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HIGHWAYS AGENCY

A453 Widening
M1 Junction 24 to A52 Nottingham

Economic Assessment Report
DRAFT

December 2008

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A453 Project Office
c/o WYG
Executive Park
Avalon Way
Anstey
Leicester, LE7 7GR

An Executive Agency of the Department for Transport

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REVISION AND ISSUE CONTROL SHEET

Issue Control

Rev	Status	Purpose of Issue	Originated	Checked	Authorised WYG	Authorised	Date
1	D	Draft for approval	RH	JKJ	CRS		24/08/07
2	F	Final for Approval	RH	CRS	CRS		30/05/08
3	F	Final for Approval	RH	CRS	CRS		02/07/08
4	F	Final for Approval	RH	CRS	CRS		15/08/08
5	P	Updated land cost estimate	RH	CRS	CRS		26/08/08
6	F	WebTAG updates Draft for approval	RH	CRS	CRS		08/12/08

Revision Control

Rev	Pages Revised	Description of Revision	Part or Full Revision
2	All	Revised Economic Assessment	F
3	All	Revised to include HA and PF comments	F
4	4, 7, 13, 14, 23-25, Appendices F, G & H	Revised to include Additional HA comments	P
5	4, 7, 13, 23, 25, 26, Appendices E and G	Updated land cost estimate	P
6	All	Revision of economics to include WebTAG updates	F

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INFORMATION FOR EXECUTIVE READER

Summary Section

Each section within this report has been summarised for ease of reading by the executive reader. The summary section is highlighted as shown below for ease of location.

Summary

- Summary information for the executive reader

Deliverables

Where appropriate, at the end of each section the discipline project deliverables are included and highlighted as shown below.

Deliverables

- Commissioning Report

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1. INTRODUCTION

Summary

- WYG are supporting Laing O'Rourke as designer on the A453 Widening Scheme.
- The initial traffic and economics work has been completed to 'Stage 2' by Pell Frischmann Consultants.
- The existing multi modal transport model using the VISEM-VISUM suite of programmes has been replaced by a DIADEM-VISUM link and updated to progress the scheme through to a Stage 3 Assessment. This was agreed with the HA TAME and DfT.
- The validation of the base year 2006 traffic model is detailed in the Local Model Validation Report (Reference: A021959-REP-T-SA-023) and the future year forecasting results and methodology are presented in the Transport Forecasting Report (Reference: A021959-REP-T-G-101).
- This report details the methodology employed for economic assessment and presents the results of the analysis.

1.1 BACKGROUND

1.1.1 WYG, supporting Laing O'Rourke, is undertaking the Early Contractor Involvement (ECI) Phase 1A design development work for the A453 Widening Scheme (A453W)

1.1.2 In 2000/2001, Pell Frischmann (PF) developed a multi modal model of the A453 on behalf of the Government Office of the East Midlands (GOEM) as part of the A453 Multi Modal Study (A453MMS). Mott MacDonald (MM) were commissioned to maintain the A453MMS model at a strategic level as part of the Highways Agency Traffic, Appraisal, Modelling and Economic (HA TAME) framework.

1.1.3 The A453MMS model has been updated to the A453W model to progress the scheme through to a Stage 3 Assessment. The A453MMS traffic model used the VISUM and VISEM suite of programs.

1.1.4 It was deemed essential by the Highways Agency (HA) to establish a coordinated approach to modelling for the A453W scheme. As such, MM initially took on a joint working role to combine meeting their objectives under HA TAME with carrying out the specific modelling work for this scheme jointly with WYG. In August 2007 WYG took over from MM the modelling for the A453W. Pell Frischmann are working as the Clients Agent to advise the HA and further ensure co-ordination between the different parties involved in the scheme. To aid this co-ordination a Technical Working Group has been set up to discuss and agree modelling and economics issues.

1.1.5 A joint working methodology has also been established with Arup, the consultant working for the HA on the Motorway Widening Contracts 1 and 2 (M1W) scheme. This joint working involves the exchange of information both as input to and output from the respective models. This is particularly significant at the forecasting stage.

1.1.6 The model was originally created using the PTV VISUM/VISEM software. The set up of the demand model meant that it was not possible to directly perform the fuel cost realism test and hence, could not comply with WebTAG requirements. As such, since the demand modelling has been updated to use VISUM and DIADEM to allow compliance with WebTAG requirements, then revised forecast traffic flows have been produced for economic appraisal.

1.1.7 Details of the data collected and the model update and validation are reported on in the Report of Transport Surveys and Local Model Validation Report (Ref: A021959-REP-T-SA-014 RTS and A021959-REP-T-SA-023 LMVR respectively). Transport forecasts produced from the future year models are presented in the Transport Forecasting Report (Report: A021959-REP-T-G-101 TFR).

1.2 PREVIOUS ECONOMIC APPRAISALS

1.2.1 During the A453MMS, economic assessments were undertaken for the leading transport options as part of the analysis undertaken to identify the preferred option. Assessments were made of user costs and benefits using the TUBA program (Transport User Benefit Assessment) and accident benefits using a spreadsheet. The assessments were undertaken on a total strategy basis over a 30 year evaluation period using a 6% discount rate. The results were presented in an Appraisal Summary Table and at the ECI bid stage indicated a Benefit Cost Ratio (BCR) of 1.5.

1.2.2 In 2005, Pell Frischmann carried out an update to the existing economic assessment for the A453 Multi Modal Scheme. Assessments were carried out for a 60 year period with zero growth post 2021 using forecast traffic flows extracted from the A453 multi modal model.

1.2.3 The economic assessment was carried out using the TUBA program, the safety assessment using COBA (COst Benefit Analysis) and the construction and maintenance assessment using QUADRO (QUeues And Delays at ROadworks) as detailed in WebTAG guidance (TAG Units 3.4 and 3.5).

1.2.4 The findings from the Pell Frischmann assessment were submitted in draft to the Highways Agency in September of 2005 (Ref: J10040/100 A453 Economics Update September 2005) and were summarised as shown in **Table 1** below.

Benefit Analysis	Cost in £k
Accident Benefits	102,252
Net Consumer Benefits	98,439
Net Business Impact	356,110
Total Benefits	556,801
Present Value of Costs	71,055
BCR	7.84

Table 1 – Analysis of Monetised Benefits and Costs including COBA and QUADRO Assessments (Pell Frischmann, September 2005)

1.3 REPORT STRUCTURE AND REFERENCES

1.3.1 This report details the methodology employed in carrying out economic assessment and details the results of the analysis based on the results from the transport forecasting as detailed in the Transport Forecasting Report (A021959-REP-T-G-101 TFR).

