Lincoln Eastern Bypass

Economic Appraisal Report

October 2016

Produced By

Lincolnshire County Council Highways Alliance

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1 Introduction

1.1 Introduction

Lincoln Eastern Bypass (LEB) is proposed as a 7.5km single carriageway road linking the existing A158 Northern Relief Road to the A15 Sleaford Road to the south, running through an area of predominantly arable farmland to the east of the city and the villages of Canwick and Bracebridge Heath, and to the west of the outlying villages of North Greetwell, Cherry Willingham, Washingborough and Branston.

The road is a key element of the Lincoln Integrated Transport Strategy (LITS) designed to provide much needed relief to the congested historic core of Lincoln and to permit a range of complementary policies, also identified in LITS, on traffic management and sustainable modes to be introduced to the city, thereby improving traffic and environmental conditions for a wide range of road users.

1.2 Background

Mouchel has been commissioned under the Lincolnshire County Council (LCC) Technical Services Partnership to produce an updated set of models, forecasting and appraisal work in support of the Best and Final Offer Business Case for the Lincoln Eastern Bypass (LEB).

The original modelling and appraisal was prepared by Jacobs to support the first Major Scheme Business Case (MSBC) submission for the scheme at Programme Entry stage. However a subsequent assessment by the Department for Transport (DfT) highlighted a number of substantive issues relating to the quality and suitability of the modelling work.

Mouchel addressed these issues to the satisfaction of the DfT and the scheme gained Funding Approval following submissions in 2011.

Following this two public inquiries related to DCO and SRO were conducted. Following this Mouchel embarked on the Final Funding Submission where updates from the public inquiry were included together with the latest assumptions on values of time and growth, together with some refinements to confirm and enhance the forecast quality of the model. The work reported here refers to and builds on this previous work.

The provision of LEB is to achieve three main objectives, these are as follows:

Objective 1: To support the delivery of sustainable economic growth and the Growth Point agenda within the Lincoln Policy Area (LPA) through the provision of reliable and efficient transport infrastructure.

Objective 2: To improve the attractiveness and liveability of central Lincoln for residents, workers and visitors by creating a safe, attractive and accessible environment through the removal of strategic through traffic (particularly HGVs).

Objective 3: To reduce congestion, carbon emissions, improve air and noise quality within the LPA, especially in the Air Quality Management Area in central Lincoln, by the removal of strategic through traffic (particularly HGVs).

1.3 Structure

This report describes the methods employed in the economic evaluation of the project. The topics covered are detailed below:

- Chapter 2 – Forecast and Appraisal Requirements;
- Chapter 3 – Value for Money Appraisal Update;
- Chapter 4 – Scheme Appraisal;
- Chapter 5 – Sensitivity tests; and,
- Chapter 6 – Summary and Conclusion.

2 Forecasting and Appraisal Requirements

2.1 Introduction to Forecasting

Forecasting the usage and performance of transport networks is a critical component of any transport appraisal. The principal purpose in the development of the future year traffic forecasts is to support the continuing LCC funding bid for the LEB scheme. This chapter describes the various requirements of the forecasting and appraisal process for LEB Improvements. These include the prediction of the future year travel demands and the assumptions relating to changes in the future year highway network.

The forecasting model has been developed in accordance with guidance provided by the DfT in the TAG series of documents. As the modelling for this project commenced some time ago the provenance of the modelling system is anchored within the guidance of the day. The model has been updated on a proportionate basis to take account of the salient elements of guidance subsequent to the initial inception of the project to arrive at the current status.

2.2 Travel Demand Scenarios

The principal requirement of the traffic model was the provision of traffic forecasts for the LEB scheme for the Opening year (2018) and Design year (2033). Future travel demands at these dates take into account the existing traffic flows together with the effects of traffic growth and the additional traffic due to new development activity.

The growth in traffic derives largely from increased incomes and reducing household sizes, and economic activity. Increasing personal income combined with reducing household size leads to an increase in car availability and car usage. The growth in economic activities leads to a redistribution of traffic and increased levels of goods vehicle journeys.

New development of residential, retail and employment land-uses in the Lincoln area will also create further demand for travelling. These factors need to be taken into account in the prediction of future travel demands in the wider Lincoln area.

There are several development schemes which are dependent on LEB scheme. These are presented in a separate development test.

The assumptions adopted in the derivation of the future travel demands for the wider Lincoln area are documented in the Forecasting Report

The future year traffic models must take into account the effects of other highway or traffic management schemes that are likely to be in place by the scheme's Opening and Design years. Information in relation to future highway/traffic management schemes was provided by LCC. The highway and traffic management schemes that have been adopted in the future year traffic models are discussed in detail in the Forecasting Report.

2.3 Requirements for Scheme Appraisal

A cost-benefit assessment was required to estimate the value for money provided by the proposed scheme. The chosen tool for this part of the project was TUBA (Transport User Benefit Analysis), a computer program developed for the Department for Transport (DfT) to undertake the appraisal of highway schemes and multi-modal transport studies.

The accident benefits resulting from the introduction of a proposed highway scheme formed a significant part of the cost-benefit assessment. The TUBA software estimates the economic benefits of a scheme based on zone-to-zone travel costs and therefore it cannot take into account link based accident costs. The evaluation of the benefits due to changes in accident costs was therefore performed by COBALT software.

3 Value for Money Appraisal Update

3.1 Introduction to VfM

This section provides a brief overview of the procedures followed in deriving the economic assessment for the Lincoln Eastern Bypass scheme (LEB).

3.2 Economic Appraisal Requirements

The elements included in the value for money assessment are summarised below. In all cases, these individual economic assessments were based on comparisons of Do-Minimum and Do-Something traffic model forecasts at specified years. The assessments have completed for the **Core** scenario. The alternative scenarios are considered in terms of user benefits only (accident benefits excluded). Roadworks and maintenance costs have not been included.

Table 3-1 – Value for Money Appraisal

VfM Element	Description	Update
Scheme Costs	Costs including construction, land, preparation and supervision are incorporated in the economic assessment and discounted to a common (2010) price base (in TUBA).	Updated scheme costs based on tender price from preferred contractor Discounted to 2010 base price Revised Optimism bias
User Benefits	Time savings, fuel vehicle operating costs (VOC), non-fuel VOC, Operator and Government revenues assessed using TUBA)	Based on revised outputs from Lincoln Traffic Model Uses TUBA v1.9.5
Accident Benefits	COBALT compatible analysis based on accident rates and vehicle kilometres	Based on updated accident values and traffic outputs

3.2.1 Annualisation of Benefits

The benefits of the scheme are calculated separately using each of the appraisal models. All traffic model outputs relate to a 12-hour weekday average, derived from the three individual period models. Outputs are in all cases converted from the weekday traffic model outputs to a yearly output using an annualisation factor. The TUBA appraisal also includes off-peak and weekend periods. Inputs to COBALT, were converted from the model peak periods to AADT using appropriate factors

3.2.2 Appraisal Period

The economic appraisal was carried out over a 60-year period, from 2018 (Opening Year) to 2078, in accordance with the DfT guidance. Earlier years have a greater influence on the economic outcome.

