0.214	0.984	0.079	0.973
12	Older D2 Roads	0.214	0.984	0.104	0.973
13	Modern D3+ Roads	0.331	0.984	0.118	0.973
14	Modern D3+ Roads with HS	0.331	0.984	0.089	0.973
15	Older D3+ Roads	0.331	0.984	0.118	0.973

LINK AND JUNCTION COMBINED (1997 Base)

ACCIDENT TYPE	ROAD TYPE	Accident Rate (Pia/mvkm)	β
1	D2 Motorway	0.107	1.001
2	D3 Motorway	0.096	1.001
3	D4 Motorway	0.096	1.001

ACCIDENT TYPE	ROAD TYPE	30/40 mph Pia/mvkm	30/40 mph β	50/60/70 mph Pia/mvkm	50/60/70 mph β
4	Modern S2 Roads	0.822	0.984	0.260	0.973
5	Modern S2 Roads with HS	0.822	0.984	0.212	0.973
6	Modern WS2 Roads	0.822	0.984	0.170	0.973
7	Modern WS2 Roads with HS	0.822	0.984	0.160	0.973
8	Older S2 A Roads	0.822	0.984	0.288	0.973
9	Other S2 Roads	0.835	0.983	0.445	0.998
10	Modern D2 Roads	0.715	0.984	0.169	0.973
11	Modern D2 Roads with HS	0.715	0.984	0.121	0.973
12	Older D2 Roads	0.715	0.984	0.169	0.973
13	Modern D3+ Roads	1.301	0.984	0.204	0.973
14	Modern D3+ Roads with HS	1.301	0.984	0.146	0.973
15	Older D3+ Roads	1.301	0.984	0.204	0.973

Note: HS refers to the one metre wide hard strip provided both sides of the carriageway

Table 4/1: Default Accident Rates and Accident Rate Reduction Factor (β) (personal injury accidents per million vehicle kilometres- 1997 Base)

4.7 Table 4/2 shows the severity split incorporated in COBA in terms of casualties per accident by link type based on data for 1996 - 1998.

LINK ONLY CASUALTIES (1997 Base)							
ACCIDENT TYPE	ROAD TYPE	CASUALTIES PER P.I.A.					
	Casualty Severity	Fatal (f)		Serious (se)		Slight (sl)	
1 – 3	Motorways	0.024		0.171		1.458	
	Speed Limit	30/40 mph			> 40 mph		
	Casualty Severity	f	se	sl	f	se	sl
4 – 8	S2 A Roads	0.016	0.193	1.106	0.059	0.352	1.236
9	Other S2 Roads	0.011	0.184	1.034	0.031	0.281	1.209
10 - 15	Dual Carriageways	0.018	0.187	1.114	0.035	0.234	1.280
LINK AND JUNCTION COMBINED CASUALTIES (1997 Base)							
	Casualty Severity	Fatal (f)		Serious (se)		Slight (sl)	
1 – 3	Motorways	0.024		0.171		1.458	
	Speed Limit	30/40 mph			> 40 mph		
	Casualty Severity	f	se	sl	f	se	sl
4 - 8	S2 A Roads	0.010	0.161	1.142	0.046	0.312	1.297
9	Other S2 Roads	0.008	0.157	1.100	0.027	0.265	1.244
10 - 15	Dual Carriageways	0.012	0.154	1.193	0.034	0.228	1.301

Table 4/2: Average Number of Casualties per Accident (1997 Base)

4.8 Table 4/3 gives the casualty rate reduction factors β for each link type incorporated in the COBA program. The changes are assumed to apply up to 2010 with zero change thereafter.

LINK ONLY Change Factors β

ACCIDENT TYPE	ROAD TYPE / Casualty Severity	ALL SPEED LIMITS Fatal (f)			Serious (se)		Slight (sl)
1 – 3	Motorways	0.960			0.946		1.010
	Speed Limit (mph)	**30/40 mph**			**> 40 mph**		
	Casualty Severity	**f**	**se**	**sl**	**f**	**se**	**sl**
4 - 8	S2 A Roads	0.959	0.965	1.011	0.994	0.979	1.003
9	Other S2 Roads	0.979	0.966	1.010	0.988	0.973	1.007
10 - 15	Dual Carriageways	0.949	0.965	1.013	0.947	0.967	1.007

LINK AND JUNCTION COMBINED Change Factors β

ACCIDENT TYPE	ROAD TYPE / Casualty Severity	ALL SPEED LIMITS Fatal (f)			Serious (se)		Slight (sl)
1 – 3	Motorways	0.960			0.946		1.010
	Speed Limit (mph)	**30/40 mph**			**> 40 mph**		
	Casualty Severity	**f**	**se**	**sl**	**f**	**se**	**sl**
4 - 8	S2 A Roads	0.954	0.964	1.010	0.988	0.975	1.005
9	Other S2 Roads	0.973	0.961	1.011	0.985	0.973	1.008
10 - 15	Dual Carriageways	0.956	0.958	1.012	0.949	0.961	1.007

Table 4/3: Casualties Per Accident Change Factors β.

4.9 Table 4/4 shows the accident costs incorporated in COBA by link type using the average 1996 - 1998 severity splits given in Table 4/2. The severity split and hence cost varies considerably by link type. Junction accidents are, on average, less severe than those attributable to links and therefore the 'combined' link and junction cost is lower than the 'link-only' average. Because the severity of accidents is expected to reduce over time the average accident costs change each year and the costs in the table are only attributable to the Base year of the data.

LINK ONLY COSTS (1997 Base)			
ACCIDENT TYPE	**ROAD TYPE**	**ACCIDENT COSTS (£)**	
1 -3	Motorways	76,660	
	Speed Limit	**30/40 mph**	**50/60/70 mph**
4 - 8	S2 A Roads	72,170	131,310
9	Other S2 Roads	65,180	93,200
10 - 15	Dual Carriageways	73,630	92,480
LINK AND JUNCTION COMBINED COSTS (1997 Base)			
1 - 3	Motorways	76,660	
	Speed Limit	**30/40 mph**	**50/60/70 mph**
4 - 8	S2 A Roads	62,380	113,430
9	Other S2 Roads	59,420	87,400
10 - 15	Dual Carriageways	64,110	90,890

**Table 4/4: Average Cost per Injury Accident by Link Type (1997 Base)
(1998 values and prices)**

ArupTransport

APPENDIX E

Response to Objectors