1.3.2 The Structure of the report is as follows:

- Chapter 2 - Economy Assessment methodology and results;
- Chapter 3 - Safety Assessment methodology and results;
- Chapter 4 - Construction Delay and Maintenance Delay Assessment methodology and results; and
- Chapter 5 - presents the conclusions from the economic assessment.

1.3.3 The following documents have been used and referred to in the economic assessments:

- WebTAG Units 3.4 and 3.5
- TUBA User Manual
- TUBA User Guidance
- Design Manual Roads and Bridges (DMRB) Vol. 13 and 14.
- COBA 11 Interim Guidance
- QUADRO 4 User Manual.

2. ECONOMY ASSESSMENT

Summary

- The TUBA programme has been used to assess the journey time and vehicle operating cost savings of the scheme.
- For the assessment, the opening year of 2012, the intermediate year of 2017, the design year of 2027, the economic projection year of 2031 and a 60 year assessment period has been used.
- Results from the TUBA assessment have been analysed to produce estimates of Present Value Costs (PVC) at £93.1m and Present Value Benefits (PVB) totalling £217.4m which is made up of Consumer User Benefits (£71.7m), Business User Benefits (£148.1m) and Carbon dis-benefits (-£2.5m).
- Results from the TUBA using the ECI construction costs as a sensitivity test give a Present Value Cost (PVC) of £70.5m and an unchanged PVB.

2.1 INTRODUCTION

2.1.1 In accordance with WebTAG guidance on the Transport Economic Efficiency Sub-Objectives (TAG Unit 3.5.2), the Transport User Benefit Appraisal programme, TUBA, (version 1.7b) has been used to estimate the benefits derived from a scheme in terms of time and vehicle operating cost savings. TUBA assesses the whole life costs and benefits of transport schemes using matrices of costs, in terms of distance and time, and trips from the transport model. The program calculates user benefits and changes in revenues and produces indicators of a project worth.

2.2 TUBA INPUTS

2.2.1 There are three main inputs to the TUBA process:

- Economic parameters
- Scheme specific control data
- Matrix data from the traffic model

2.3 ECONOMIC PARAMETERS

2.3.1 In accordance with WebTAG guidance, the standard TUBA economics file has been used. This file provides details of tax rates, Values Of Time (VOT) and Vehicle Operating Cost (VOC) parameters and growth forecasts for VOT and VOC.

2.3.2 The economic parameters file has been amended to accommodate the 9 vehicle types as defined within the model which splits the ‘car’ mode into ‘car internal’ and car external’. The two car vehicle types have the same parameters and are

therefore assessed for the economy objective in the same way but have been defined as separate vehicle types as part of the forecast matrix building process.

2.3.3 The vehicle types included in the revised economic parameters are therefore:

- Car Internal
- Light Goods Vehicles (LGV) Personal
- Light Goods Vehicles (LGV) Freight
- Other Goods Vehicles 1 (OGV1)
- Other Goods Vehicles 2 (OGV2)
- Bus
- Light Rail
- Heavy Rail
- Car External

2.3.4 **Appendix A** contains a copy of the standard economics file with the additional economics data used for this assessment highlighted.

2.4 SCHEME SPECIFIC CONTROL DATA

2.4.1 The control data file used by TUBA is scheme specific and defines the appraisal period, sets out the scheme costs, provides details of model specific data (e.g. time slices and user classes) and defines the annualisation factors (i.e. to convert model time periods to their annual equivalent).

2.4.2 For the purposes of the TUBA assessment the current year has been taken as 2008 and, with an opening year of 2012, the horizon year is 2071, thus providing a 60 year assessment period in accordance with WebTAG guidance (TAG Unit 3.5.2). As detailed in the Transport Forecasting Report (Reference: A021959-REP-T-G-101 TFR) the scheme appraisal years to be input to TUBA are:

- 2012 – Opening Year;
- 2017 – Intermediate year between the opening and design year;
- 2027 – 15 years after opening design year,
- 2031 – Economic projection year.

2.4.3 The time periods from the transport model were:

- 0730 – 0830 (AM peak);
- average hour between 1000 and 1600 (Inter peak);
- 1630 – 1730 (PM peak).

2.4.4 Using TUBA guidance notes the above hour long modelled time periods have been converted into the proposed TUBA time periods based on data collected from the permanent counter site (TRADS) on the A453 at Barton Lodge. These factors differ from those discussed in the 'Report of Transport Surveys' (Reference: A021959-REP-T-SA-014 RTS), which used factors based on data from the TRADS site on the A50 near Shardlow. Since that report was issued more recent data have become available from the A453 Barton Lodge TRADS

site. It has been decided to update the factors given in the Report of Transport Surveys to use data from the A453 Barton Lodge TRADS site since this site is on the A453 itself and should therefore provide a better traffic profile for the scheme as discussed in the Transport Forecasting Report (A021959-REP-T-G-101 TFR).

2.4.5 The annualisation factors have been calculated by assessing the profile of the traffic flow as shown in **Appendix B**. The number of hours which are equivalent to one of the modelled peak hours are multiplied by the number of weekdays in a year (253). The resultant annualisation factors are summarised below:

- AM peak single 1 hour time slice of 0730 – 0830 assumed for the TUBA AM peak period of 0700 – 0900 with a TUBA annualisation factor of 506 used.
- PM peak single 1 hour time slice of 1630 – 1730 assumed for the TUBA PM peak period of 1500 – 1800 with a TUBA annualisation factor of 759 used.
- Inter peak single 1 hour (average 0900 – 1500) assumed for the TUBA Inter peak period of 1000 – 1600 (annualisation factor 1518).
- An assessment of the off peak experiencing flows equivalent to the peak or inter peak hours has been carried out based on observed count data. The results show that the off peak period 1800 - 1900 is equivalent to the inter peak modelled hours. This gives an additional 253 interpeak hours.
- An assessment of the weekend hours experiencing flows equivalent to the peak or inter peak hours has been carried out based on observed count data. The results show that 5 weekend hours are equivalent to the inter peak modelled hours. This equates to 260 hours per annum (5x52). Due to the likely journey purposes of off peak and weekend trips these additional hours have been included in the inter peak annualisation factor producing a final inter peak TUBA annualisation factor of 2031 (1518+253+260).