3.3 LEB Scheme Costs Update

The updated scheme costs are detailed in Table 3-2 and are based on the tender price from preferred contractor.

Table 3-2 – Lincoln Eastern Bypass Scheme Cost

Cost Area	Base Costs
Preparation Fees	£7,261,386
Supervision Fees and Testing	£4,276,712
Construction tender	£52,953,475
Enabling Works	£100,000
Statutory Undertakers	£4,785,774
Archaeology	£1,978,546
Land	£2,000,000
Land drainage mitigation	£35,739
Risk	£6,086,000
Network Rail Spalding Bridge	£14,474,810
Other misc costs	£500,000
Preparation Fees	£7,261,386
Total	**£94,452,442**

3.3.1 Quantified Risk Assessment & Optimism Bias

The impact of inflation and optimism bias has been updated as part of this appraisal. As described above the base scheme costs are based on the preferred tender price where the inflation risk has been transferred to the preferred contractor.

In addition a revised optimism bias has been applied to adjust the base costs identified in Table 3-3. The approach set out in TAG Unit A1.2 identifies that based on the fact that the scheme is at the Full Approval Stage an optimism bias of 3% is appropriate.

Inflation was only added to site supervision, all other costs being via target cost tender or already fixed. The figures below were converted from £ of the day (2016) to 2010 values

Table 3-3 – Impact of Inflation and Optimism Bias

Cost Estimate Uplift	Package Costs
Optimism Bias	3%
Base Costs + OB + Inflation	£97,571,179
Base Costs + Optimism Bias	£97286015
Base Costs	£94,452,442

3.3.2 Scheme Cost Profile

The revised scheme cost profile based on the current scheme programme is set out in Table 3-4 below.

Table 3-4 – Lincoln Eastern Bypass Scheme % Expenditure Profile Including OB

Year	Construction	Land	Preparation	Supervision
2011	0	0	1	0
2012	0	0	3	0
2013	0	0	5	0
2014	0	0	8	0
2015	0	0	10	0
2016	0	39	14	0
2017	2	40	23	13
2018	36	21	12	35
2019	44	0	12	35
2020	18	0	12	17
Total	**100**	**100**	**100**	**100**

3.4 Assessment of User Benefits

The following section provides an overview of the TUBA economic assessment, including the key inputs and parameters used within the assessment and the outputs and results.

3.4.1 Scheme Parameters File – Main Parameters

Table 3-5 below shows the main parameters that have been used in the TUBA scheme file.

Table 3-5 – Parameters for Do Something Option

Parameter	Option – Do-Something
TUBA Version	v1.9.5
First Year	2018
Horizon Year	2033
Modelled Years	2018 & 2033
Current Base Year	2006

3.4.2 Scheme Parameters File – Time Slices

The time slices that were used in the TUBA model are set out below.

Table 3-6 – TUBA Time Slices

Period	Time
AM Peak	08:00 – 09:00
Average Inter Peak hour	10:00 – 16:00
PM Peak	17:00 – 18:00
Off Peak	19:00 – 07:00
Weekends	including bank holidays

Table 3-7 – TUBA Analysis Periods and Corresponding Model Input Periods

TUBA Analysis Periods	Model Input Periods
AM Peak Period (0700-1000)	AM Peak Hour (0800-0900);
Inter-peak Period (1000-1600)	Average Inter-peak Hour (1000-1600)
PM Peak Period (1600-1900)	PM Peak Hour (1700-1800).
Off-Peak Period (1900-0700)	Average Inter-Peak Hour (1000-1600)
Weekend + bank Holiday	Average Inter-Peak Hour (1000-1600)

3.4.3 *User Classes*

Five user classes were used in the TUBA assessment and are listed below:

- User Class 1: Non Work Commute;
- User Class 2: Non Work Non Commute;
- User Class 3: Employers Business ;
- User Class 4: Light Goods Vehicles (LGVs);
- User Class 5: Heavy Goods Vehicles (including OGV1, OGV2 and PSVs).

Table 3-8 below shows the model user classes with the corresponding TUBA matrices. Model user classes 4 and 5 (LGV and HGV) were split into two matrices. The LGV were split into personal and business while the HGV were split into OGV1 and OGV 2 to give more accurate presentation of the purpose split based on standard TUBA values

Table 3-8 – Model Output to TUBA Matrices Conversions

Model User Class	TUBA User Classes	TUBA Input		
		Veh / submode	purpose	Factor Split
1	1	1	2	1.00
2	1	1	3	1.00
3	1	1	1	1.00
4	2	2	0	0.12
4	3	3	0	0.88
5	4	4	0	0.82
5	5	5	0	0.18

3.4.4 *Non Modelled Hours and Annualisation Calculations*

TUBA (Transport User Benefits Assessment) version 1.9.5 (which incorporates the latest DfT values of time in November 2014) was used to provide the benefits of the proposed LEB 60 year appraisal periods (in compliance with WebTAG A.1.1). Sensitivity tests of other Values of Time have been conducted on the economics

The forecast models consist of three modelled periods: AM Peak (08:00-09:00), Inter-Peak (hourly average 10:00-16:00) and PM peak (17:00-18:00). TUBA is however required to be carried out for all periods for the whole year, which includes:

- Weekday AM Peak (07:00-10:00);
- Weekday Inter-Peak (10:00-16:00);
- Weekday PM Peak (16:00-19:00);
- Weekday Night-Time period (19:00-07:00); and
- Weekend and Bank Holiday.

For non-modelled periods (such as Pre-AM (07:00-08:00), Post-AM (09:00-10:00), Inter-Peak (10:00-16:00), Pre-PM (16:00-17:00), Post-PM (17:00-19:00), off-peak and weekend/bank holiday) it is only appropriate to calculate the benefits for hours in which traffic levels are similar to the modelled hours. This has been established with DfT earlier at the BaFB stage. For example, it would not be appropriate to expand the AM peak hour traffic into the AM peak period in the event that traffic was significantly lower in the peak shoulders. TUBA guidance suggests that a conservative approach should be used to identify benefits/dis-benefits for non-modelled periods so that it would represent as close as possible the changes in travel time between Do-Minimum and Do-Something compared to changes between Do-Minimum and Do-Something in the modelled hours.

Observed traffic counts for number of Automatic Traffic Counter locations surrounding Lincoln were collected for two weeks in September-October 2006 for the purpose of base year model validation were also used to obtain the daily traffic profile. Figure 3.1 below provides a summary of the traffic daily profile of traffic within Lincoln. No bank holiday data was included.

Figure 3-1 – Lincoln Traffic Flow Profile

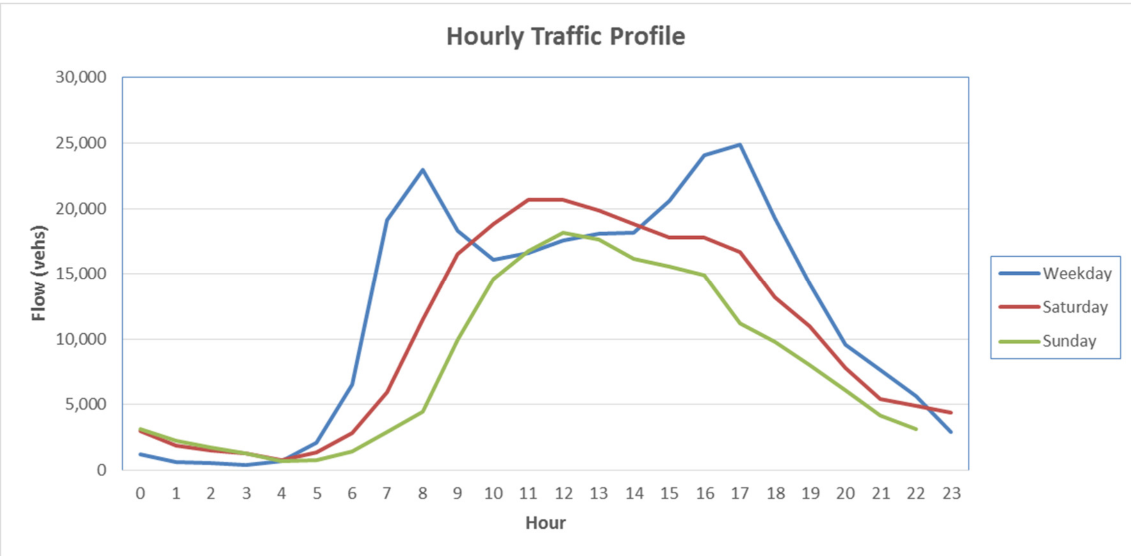


Table 3.9 below provides a summary of traffic flows in Lincoln for weekdays, Saturday and Sunday and also the derivation of the annualisation factors for each modelled period.

Table 3-9 – Derivation of Annualisation Factors

Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid	Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid
Off-Peak	0	1,188	IP	0.07		Sunday	0	3,113	IP	0.17	
	1	642	IP	0.04			1	2,218	IP	0.12	
	2	547	IP	0.03			2	1,759	IP	0.10	
	3	378	IP	0.02			3	1,293	IP	0.07	
	4	692	IP	0.04			4	718	IP	0.04	
	5	2,133	IP	0.12			5	790	IP	0.04	
	6	6,572	IP	0.37			6	1,450	IP	0.08	
AM Peak	7	19,078	IP	1.07	1		7	2,881	IP	0.16	
	8	22,975	AM	1.00	1		8	4,475	IP	0.25	
	9	18,298	IP	1.03	1		9	9,910	IP	0.56	
Inter-Peak	10	16,102	IP	0.90	1		10	14,603	IP	0.82	
	11	16,595	IP	0.93	1		11	16,781	IP	0.94	
	12	17,552	IP	0.98	1		12	18,133	IP	1.02	1
	13	18,063	IP	1.01	1		13	17,618	IP	0.99	1
	14	18,186	IP	1.02	1		14	16,150	IP	0.90	
	15	20,579	IP	1.15	1		15	15,577	IP	0.87	
PM Peak	16	24,044	PM	0.98	1		16	14,902	IP	0.84	
	17	24,871	PM	1.02	1		17	11,202	IP	0.63	
	18	19,289	IP	1.08	1		18	9,797	IP	0.55	
Off-Peak	19	14,265	IP	0.80			19	8,000	IP	0.45	
	20	9,606	IP	0.54			20	6,093	IP	0.34	
	21	7,630	IP	0.43			21	4,180	IP	0.23	
	22	5,668	IP	0.32			22	3,162	IP	0.18	
	23	2,914	IP	0.16			23	1,816	IP	0.10	
Saturday	0	3,025	IP	0.17		Bank Holiday	0		IP		
	1	1,918	IP	0.11			1		IP		
	2	1,524	IP	0.09			2		IP		
	3	1,271	IP	0.07			3		IP		
	4	761	IP	0.04			4		IP		
	5	1,359	IP	0.08			5		IP		
	6	2,808	IP	0.16			6		IP		
	7	5,984	IP	0.34			7		IP		
	8	11,470	IP	0.64			8		IP		
	9	16,521	IP	0.93			9		IP		
	10	18,796	IP	1.05	1		10		IP		
	11	20,696	IP	1.16	1		11		IP		
	12	20,666	IP	1.16	1		12		IP		
	13	19,821	IP	1.11	1		13		IP		
	14	18,785	IP	1.05	1		14		IP		

Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid	Period	Hour	Traffic Flow	Donor Hour	Factor /Donor Hour	Valid
	15	17,810	IP	1.00	1		15		IP		
	16	17,784	IP	1.00	1		16		IP		
	17	16,706	IP	0.94			17		IP		
	18	13,228	IP	0.74			18		IP		
	19	10,980	IP	0.62			19		IP		
	20	7,822	IP	0.44			20		IP		
	21	5,447	IP	0.31			21		IP		
	22	4,942	IP	0.28			22		IP		
	23	4,370	IP	0.24			23		IP		

As can be seen, traffic volume reaches its one hour peak at 08:00-09:00 in the morning. In the PM period, however, traffic volume is at similar level for two hours from 16:00-18:00. It was therefore suggested that only one hour for the AM and two hours for the PM period will be used for the calculation of the benefits for the scheme. This was based on traffic expanded into the Off Peak periods being less than 95% of the traffic within the peak of the period. The Inter peak was taken as a proxy for the off peak. The 95% of flow criteria was also employed for Saturdays and Sundays also with an expansion of the inter peak.

To claim benefits for the non-modelled periods, the following factors were applied for relevant modelled hour benefits, as listed below:

- Weekday AM Period (08:00 – 09:00): 1 x AM Peak modelled hour;
- Weekday Inter-Peak (09:00 – 16:00): 7 x Inter-Peak modelled hour;
- Weekday PM Period (16:00 – 18:00): 2 x PM Peak modelled hour;
- Weekday Off-Peak Period (07:00-08:00 + 18:00 – 19:00): 2 x Inter-Peak modelled hour;
- Saturday (10:00 – 17:00): 7 x Inter-Peak modelled hour;
- Sunday (12:00 – 14:00): 2 x Inter-Peak modelled hour;
- Bank Holiday (11:00 – 13:00): not included

The annualisation factors for each TUBA time period is defined by the number of times the period occurs each year, as below:

- 253 normal weekdays;
- 52 weekends; and
- 8 bank holidays.