2.4.6 The total annual hours assessed therefore are 3296 (out of an annual total of 8760 hours). This is considered to be a robust assessment.

2.4.7 The following vehicle mode types have been used in the TUBA assessment:

- Cars Internal
- Cars External
- Light Goods Vehicles (LGV)
- Other Goods Vehicles (OGV1 and OGV2)
- Buses (This vehicle mode has been used for all public transport trips in terms of passengers rather than vehicles)

2.4.8 The 'heavy' vehicle trip matrices output from the VISUM model have been disaggregated into OGV1 and OGV2 matrices by the application of observed percentage splits as derived from the 2006 Manual Classified Turning Counts. The analysis was carried out across all of the turning count locations to provide average A453 factors. These are presented in **Table 2** below. All LGV's are assumed to be used for business purposes for this assessment. Further

information regarding the survey locations is detailed in the Report of Transport Surveys (Ref A021959-REP-T-SA-014 issue 2).

Time Period	OGV1 (%)	OGV2 (%)
AM	45.2%	54.8%
Inter	45.8%	54.2%
PM	45.6%	54.4%

Table 2 – Heavy Goods Vehicles Percentage Splits

2.4.9 The 'buses' vehicle trip matrices are output from the DIADEM-VISUM model disaggregated into the purpose splits of Commute, Employers Business and Other. These splits have been retained in the TUBA assessment.

2.4.10 Costs for construction have been taken from the Indicative Funding Figure (IFF) provided by the Highways Agency at the time of preparing the TUBA assessments. The total costs are adjusted before entry into TUBA in line with current guidance as follows:

- Non Recoverable VAT is removed;
- Historic costs are removed;
- Inflation is adjusted to remove the 2.5% per annum that is automatically assumed by TUBA. HA inflation over and above this 2.5% is included in the costs;
- The Preparation and Supervision element of the costs are assumed to follow the same profile and total as predicted in the ECI Contractor Costs; and
- Programme risk is included in the costs (this is broadly similar to the old Optimism Bias). Scheme harm risk has already been included in the scheme costs calculations;

2.4.11 The cost calculation summary is attached as **Appendix C**. The total scheme costs input to TUBA are summarised as follows:

- Construction (including Risk and Optimism Bias (OB)) = £123.0m
- Land = £8.4m (including Non-Recoverable VAT, Risk Allowance, Statutory Interest, Agency Fees, Client fees and Inflation)
- Preparation and Supervision = £8.3m

2.4.12 All scheme costs have been entered as Factor Costs to allow TUBA to convert to Market Prices.

2.4.13 Scheme construction costs have been supplied broken down by financial year. TUBA, however, requires costs to be entered by calendar year.

2.4.14 The following methodology has been used to profile the costs:

- As the current year is 2008, all costs for the 2007/2008 financial year have been included in 2008 to be robust since if the costs were assigned to 2007 they would be ignored as historic costs.
- As construction is due to be complete in late 2012, all costs for the 2012/2013 financial year have been included in 2012;
- For the intermediate years, such as 2010/2011, the costs have been assigned assuming a flat profile over the calendar year, i.e. 75% in 2010 and 25% in 2011.

2.4.15 Profile information for works has been entered as supplied by the HA. Profile information for preparation and supervision costs have been taken from the ECI cost information.

2.4.16 Since the costs were at Q2 2006 the Retail Price Index (RPI) value of 197.6 has been used, as published on the National Statistics Online website. This factor was used to adjust the input scheme costs to the relevant price base used by TUBA (2002).

2.4.17 All costs have been assumed to be attributable to TUBA Mode 1 (i.e. Private Mode).

2.4.18 A sensitivity test using construction costs as supplied by the ECI contractor has also been carried out. These costs are included in **Appendix D** and constitute the most up to date at time of writing Scheme Cost Summary (Annex 1). It should be noted that these costs are used as a sensitivity test only and it is the IFF which forms the basis of the scheme economic assessment results.

2.4.19 The total scheme costs (excluding Non Recoverable VAT and 2.5% base inflation) from the ECI Annex 1 input to TUBA are summarised as follows:

- Construction (including Risk and Optimism Bias (OB)) = £92.9m
- Land = £7.9m (including Non-Recoverable VAT, Risk Allowance, Statutory Interest, Agency Fees, Client fees and Inflation)
- Preparation and Supervision = £9.1m

2.4.20 The construction costs outlined in **Appendix D** include Risk at approximately £8m and Optimism Bias at 7.08%.

2.4.21 Again, since the costs were at Q2 2006 the Retail Price Index (RPI) value of 197.6 has been used.

2.5 MATRIX DATA FROM THE TRANSPORT MODEL

2.5.1 Forecast flows from the A453 DIADEM / VISUM model, as detailed in the Transport Forecasting Report (Reference: A021959-T-G-101), have been used in the economic assessments.

2.5.2 Based on the VISUM assignments detailed in the Transport Forecasting Report the following skimmed variable trip matrices output from VISUM have been used for each vehicle type/demand segment:

- 2012 AM Do Minimum and Do Something Trip Matrices

- 2012 PM Do Minimum and Do Something Trip Matrices
- 2012 IP Do Minimum and Do Something Trip Matrices

- 2017 AM Do Minimum and Do Something Trip Matrices
- 2017 PM Do Minimum and Do Something Trip Matrices
- 2017 IP Do Minimum and Do Something Trip Matrices

- 2027 AM Do Minimum and Do Something Trip Matrices
- 2027 PM Do Minimum and Do Something Trip Matrices
- 2027 IP Do Minimum and Do Something Trip Matrices

- 2031 AM Do Minimum and Do Something Trip Matrices
- 2031 PM Do Minimum and Do Something Trip Matrices
- 2031 IP Do Minimum and Do Something Trip Matrices

- 2012 AM Do Minimum and Do Something Time Matrices
- 2012 PM Do Minimum and Do Something Time Matrices
- 2012 IP Do Minimum and Do Something Time Matrices

- 2017 AM Do Minimum and Do Something Time Matrices
- 2017 PM Do Minimum and Do Something Time Matrices
- 2017 IP Do Minimum and Do Something Time Matrices

- 2027 AM Do Minimum and Do Something Time Matrices
- 2027 PM Do Minimum and Do Something Time Matrices
- 2027 IP Do Minimum and Do Something Time Matrices