The factors obtained from the observed counts above were therefore used to derive the annualisation factors for TUBA assessment. Table 3.10 summarises the annualisation factors to be used for the TUBA analysis. Bank holidays are excluded

Table 3-10 – Annualisation Factors

No	Time Slice	Duration (min)	Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1 x 253 = 253
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7 x 253 = 1,771
3	Weekday PM Period	60	PM Peak Hour model	2 x 253 = 506
4	Weekday Off-Peak period	60	Inter-Peak hour model	2 x 253 = 506
5	Weekend	60	Inter-Peak hour model	9 x 52 = 468

The revised annualisation factors compare against the original annualisation factors which was used for the original Public Inquiry and also in the FABC, as below:

Table 3-11 – Comparative Annualisation Factors

No	Time Slice	Duration (min)	Previous Factors	Revised Factors
1	Weekday AM Period	60	253 x 2.627 = 664	253 x 1 = 253
2	Weekday Inter-Peak Period	60	253 x 6 = 1,518	253 x 7 = 1,771
3	Weekday PM Period	60	253 x 2.724 = 693	253 x 2 = 506
4	Weekday Off-Peak period	60	253 x 0.82 = 209	253 x 2 = 506
5	Weekend	60	52 x 18.88 = 982	52 x 9 = 468

*Note: 0.82 and 18.88 are factors converting off-peak and weekend traffic volume to average inter-peak hour volume

The revised values used in this analysis are conservative in comparison with the earlier information.

3.4.5 *Matrix Data*

Matrices have been extracted from the Lincoln VISUM Model to supply time and distance information for each origin-destination pair, and factored into an acceptable format for use in TUBA. The following time periods were extracted:

- 2018 Do-Minimum AM/IP/PM
- 2018 Preferred Option AM/IP/PM
- 2033 Do-Minimum AM/IP/PM
- 2033 Preferred Option AM/IP/PM

Due to the large volume of data being input into TUBA, a short verification process was required to ensure that the correct matrices had been specified.

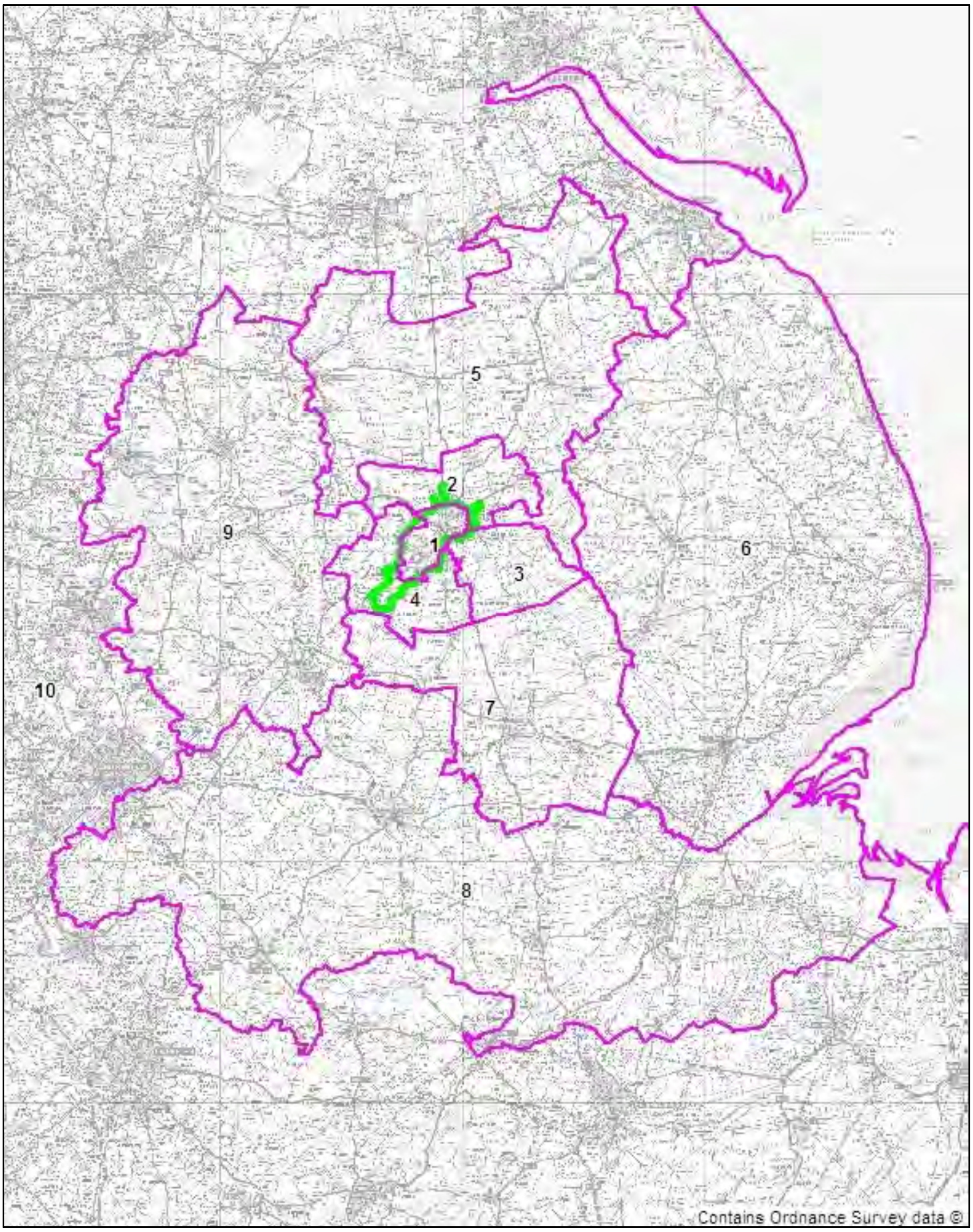
3.4.6 *Sectors*

Ten reporting sectors were developed for the TUBA analysis and these are described in Table below.

Table 3-12 – TUBA Reporting Sectors

Sector	Description
Sector 1	Lincoln City (including all City of Lincoln District and part of North Kesteven District)
Sector 2	Lincoln Planning Area North (within West Lindsey District)
Sector 3	Lincoln Planning Area South East (within North Kesteven District)
Sector 4	Lincoln Planning Area South West (within North Kesteven District)
Sector 5	West Lindsey District
Sector 6	East Lindsey and Boston Districts
Sector 7	North Kesteven District
Sector 8	Rushcliffe, Melton, South Kesteven and South Holland Districts
Sector 9	Bassetlaw and Newark & Sherwood Districts
Sector 10	Rest of England, Wales and Scotland

Figure 3-2 – Sector System



3.5 Output Checks

The TUBA output file details several analyses of the input file to facilitate checking of the runs by highlighting possible errors or inconsistencies within the input data. These warning messages were checked to ensure:

- Matrix totals were consistent;
- High ratios for DS/DM times were justified;

- Low ratios for DS/DM times were justified;
- High ratios for DS/DM distances were justified; and
- Low ratios for DS/DM distances were justified.

Table 3-13 details the number of warnings for the Core Scenario.

Table 3-13 – TUBA Warning Summary

Warning Type	Total	Serious
Ratio of DM to DS travel time lower than limit	10,768	239
Ratio of DM to DS travel time higher than limit	111,410	2,639
Ratio of DM to DS travel distance lower than limit	2,499	9
Ratio of DM to DS travel distance higher than limit	11,363	11,363
DM speeds less than limit for the following	1,191	0
DS speeds less than limit for the following	347	0
Total Warnings	**137,578**	**14,250**

4 Scheme Appraisal

4.1 Scheme Economic Performance

A summary of the revised TUBA outputs are detailed in Table 4-1 below. All Values are in £'000 at 2010 prices and values.

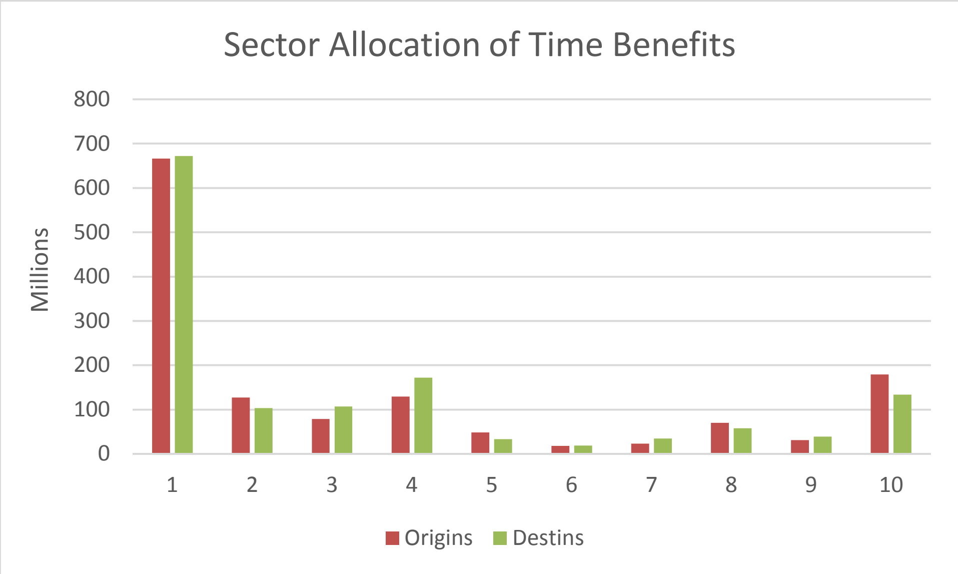
Table 4-1 – TUBA Results Summary Table

Cost and Benefits	Core Scenario
Economic Efficiency	
Consumer User (Commute)	138,722
Consumer User (Other)	596,193
Business User and Provider	754,928
Indirect Tax Revenue	-39,233
Carbon Benefits	15,042
Present Value of Benefits (PVB)	**1,465,652**
Broad Transport Budget	
Investment Costs	79,789
Present Value of Costs (PVC)	**79,789**
Overall Impacts	
Net Present Value (NPV)	1,385,863
Number of warnings	137624
User Benefits and Charges by Time Period	
AM Peak – 2016	2,148
AM Peak - 2031	3,010
PM Peak – 2016	5,137
PM Peak – 2031	4,954
Inter Peak – 2016	16,226
Inter Peak - 2031	15,337
Off Peak – 2016	3,135
Off Peak - 2031	2,744
Weekend – 2016	3,133
Weekend - 2031	2,724

4.2 Sector benefits

Analysis of scheme time saving benefits at sector level as shown in Figure 4-1 below indicates that the levels of cost change are consistent with the expected changes in flow patterns. The main changes in benefits were seen in Lincoln area (Sector 1). It is then followed by Lincoln Planning Area (Sectors 2, 3 and 4). External traffic bypassing Lincoln is reflected in Sector 10.

Figure 4-1 – LEB Sector Benefits



4.3 Time and Distance Distribution of Benefits

Figure 4.2 below demonstrates that the majority of time savings are accrued over the >5 minute band. This is reflective of the LEB ability to save considerable time for journeys between north and south Lincoln whilst avoiding the city centre.

Figure 4-2 – Time Saving by Time Band

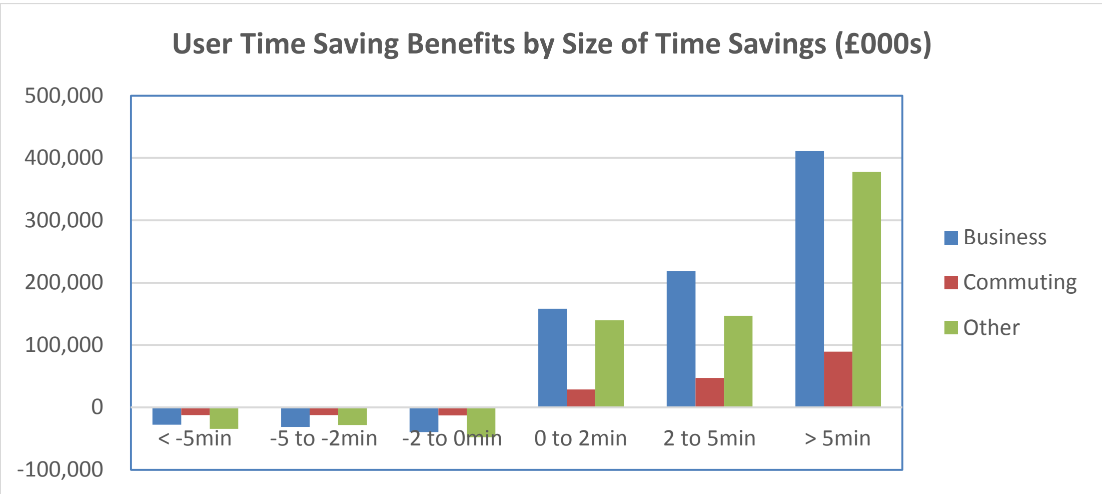
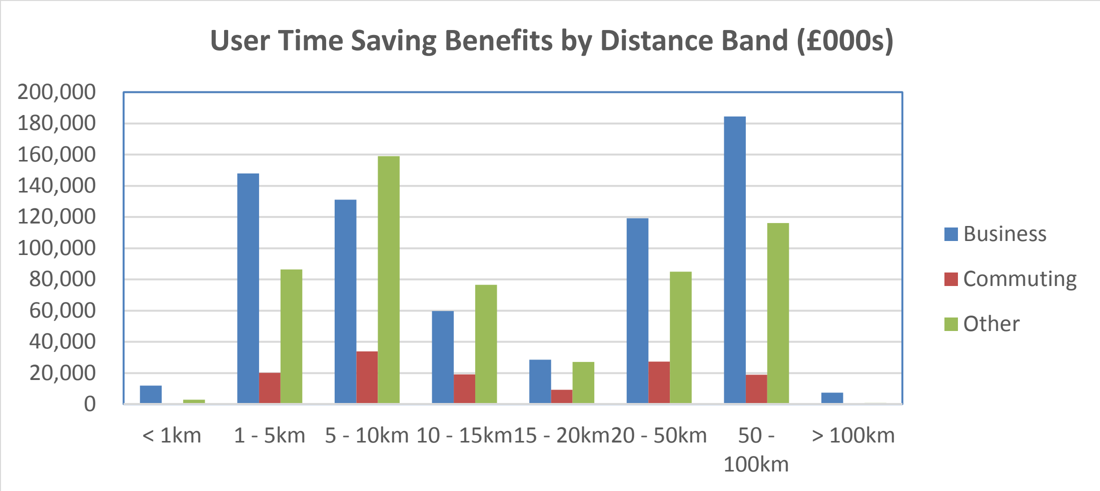