- 2031 AM Do Minimum and Do Something Time Matrices
- 2031 PM Do Minimum and Do Something Time Matrices
- 2031 IP Do Minimum and Do Something Time Matrices

- 2012 AM Do Minimum and Do Something Distance Matrices
- 2012 PM Do Minimum and Do Something Distance Matrices
- 2012 IP Do Minimum and Do Something Distance Matrices

- 2017 AM Do Minimum and Do Something Distance Matrices
- 2017 PM Do Minimum and Do Something Distance Matrices
- 2017 IP Do Minimum and Do Something Distance Matrices

- 2027 AM Do Minimum and Do Something Distance Matrices
- 2027 PM Do Minimum and Do Something Distance Matrices
- 2027 IP Do Minimum and Do Something Distance Matrices

- 2031 AM Do Minimum and Do Something Distance Matrices
- 2031 PM Do Minimum and Do Something Distance Matrices
- 2031 IP Do Minimum and Do Something Distance Matrices

2.5.3 Checks have been carried out to ensure the correct matrices have been input into the TUBA assessment process.

2.5.4 As detailed in the Transport Forecasting Report, 2031 is assumed to be the last modelled year. For the evaluation post 2031, TUBA assumes a constant stream of benefits with a flat profile from the 2031 level. This is considered reasonable since the levels of congestion within the scheme area could restrict further traffic growth and hence traffic flows are unlikely to change significantly in the area between 2031 and the Horizon year. There are also no currently committed highway network changes between 2031 and the Horizon year that would change traffic flows.

2.5.5 In accordance with TUBA guidance, a factor of 0.01667 has been used to convert the time matrices from minutes to hours and a factor of 0.001 has been used to convert the distance matrices from metres to kilometres.

2.6 TUBA ERROR / WARNING MESSAGE ANALYSIS

2.6.1 TUBA outputs error and warning messages generated during the assessment. These were checked and are summarised below:

Errors

2.6.2 No scheme related errors have been recorded.

Warnings

2.6.3 114760 warnings were generated, which have been checked and summarised below:

- Ratio of DM to DS travel time *lower* than limit (600 warnings – 42 serious) – these warnings relate to journeys where there has been a large cost change following the introduction of the scheme. A serious warning is flagged when the ratio exceeds TUBA defined levels. In this case the warnings relate to increases in travel time between some origins and destinations as a result of the scheme. Although the ratio of the travel time change is significant, if the travel times are small to start with, a minor increase in travel time would give a large change ratio. As such, the relevant origin destination pairs have been assessed and it was found that, in all cases, the increases in journey times were for short distance trips. All of these warnings were generated by trips in and around Clifton where the

removal of the right turn out facility from side roads along the A453 has lead to a small increase in travel time. The largest absolute value for these was the trips from north of Gotham to Barton-in-Fabis where the travel time increased from 3 to 8 minutes as would be anticipated by the removal of the Barton Lane junction onto the A453. Due to the small absolute values for all of these warnings, they were not considered to highlight any issues with either the transport model or the economic assessment.

- Ratio of DM to DS travel time *higher* than limit (75 warnings – none serious) – these warnings relate to journeys where there has been a large cost change following the introduction of the scheme. In this case the warnings relate to a reduction in travel time between some origins and destinations as a result of the scheme. Again, although the ratio of the travel time change is significant, if the travel times are small to start with, a minor change in travel time would give a large change ratio. A small number of short distance trips were found to have a high ratio change in time between the DM and DS based on improved entry and exit times to side roads in the urban section of the A453 (e.g. less time queuing at a new signalised junction than on the existing give way approach). The largest of these was a five minute time saving for trips utilising the left turn out of Farnborough Road which is an allowed movement provided with the A453W scheme. The only warning flagged up in this section that was not in or around Clifton relate to movements from the University of Nottingham to Attenborough/Beeston which saw a six minute time saving with the scheme. Here, journey times benefited from a reduction in numbers of vehicles due to rerouting of through trips to use the A453 in the DS.
- Ratio of DM to DS travel distance *lower* than the limit (1026 warnings – none serious) – this warning relates to changes in the average route costs causing vehicles to use shorter routes in the Do Something compared to the Do Minimum due to changes in journey time on links and/or at junctions. An increase in the DS distance has been caused by a general shifting of traffic from congested parallel routes such as the A52 to take advantage of the increased capacity of the A453. Also an increase in travel distance is seen for vehicles wanting to turn right onto the A453 from side roads in the urban section having to reroute to perform the manoeuvre. In both cases, the absolute values are considered reasonable (5 miles for the largest ratio change and approximately 11 miles for the largest absolute change)
- Ratio of DM to DS travel distance *higher* than the limit (204 warnings – none serious) – this warning relates to changes in the average route costs causing vehicles to use longer routes in the Do Something compared to the Do Minimum to changes in journey time on links and/or at junctions. A decrease in the level of congestion has caused longer distance rat running trips to re route back onto the A453. Trips rat running to avoid parallel routes such as the A52 also return to more direct routes as trips returning to the A453 have a positive knock on effect on the parallel routes. The

largest ratio change is for a short distance trip (approx 1 mile absolute difference). The largest absolute change is around 14 miles. As such, these results are considered reasonable.

- DM speeds less than the limit (15651 warnings) – this warning relates to movements that experience significant delay in the Do Minimum scenario. The average speed of vehicles between some Origin-Destination pairs is considered low. This warning related to three different groups of vehicles. The first constituted most of the warnings are relates to vehicles having to queue to access or leave East Midlands Airport (EMA). The committed development information supplied indicated a significant increase in the number of trips going to/from EMA and this has been reflected in the increase in congestion. The second and third groups are small numbers of trips which have to queue to leave the zones covering Loughborough and East Derby predominantly in the 2027 and 2031 scenarios.
- DS speeds less than the limit (15651 warnings) – this warning relates to movements that experience significant delay in the Do Something scenario. The average speed of vehicles between some Origin-Destination pairs is considered low. These warnings again predominantly relate to the increase in congestion due to an increase in trips to/from EMA and are a duplicate of the DM speed less than the limit wanting. As such, these do not invalidate the TUBA assessment.
- DM/DS speeds higher than the limit (927 warnings for the DM and 924 warnings for the DS) – These warnings relate to movements that require speeds that exceed 70mph. In VISUM, it is possible to allow some vehicles to travel at speeds closer to observed values e.g. higher than 70mph on motorways. This is highlighted as a warning in TUBA but does not detrimentally affect the model.
- DM/DS time greater than the limit (39875 warnings for DM and 39827 warnings for DS) – this warning is generated for high journey times and cover two sets of data. The first set are journey times relating to trips to/from East Midlands Airport as discussed above. The second set is concerned with Public Transport (PT) trips. In the Visum model, the PT demand segment also covers the “slow mode” sections of the full PT trip e.g. includes the time to walk to a bus stop and waiting time at the stop. For large external zones with no regular PT service, a journey time is generated based on walk times between zones. This is obviously a very long journey and hence flags a warning in TUBA. As these are consistent between the DM and DS, and do not necessarily relate to any actual trips, they are not considered a problem.