Figure 4.3 below demonstrates that a significant number of time savings are accrued over the longer distance band, although the sum of trips <10km reflecting local relief

is also a large component. The heavy savings of longer distance movements reflects relief to existing A46 (NE-SW) movements and provision of a new A15 corridor (NW-SE) movements. Business time dominates the savings.

Figure 4-3 – Time Saving by Distance Band



4.4 Assessment of Accident Benefits

The calculation of accident savings and benefits relating to the LEB has been undertaken using a spreadsheet-based method which is similar to the Highways Agency's COBA LighT (COBALT) program, and has been used by Mouchel to calculate accident savings/benefits on a number of schemes including Manchester Managed Motorways (MMM) and Heysham-M6 Link. The process calculates accident costs/benefits as described in the COBA / COBALT manual and uses the latest COBA accident rates and WebTAG guidance.

This section provides an outline of the methodology, assumption, and the results of the accident benefits calculated for the LEB.

Methodology

As defined in the COBA manual, the total cost of accidents on a network is calculated by multiplying the number of accidents predicted to occur on the network by the cost per accident. The number of accidents on a given length of road is expressed by accident rates, defined as the number of Personal Injury Accident (PIA) per million vehicle kilometres. The outputs are expressed as the change in the number of accidents and casualties when a scheme is introduced, and the economic cost implications of these changes.

The savings in the number of accidents/casualties as a result of the LEB scheme were calculated from the difference between accident and casualty costs between the Do-Minimum and Do-Something The accident benefits were calculated over a 60 year appraisal period and discounted to 2010 base prices and values.

COBA Networks

COBA uses nodes and links to represent the Do-Minimum and Do-Something highway networks. The COBA networks assessed included all the internal 'simulation' links from the VISUM forecasting models to ensure the full extent of the accident impact. The external 'buffer' links were not included in the assessment as it was felt that these would not be impacted by the LEB and to be consistent with the TUBA methodology. COBA networks were defined for the Do-Minimum and Do-Something networks, for both the opening and design years. The COBA link types and associated COBA accident rates were specified for all links, along with the link distances and free-flow speeds. Junctions were not modelled in the COBA network due to the size of the network.

Input Information

Table 4-2 – Accident Benefits Calculation General Parameters

Parameter	Value
First Year of Assessment	2018
Evaluation Period	60 years (blank)
Network Classification	Built-up Principal (PBU)
Traffic Flow Input Format	AADT
Type of Accident Calculations	Link and Junction Separate (SEP)
Traffic Flow Input Year	2016
Traffic Growth Assumption	Core
Traffic Composition Input Year	2006

Traffic Input

Traffic flows were input as 24-hour Annual Average Daily Traffic (AADT) link flows for 2018 and 2033, Do-Minimum and Do-Something. Standard accident rates were applied to the data and the difference in accidents was taken for the core of the model. This helped to remove peripheral noise resultant from small changes to large flows and focussed the impact on the LEB corridor and areas relieved by it.

4.4.1 Scheme Accident Benefits

The table below summarises the accident benefits generated by the LEB scheme over the 60 year assessment period, discounted to 2010 prices. It can be seen that the scheme generates significant accident benefits of £18.889m.

Table 4-3 – LEB Accident Benefits

	LEB
Accident Benefits (£m)	18,889

The table below summarises the number of accidents and casualties that the LEB scheme is anticipated to save over the 60 year evaluation period. The scheme is anticipated to save over 622 accidents, with a saving of over 607 casualties.

However, diversion to a faster corridor with, on balance, more serious accidents results in a net increase of four fatal accidents over the 60 year period.

Table 4-4 – LEB Casualty savings

Scheme	Number of Accidents Saved	Number of Casualties Saved		
		Fatal	Serious	Slight
LEB	622	-4	19	607

4.5 Performance Summary

LEB economic benefits are summarised below.

Table 4-5 – Overall Scheme Benefits Summary (£000s)

Net Present Value for Benefits	DM v DS
Consumer – Commuting User Benefits	138,722
Consumer – Other User Benefits	596,193
Business User Benefits	754,928
Carbon Benefits	-39,233
Indirect Taxation	15,042
Accident Benefits	18,889
Present Value of Benefits (PVB)	1,484,541
Present Value of Costs	
Investment Costs	79,789
Present Value of Costs (PVC)	79,789
Overall Impact	
Net Present Value (NPV)	1404752
Benefit to Cost Ratio (BCR)	**18.6**

A full presentation of the TEE and PA tables is provided in the Appendix. Supply of TUBA outputs is included under separate cover.

5 Sensitivity Tests

5.1 Variable Demand Core

The core test presented in the earlier chapter is based on fixed demand. The test below considers the impact of supressed and induced traffic resultant from the variable demand model.

Include VDM evaluation

5.2 Optimistic and Pessimistic

This test rolls up two elements into a single test to provide high and low forecasts. It includes elements of national growth certainty and local development certainty.

Include High & Low evaluation

5.2.1 National Growth

There is a range of inputs into forecasting that are difficult to gauge either the likelihood or the impact to a sufficient degree. GDP growth, fuel price trends, vehicle efficiency changes and other national trends are assessed and reported at a national level and forecasts rely on the results from TEMPRO. To deal with the uncertainty in highway models WebTAG expects that scenarios use an appropriate range about the central forecast of +-2.5% for traffic forecasts one year ahead, rising with the square root of the number of years to +-15% for forecasts 36 years ahead. In accordance with advice provided in TAG Unit 3.15.5 (April 2011) sensitivity tests were developed to test the uncertainty regarding future growth. Paragraph 1.4.13 of

Unit 3.15.5 provides the guidelines on how to derive the test demands as described below:

"To deal with such uncertainty in highway models, it is expected that the analyst will explore scenarios using an appropriate range about the core scenario growth forecast of +2.5% for traffic forecasts one year ahead of the model base year, rising with the square root of the number of years to +15% for forecasts 36 years ahead."