2.6.4 The warnings have been analysed and are not considered a cause for concern.

2.6.5 The TUBA output files are included in **Appendix E**.

2.6.6 Average vehicle travel time differences along the A453 between M1 Junction 24 and the A6019 in central Nottingham are given for the 2012 opening and 2027 design years in **Appendix F**. This route corresponds to the A453 journey time

route as presented in the Transport Forecasting Report. These show that, in all cases, there is a reduction in travel times along the A453, in both directions.

2.6.7 Link based travel time differences for the wider area between the Do Minimum and Do Something for each peak, modelled year and vehicle type are also given diagrammatically in **Appendix F**. These show a range of differences between the Do Minimum and Do Something scenarios which can be attributed to the different routing behaviour exhibited by vehicles due to the A453W scheme. (The diagrams do not include any time differences at nodes as these are difficult to illustrate over the larger area but are included in the TUBA assessment.)

2.6.8 The results have been analysed to highlight particular areas where benefits or dis-benefits are incurred.

2.6.9 The results indicate that the majority of the benefits are derived from short distance movements into and out of zones in central Nottingham, the Clifton area and longer distance trips generated to the west of the M1.

2.7 ECONOMY ASSESSMENT RESULTS – INDICATIVE FUNDING FIGURE

2.7.1 The TUBA process is as follows:

- Calculation of costs and benefits for each time period modelled
- Expansion of the time periods to annual totals for the modelled years
- Expansion of the annual totals to appraisal period totals
- Results are then presented in the form of comprehensive output tables including Do Minimum and Do Something total user costs and VOT, VOC benefits by category and year
- Summary data is provided in three tables:
    - Table 1- Transport Economic Efficiency (TEE);
    - Table 2- Public Accounts (PA); and
    - Table 3- Analysis of Monetised Cost and Benefits (AMCB).

2.7.2 The TEE, PA and AMCB results from TUBA have been summarised as the WebTAG TEE worksheets attached as **Appendix G** (these worksheets incorporate, for completeness, the results from the Safety and QUADRO assessments detailed in Sections 3 and 4 respectively).

2.7.3 The results of the TUBA assessments are summarised below using the Indicative Funding costs discounted to a 2002 present value year, in 2002 prices:

- PVC = £93.117m
- PVB = £217.375m (made up of £71,740m consumer user, £148,098m business user benefits and -£2.463m carbon dis-benefit)

2.7.4 The results above demonstrate that the scheme provides high benefits over the 60 year appraisal period which is primarily due to journey time savings with the scheme.

2.8 ECONOMY ASSESSMENT RESULTS – SENSITIVITY TEST USING ECI COST

2.8.1 The results from TUBA using the ECI construction costs have been summarised in the WebTAG TEE, PA and AMCB worksheets attached as **Appendix H** (these worksheets incorporate, for completeness, the results from the Safety and QUADRO assessments detailed in Sections 3 and 4 respectively).

2.8.2 The results of the TUBA assessments using the ECI construction cost estimate discounted to a 2002 present value year, in 2002 prices are:

- PVC = £70.499m
- PVB = £217,375m (made up of £71,740m consumer user, £148,098m business user benefits and -£2.463m carbon dis-benefit)

2.8.3 The results above demonstrate that the scheme provides high benefits over the 60 year appraisal period which is primarily due to journey time savings with the scheme.

2.9 OPTIMISM BIAS SENSITIVITY TESTING

2.9.1 In accordance with WebTAG Unit 3.5.9, sensitivity tests using different assumptions for Optimism Bias have been carried out for the ECI contractor costs. This has not been carried out for the IFF costs as Optimism Bias is no longer used in the calculations. **Table 3** below illustrates the resultant Present Value Costs using a range of percentages. Please note, the Net Present Value (NPV) presented is for user benefits only and does not include savings in terms of accidents or delays during construction and maintenance:

Optimism Bias (%)	Optimism Bias (£k)	PVC (£k)	PVB (£k)	NPV (£k)
0%	0	65,127	217,375	152,248
7.08%	6,741	70,499	217,375	146,876
15%	14,281	76,508	217,375	140,867
30%	28,562	87,888	217,375	129,487
44%	41,892	98,510	217,375	118,865

Table 3 – Optimism Bias Testing

2.9.2 As can be seen from the table above, a change in the percentage assumed for optimism bias produces a similar change in the Present Value Cost. An increase in the scheme cost therefore reduces the overall Net Present Value. The use of a worst case (44%) Optimism Bias still gives a significant benefit in terms of NPV (£119m) and a BCR of 2.2.

3. SAFETY ASSESSMENT

Summary

- A spreadsheet COBA based methodology has been used to assess the Safety benefits to allow specification of alternative carriageway link types.
- Predicted accident rates for 4 lane single carriageway link types have been derived from observed data at existing sites.
- For the assessment, the opening year of 2012 and a 60 year assessment period have been used.
- Results from the safety assessment have been analysed to produce estimates of accident savings benefits of £50.9m.

3.1 INTRODUCTION

3.1.1 Two alternative approaches were carried out by Pell Frischmann for the safety assessment prior to the updating of the A453W transport model. The latest (September 2005) was carried out using the Cost Benefit Appraisal (COBA 11 version 6) programme to derive the accident benefits for the scheme.

3.1.2 COBA is a link and junction based economic assessment software programme and is the standard assessment package for the safety assessment. However, the COBA model area covered by the Pell Frischmann model was of limited size covering only the scheme extents and therefore potentially under or over estimated the Safety (dis)benefits for the wider area. Furthermore, COBA uses predefined link classifications to predict accident rates. These predefined classifications do not cover the 4 lane single carriageway road type proposed for the urban section of the scheme, so an alternative road type was used within the model to predict accident rates. However, this approach created considerable potential for over or underestimation of (dis)benefits.