Two alternative growth scenarios were developed using the Core Scenario as basis:

- Low Growth: 1 - 2.5% * (Future Year – Base Year)
- High Growth: 1 + 2.5% * (Future Year – Base Year)

Growth Table

5.2.2 Local Growth

To be added

Results

To be added

5.3 TEMPRO 7 Growth

Tempro 7 has been released in early 2016. It represents an update on TEMRPO 6.2 which dates from 2011. A number of changes have been included as below:

- Population – updated using ONS 2012-based projections;
- Dwellings – updated using local authority annual monitoring reports;
- Employment – updated using UKCES 2012-based employment projections ("Working Futures") project;
- the distribution of employment and workers by region in the base year 2011 (and hence in all years) – updated using workforce jobs and the labour force survey;
- a comprehensive update and re-estimation of the National Car Ownership Model; and,
- re-estimated trip rates based on National Travel Survey.

Results
To be added

5.4 Forthcoming VOT Updates

For all other tests the analysis was conducted in TUBA v1.9.5 which reflects the version of the software released at the commencement of the update exercise. DfT has given notice of a move to distance based VOT for employers business. The guidance on the application of this has evolved over recent years and the original information available in late 2015 has been superseded.

Nevertheless the LEB has been demonstrated to be moderately insensitive to small changes in VOT. Further the EB segment of demand is relatively small within the model at x%

This test therefore focusses on application within the Economic Appraisal rather than traffic forecasting. TUBA 1.9.7 was employed with the latest values of time.

Results
To be added

5.5 Annualisation Variation

The current annualisation follows WebTAG guidance on avoiding extrapolation of time periods where flows and costs are significantly different from the donor time period. On this basis the peak shoulders (which are less congested) have been included within the Off Peak period.

The annualisation test considers a conservative revision to expansion factors. It excludes the reallocation of the peak shoulders into the off peak, leaving a single AM peak hour and 2 PM peak hours. It also considers excluding the Sunday profile by way of limiting evaluation to the most congested travel times.

Results
To be added

5.6 Dependent Development

The analysis for all prior tests removes the dependent development in the North-East and South-East Quadrant Sustainable Urban Extensions. This test reintroduces the development. The caveat with this is that the Do-Minimum network operates with poorer performance than would be ideal due to capacity issues. The dependent development test provides a quantification of benefit of land value offset against congestion resultant from extra development.

Results
To be added

6 Conclusions

This report covers the economic assessment of the LEB route. The core test is provided by way of comparison with earlier works. Within the core test the following elements are included:

- Base model recalibration;
- Projection of model to 2015;
- Design revisions of LEB since 2011;
- Enhancements to modelling resultant from outcome of public inquiries;
- Updated development assumptions;
- Updated scheme costs; and
- Update to original VOT,

Sensitivity tests are conducted in a number of areas which are of interest to the DfT, including:

- TEMPRO 7
- Variable Demand
- Forthcoming Values of Time
- High and Low Growth
- Dependent Development

On the basis of the analysis conducted to date the LEB has been demonstrated to provide a robust economic performance which suggests a continued high Value For Money.

Appendix A – Modelled Highway Networks

Figure A1 – Do-Minimum Network

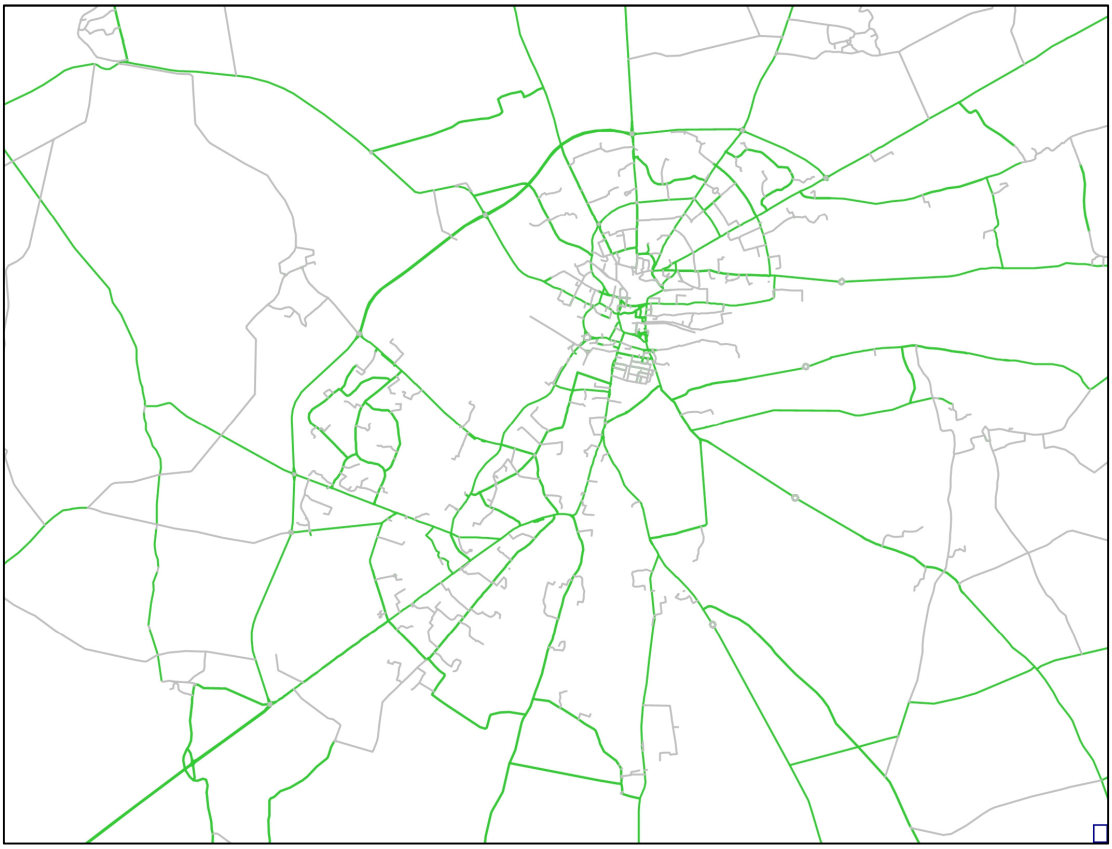
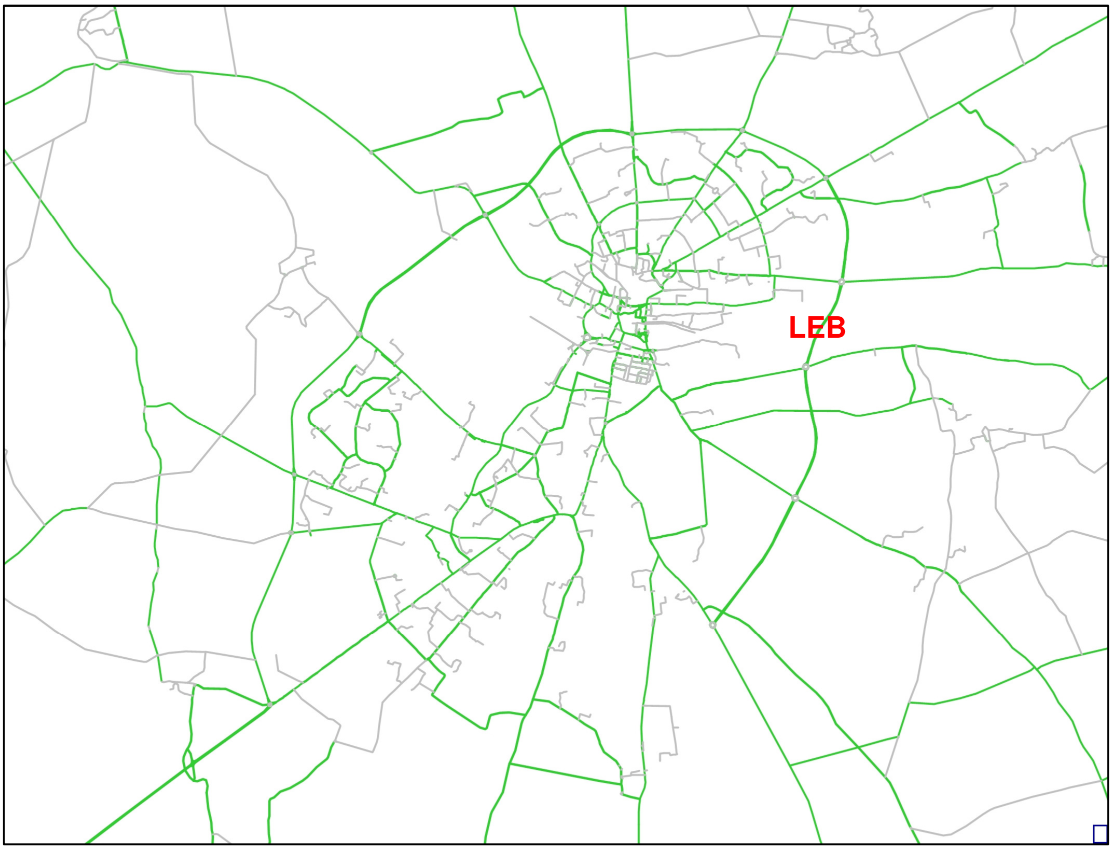


Figure A2 – Do-Something Network



Appendix B – Economic Appraisal Tables

Core Test – Economic Evaluation Outputs

Economic Efficiency of the Transport System (TEE)

Non-business: Commuting	**ALL MODES**		**ROAD**	**BUS/COACH**	**RAIL**	**OTHER**
User benefits	**TOTAL**		**Private Cars/LGVs**	**Passengers**	**Passengers**	
Travel Time	129,019		129,019	0	0	0
Vehicle operating costs	9,703		9,703	0	0	0
User charges	0		0	0	0	0
During Construction & Maintenance	0		0	0	0	0
NET NON-BUSINESS BENEFITS: COMMUTING	**138,722**	*(1a)*	**138,722**	**0**	**0**	**0**

Non-business: Other	**ALL MODES**		**ROAD**	**BUS/COACH**	**RAIL**	**OTHER**
User benefits	**TOTAL**		**Private Cars/LGVs**	**Passengers**	**Passengers**	
Travel time	553,838		553,838	0	0	0
Vehicle operating costs	42,355		42,355	0	0	0
User charges	0		0	0	0	0
During Construction & Maintenance	0		0	0	0	0
NET NON-BUSINESS BENEFITS: OTHER	**596,193**	*(1b)*	**596,193**	**0**	**0**	**0**

Business			**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Good Vehicles**	**Business Cars/LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	690,106		352,256	337,850	0	0	0	0
Vehicle operating costs	64,822		45,539	19,283	0	0	0	0
User charges	0		0	0	0	0	0	0
During Construction & Maintenance	0		0	0	0	0	0	0
Subtotal	**754,928**	*(2)*	**397,795**	**357,133**	**0**	**0**	**0**	**0**

					Freight	Passengers	
Private sector provider impacts							
Revenue	0						
Operating costs	0						
Investment costs	0						
Grant/subsidy	0						
Subtotal	**0**	*(3)*		**0**	**0**	**0**	**0**
Other business impacts							
Developer contributions	0	*(4)*					
NET BUSINESS IMPACT	**754,928**	*(5) = (2) + (3) + (4)*					

TOTAL

Present Value of Transport Economic Efficiency Benefits (TEE)	**1,489,843**	*(6) = (1a) + (1b) + (5)*

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values (£,000s)

Public Accounts for the Appraisal of Major Highway Schemes

	ROAD INFRASTRUCTURE TOTAL	
Local Government Funding		
Operating Costs	0	
Investment Costs	33,574	
Developer and Other Contributions	0	
NET IMPACT	**33,574**	*(7)*
Central Government Funding: Transport		
Operating costs	0	
Investment Costs	46,215	
Developer and Other Contributions	0	
NET IMPACT	**46,215**	*(8)*
Central Government Funding: Non-Transport		
Indirect Tax Revenues	39,233	
TOTALS	**39,233**	*(9)*
Broad Transport Budget	**79,789**	*(10) = (7) + (8)*
Wider Public Finances	**39,233**	*(11) = (9)*

Analysis of Monetised Costs and Benefits

Noise	3,363	*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	15,042	*(14)*
Journey Ambience		*(15)*
Accidents	18,889	*(16)*
Economic Efficiency: Consumer Users (Commuting)	138,722	*(1a)*
Economic Efficiency: Consumer Users (Other)	596,193	*(1b)*
Economic Efficiency: Business Users and Providers	754,928	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-39,233	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Option Values		*(17)*
Present Value of Benefits (see notes) **(PVB)**	**1,487,904**	*(PVB) = (12) + (13) + (14) + (15) + (16) + (1a) + (1b) + (5) + (17) - (11)*
Broad Transport Budget	79,789	*(10)*
Present Value of Costs (see notes) **(PVC)**	**79,789**	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	**1,408,115**	*NPV = PVB - PVC*
Benefit to Cost Ratio (BCR)	**18.648**	*BCR = PVB/PVC*

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.