3.1.3 To try to remove the potentially erroneous assumption, an alternative methodology was initially carried out by Pell Frischmann using spreadsheet calculations following the COBA methodology. This allowed alternative predicted accident rates to be used but again covered a limited area.

3.1.4 For the purposes of this economic assessment work the spreadsheet methodology has been adopted. As agreed with the Highways Agency and Pell Frischmann, the assessment area has been expanded to cover the alternative routes to the A453 in the study area and the local roads around the A453 in addition to the scheme. The area covered is illustrated in **Figure 1**.

3.2 INPUT DATA

3.2.1 The procedure carried out by the spreadsheet assessment to derive the accident benefits of the scheme and immediate study area has followed the process used by the COBA program.

3.2.2 As in COBA, the opening year (2012) forecast traffic flows for Do Minimum and Do Something scenarios, output from the traffic model and converted to Annual Daily Traffic (AADT), have been used as a basis for assessment. Further, the intermediate year (2017), design year (2021) and economic projection year (2031) traffic flows have also been specified. Traffic flows between these years have been assumed to grow linearly and hence interpolation has been applied to derive each individual year traffic flows between 2012, 2017, 2027 and 2031 for each link.

3.2.3 Central Growth forecasts derived from the National Road Traffic Forecasts (NRTF 1997) were used to forecast the flows over the 60 year assessment period post 2031 in line with latest Government guidelines. Zero growth has been assumed post 2036 in line with current NRTF assumptions.

3.2.4 The first scheme year is 2012 and with a 60 year assessment period, the horizon year is 2071.

3.2.5 Accident data from the Report of Transport Surveys Accident Addendum (A021959-REP-T-SA-114 Rev 2) have been input for the Do Minimum (DM) links and nodes where available covering the five year period from 2003 to 2007 (inclusive). Default COBA accident rates have been used where observed accident data is not available, for example on the proposed M1 Widening Contract 2 links. The same observed accident data have been carried through into the Do Something (DS) for all links and nodes in the DM remaining unchanged by the scheme to ensure a like for like comparison with the Do Minimum scenario.

3.2.6 Calculations have been carried out using a combined link and junction methodology. Due to the extent of the safety study area, no account of 'bendiness' and/or 'hilliness' has been made.

3.2.7 Predicted accident rates and severity splits for the 4 lane single carriageway have been derived from observed data collected from existing sites across the UK and are shown in **Table 4**. The methodology employed to derive them is detailed in the technical note "4-Lane Single Carriageway Accident Rates", Ref: A021959-REP-T-EC-141. The reduction factor, Beta, could not be derived from the data set collected. As such, the Beta factor for single 2 lane carriageway has been used as the COBA S2 rate was closest to that observed for S4 and was hence deemed most appropriate.

Casualties	Factor (0<n<1)
Fatal	0.0067
Serious	0.1275
Slight	0.8658
Rate (accidents per year)	**0.4884**

Table 4 – S4 Accident Rate and Severity Split (2004 Base)

3.2.8 The COBA process is as follows:

- Calculation of predicted million vehicle kilometres for each year between the input modelled opening year and the horizon year for both Do Minimum and Do Something.
- Calculation of predicted accident rates for each year between the modelled opening year and the horizon year for both Do Minimum and Do Something.
- Calculation of the predicted number of accidents for each year between the modelled opening year and the horizon year for both Do Minimum and Do Something.
- Evaluation of the cost of the predicted accidents for each year between the modelled opening year and the horizon year for both Do Minimum and Do Something.
- Summary of the predicted accident costs over the 60 year appraisal period for both Do Minimum and Do Something.
- Summary of the overall benefit or dis-benefit of the scheme in terms of accident cost by calculating the difference between the Do Minimum and Do Something predicted costs.

3.2.9 Details of all calculations are included in **Appendix I.** The results for the safety analysis are summarised in **Table 5** below and included in the TEE Tables in **Section 5**.

Scenario	Number of Accidents	Accidents by Severity		Cost £m
		KSI	Slight	
Do Minimum	30340	4267	26073	1543.6
Do Something	29887	4092	25795	1492.7
Accident Savings	**453**	**175**	**278**	**£50.9m**

Table 5 – Accident Saving Summary

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002,
(ii) KSI stands for killed or seriously injured.

3.2.10 Analysis of the results indicates a significant benefit in terms of a reduction in accidents across the study area. **Figures 2** and **3** show the location of predicted differences in number of accidents between the Do Minimum and Do Something for the A453 and the wider area respectively.

3.2.11 The largest savings in terms of numbers and costs of accidents are on the local roads in the A453 area between the M1 and Clifton Boulevard and on the M1 itself. This is due to reductions in the traffic flows on these routes, which have a high accident rate and reductions in the traffic flows on alternative, longer distance routes.

4. CONSTRUCTION AND MAINTENANCE DELAY ASSESSMENT

Summary

- QUADRO has been used to assess construction delay costs and maintenance delay savings.
- For the assessment, the 2012 opening year for construction and a 60 year assessment period for maintenance have been used.
- The Do Minimum (without scheme) and Do Something (with scheme) maintenance costs have been evaluated.
- The Do Something construction delay costs have been evaluated.
- Results from the QUADRO indicate a construction dis-benefit of £11.0m and a maintenance benefit of £57.0m giving an overall benefit of £46.0m.

4.1 INTRODUCTION

4.1.1 The software program QUADRO 4 Release 6 program was used to calculate the economic dis-benefits due to traffic delays experienced during construction of the scheme and the economic benefits from ongoing maintenance over a 60 year period.

Construction

4.1.2 QUADRO was used to assess the effects of construction delays due to the proposed roadworks over the 31 month construction period starting in spring 2010 and ending winter 2012.

Maintenance

4.1.3 QUADRO was also used to assess the effects of maintenance delays on the existing highway (Do Minimum) and proposed highway (Do Something) over a sixty year period. In the case of the Do Minimum scheme, the maintenance program was assumed to start between years 2010 and 2015, and for the Do Something scheme, the maintenance programme was assumed to start in 2022. The results presented include the accident effects during maintenance and construction.

4.2 CONSTRUCTION DELAY COSTS

4.2.1 The route was subdivided into sections based on an assumed construction profile developed by Laing O'Rourke as shown in **Appendix J**. For the on - line section construction it was generally assumed that a new southbound carriageway would be constructed with two way traffic remaining on the existing road. Upon completion the traffic would be transferred to the new road prior to allow reconstruction of the existing road. For the off - line section, it has been assumed that the new carriageway would be constructed with two way traffic remaining on the existing road.

Traffic Input

4.2.2 Existing 2006 24 hour AADT flows taken from the Report of Transport Surveys (A021959-Rep-T-SA014). The flow along each section was calculated by taking a weighted average where necessary. Details are shown in **Appendix K**.

4.2.3 Default seasonality and vehicle category proportions were used.

Highway Input

4.2.4 The scheme length was subdivided into sections according to the most appropriate diversion point and scheme lengths. Carriageway characteristics were based on a mix of road measurements and default values. Details are shown in **Appendix L**.

4.2.5 Delay calculations assume a 50mph speed limit along the rural section and a 30mph speed limit along the urban section compared to existing 60mph speed limit over the rural section and 40mph over the urban section. The speed limits were applied during the construction period for each section.

Delays at Junctions

4.2.6 The QUADRO methodology does not assess in detail delays at junctions caused during construction. An assessment was made of the construction programme and, where particular items in the construction programme would be likely to cause significant delays at junctions that would not be covered by QUADRO, further assessment would be undertaken if appropriate. A dialogue of the findings of the assessment is covered in the construction profile developed by Laing O'Rourke shown in **Appendix J**.

Construction Delay Profile

4.2.7 In the case of both the urban and rural sections the maximum queuing delay option was used to model and control delays likely during maintenance works. Adoption of a maximum delay value of 15 minutes has been assumed which is considered to represent a reasonable delay along this section of road.

Results

4.2.8 The construction delay results are shown in **Appendix O** and summarised in **Table 6**. It can be seen that the overall delay costs during construction are around £11.0 million.

Location	User Costs (£'000's)	Capital Works Costs (£'000's)	Total Costs (£'000's)
Urban Section	4,718	-13	4,705
Rural Section	6,304	-10	6,294
TOTAL DELAY COST	**11,021**	**-23**	**10,998**

Table 6 - Construction Delay Costs

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002
(ii) 3.5% discount factors are used in assessment

4.3 MAINTENANCE DELAY COSTS

4.3.1 The route was subdivided into sections based on a maintenance profile spread over a 5 year period to spread maintenance delays as advised by the maintenance contractors for the Highways Agency as shown in **Appendix N**.

Traffic Input

4.3.2 The traffic flows along each section were taken from the Report of Transport Surveys (A021959-Rep-T-SA014), and calculated by taking a weighted average where necessary. Existing 2006 AADT flows were input for the Do Minimum and Do Something assessments as shown in **Appendix M**.

4.3.3 Default seasonality and vehicle category proportions were used.

Highway Input

4.3.4 The scheme length was subdivided into sections according to the most appropriate diversion point for each of the Do Minimum and Do Something schemes. In the case of the Do Minimum situation, the carriageway characteristics were based on a mix of road measurements and default values. The Do Something carriageway characteristics were based on default values. Details are shown in **Appendix L.**

Capital Costs and Maintenance Durations

4.3.5 The default maintenance cost and duration profiles in DMRB Volume 14 were assumed for the Do Minimum and Do Something options.

4.3.6 In the Do Minimum scheme, it was assumed that maintenance works will require weekend road closures to be undertaken between 21.00 on Friday and 06.00 on Monday. In the Do Something scheme, it was assumed that maintenance works will require closure of each carriageway in turn and contra flow working on the live carriageway will require weekend road closures to be undertaken between 21.00 on Friday and 06.00 on Monday.

Maintenance Delay Profile

4.3.7 In the Do Minimum situation, it has been assumed that a single lane shuttle system will be used along the urban section of the scheme with a 30 mph speed limit along the site and approach lengths. The Do Something maintenance profile urban section assumes single lane contra-flow will be in operation with a 40 mph speed limit in operation.

4.3.8 In the case of the urban section the maximum queuing delay option (set to 15 minutes) was used to model and control delays likely during maintenance works. In the case of the rural section a preferred diversion route via the M1 and A52 was assumed during maintenance works.

Results

4.3.9 The maintenance delay results are shown in **Appendix M** and summarised in **Table 7**. It can be seen that the overall benefits during the 60 year maintenance period are around £57 million.

User Costs	Capital Works Costs (£'000's)	User Costs (£'000's)	Total Costs (£'000's)
Do Minimum	1,673	86,745	**88,418**
Do Something	6,961	24,446	**31,407**
TOTAL MAINTENANCE SAVINGS			**57,012**

Table 7 - Maintenance Delay Savings

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002
(ii) 3.5% discount factors are used in assessment

4.4 COMBINED DELAY COSTS AND MAINTENANCE DELAY BENEFITS

4.4.1 **Table 8,** below, provides a summary of the overall maintenance and construction impacts:

	Total
Government Funding	
Investment Costs (Maintenance Works Costs)	1,245
Indirect Tax Revenues	4,019
Present Value of Costs	5,264
Non-Exchequer Impacts	
Net Consumer Impact	24,379
Net Business Impact	20,325
Accident Costs	5,043
Carbon Emission Costs	1,531
Total Non-Exchequer Impacts	51,278
OVERALL IMPACT	**46,013**

Table 8 - Summary Maintenance Delay and Construction Impacts

4.4.2 This shows that, overall, the scheme provides a positive benefit in terms of maintenance delay savings.

4.4.3 The results for the QUADRO analysis are included in the TEE Tables in **Section 5**.

5. COMBINED ECONOMIC ASSESSMENT RESULTS

5.1.1 The TUBA, Safety analysis and QUADRO results from the previous sections have been combined and the Appraisal Summary Tables included in **Appendix H** and are summarised in **Tables 9** and **10** below. (Please note that all subtotals are calculated prior to rounding and as such, the rounded figures presented in this section and in **Appendix H** may appear to be marginally out when summing from these values).

5.1.2 The Net Present Value Costs have been made up as shown in **Table 9** below:

Source		Cost £k
Local Government Funding		0
Central Government Funding	Investment Costs	111,518
Central Government Funding	Indirect Tax Revenues	-13,137
Total Present Value of Costs (PVC)		98,381

Table 9 – Public Accounts (Indicative Funding Figure Cost)

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002
(ii) Please note: totals are calculated prior to rounding

5.1.3 This gives the combined TUBA, Safety and QUADRO results in **Table 10** below.

	£k
Consumer User Benefits	96,119
Business User Benefits	168,423
Carbon Benefits	-932
Accident Benefits	55,954
Net Present Value Costs (PVC)	98,381
Net Present Value of Benefits (PVB)	319,563
Net present Value (NPV) [PVB - PVC]	221,182
Benefit to Cost Ratio (BCR) [PVB ÷ PVC]	**3.25**

Table 10 – Combined TUBA, Safety and QUADRO Analysis Results (Indicative Funding Figure Cost)

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002
(ii) Please note: totals are calculated prior to rounding

5.1.4 As can be seen from the table above, the largest benefits are gained from the time savings to businesses and consumers.

5.1.5 The BCR has been presented for information purposes only but can be used as a guide to indicate whether the scheme meets it's objectives in terms of safety and economy and in accordance with the DfT guidance on Value for Money (15th December 2004). The specification by the DfT is that a scheme provides high value for money if the BCR exceeds the criteria of 2.

5.1.6 If the combined assessment is carried out using the ECI costs and the TUBA, Safety analysis and QUADRO results from the previous sections the results can be summarised as follows (Full results in **Appendix I**):

5.1.7 The Net Present Value Costs have been made up as shown in **Table 11** below:

Source		Cost £k
Local Government Funding		0
Central Government Funding	Investment Costs	88,900
Central Government Funding	Indirect Tax Revenues	-13,137
Total Present Value of Costs (PVC)		75,763

Table 11 – Public Accounts (ECI costs)

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002
(ii) Please note: totals are calculated prior to rounding

5.1.8 This gives the combined TUBA, Safety and QUADRO results in **Table 12** below.

	£k
Consumer User Benefits	96,119
Business User Benefits	168,423
Carbon Benefits	-932
Accident Benefits	55,954
Net Present Value Costs (PVC)	75,763
Net Present Value of Benefits (PVB)	319,563
Net present Value (NPV) [PVB - PVC]	243,800
Benefit to Cost Ratio (BCR) [PVB ÷ PVC]	**4.22**

Table 12 – Combined TUBA, Safety and QUADRO Analysis Results (ECI Costs)

NB: (i) All costs are £ thousands 2002 prices, discounted to 2002
(ii) Please note: totals are calculated prior to rounding

5.1.9 As can be seen from the table above, the largest benefits are gained from the time savings to businesses and consumers.

5.1.10 Again, the BCR has been presented for information purposes only but can be used as a guide to indicate whether the scheme meets it's objectives in terms of safety and economy and in accordance with the DfT guidance on Value for Money (15th

December 2004). The specification by the DfT is that a scheme provides high value for money if the BCR exceeds the criteria of 2.

6. CONCLUSION

Summary

- Time and Vehicle Operating Cost benefits have been assessed using TUBA.
- Safety benefits have been assessed using spreadsheet calculations based on the COBA methodology.
- Maintenance benefits and construction delay costs have been assessed using QUADRO.
- Results have been summarised in AST and TEE tables. This gives the following results discounted to a 2002 present value year, in 2002 prices:
  - Present Value Costs (PVC): £98.4m,
  - Present Value of Benefits (PVB): £319.6m,
  - Net Present Value (NPV): £221.2m; and
  - Benefit to Cost Ratio (BCR): 3.3
- Results using the ECI Costs as a sensitivity test have been summarised in AST and TEE tables. This gives the following results discounted to a 2002 present value year, in 2002 prices:
  - Present Value Costs (PVC): £75.8m,
  - Present Value of Benefits (PVB): £319.6m,
  - Net Present Value (NPV): £243.8m; and
  - Benefit to Cost Ratio (BCR): 4.2

6.1.1 This report has presented the methodology employed for the economic appraisal of the proposed A453 Widening M1 Junction 24 to A52 Nottingham. The following programs have been used to assess the different benefits and dis-benefits of the scheme:

- Transport User Benefit Appraisal (TUBA version 1.7b);
- Safety Cost Benefit Appraisal using spreadsheet calculations based on the COBA 11 methodology; and
- Queues and Delays at Roadworks (QUADRO 4 release 6).

6.1.2 All the work has been carried out in accordance with DMRB and WebTAG guidance.

6.1.3 For the assessment, the 2012 opening year, 2017 intermediate year, 2027 design year, 2031 economic projection year and a 60 year assessment period have been used.

6.1.4 The results from the economic assessment have been input to the Appraisal Summary Tables (AST) with the Transport Economy Efficiency (TEE) table using the following sub headings:

- Consumer User Benefits;

- Business Benefits;
- Safety Benefits;
- Maintenance Savings; and
- Construction Delay Costs.

6.1.5 These have been combined to give the following (discounted to a 2002 present value year, in 2002 prices):

- Net present Value Costs (PVC): £98.4m,
- Net present Value of Benefits (PVB): £319.6m,
- Net present Value (NPV): £221.2m; and
- Benefit to Cost Ratio (BCR): 3.25

6.1.6 The BCR has been presented for information purposes only but can be used as a guide to indicate whether the scheme meets it's objectives in terms of safety and economy and in accordance with the DfT guidance on Value for Money (15th December 2004) based on the specification by the DfT that a scheme provides high value for money if the BCR exceeds the criteria of 2.

6.1.7 A sensitivity test was carried out using construction costs supplied by the ECI contractor. The above results from the TUBA QUADRO and Safety assessment have been summarised using the ECI costs to give the following results:

- Net present Value Costs (PVC): £75.8m,
- Net present Value of Benefits (PVB): £319.6m,
- Net present Value (NPV): £243.8m; and
- Benefit to Cost Ratio (BCR): 4.22

FIGURES

Appendix A – TUBA Economic Parameters File with Additional Data

Appendix B – Annualisation Factor Calculations

Appendix C – Indicative Funding Cost Summary

Appendix D – ECI Scheme Cost Summary (Annex 1)

Appendix E – TUBA Output Files (Enclosed on Disc)

Appendix F – Travel Time Differences

Appendix G – TEE Worksheets (Indicative Funding Costs)

Appendix H – TEE Worksheets (ECI Costs)

Appendix I – Spreadsheet Safety Analysis (Enclosed on Disc)

Appendix J – Draft Construction Methodology and Programme

Appendix K – QUADRO Input Traffic Flows (By Section)

Appendix L – QUADRO Construction Delay Input

Appendix M – QUADRO Construction Delay Results (Enclosed on Disc)

Appendix N – QUADRO Maintenance Delay Input

Appendix O – QUADRO Maintenance Delay Results (Enclosed on Disc)