The Norfolk County Council (Norwich Northern Distributor Road (A1067 to A47(T))) Order

5.11 Summary Results of Sensitivity Tests

Planning Act 2008

Infrastructure Planning

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Author: Mott MacDonald

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0	S Sirivadidurage	M Shahkarami G Gessa R Tyler	C White

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1 Key Summary

1.1.1 Funding approval for the Norwich Northern Distributor Road (NDR) was sought in 2011 through the Department for Transport's (DfT) Development Pool process. A business case was developed and submitted in accordance with the guidance in the Treasury Green Book. Ministerial decisions were made in December 2011 to award funding.

1.1.2 The NDR is a project of national significance which requires a Development Consent Order (DCO) under the Planning Act 2008. The submission was made in January 2014. Since that time there have been some further developments that are considered in this report. These include:

- Revised WebTAG guidance was made definitive at the end of January 2014 after the Scheme submission; and
- The Joint Core Strategy (JCS) that was reviewed and approved at Examination in 2013 has been formally adopted by the Greater Norwich Development Partnership (GNDP) authorities; and
- The Postwick Scheme orders have been approved by the Secretaries of State and Ministerial approval of funding was confirmed in April 2014.

1.1.3 The Transport Assessment for the Scheme is set out in submission document ref. 5.5. This included an operational assessment of the Scheme design with traffic forecasts based on the full implementation of JCS, as set out in the Traffic Forecasting Report document ref. 5.6. The forecasts were based on the transport model described in the Highway and Public Transport Local Model Validation Reports (document refs. 5.9 and 5.10). The transport assessment concluded that the Scheme design is considered to be the best possible balance between relieving the existing network whilst ensuring acceptable conditions on this new part of the network.

1.1.4 The Economic Appraisal Report (document ref. 5.7) shows that the Scheme would deliver very high value for money (VfM), the Benefit Cost Ratio (BCR) value exceeding 4, according to DfT's VfM criteria. In addition the Land Use and Economic Development Report (document ref. 10.3) sets out the substantial benefits of jobs, GVA and infrastructure investment that the Scheme would help to bring to the City.

1.1.5 This report contains a number of sensitivity test results to address the changes since the submission and to further examine the robustness or sensitivity of the results. The tests include:

- Showing the effect on the economic appraisal of new WebTAG values of time and growth;
- Sensitivity testing upper and lower bound ranges for values of time;
- Testing low and high growth;
- An alternative network scenario with Postwick included in the Do Minimum network;
- An alternative growth scenario with only JCS developments that would be unlocked by Postwick and an economic appraisal using a dependent development approach. This has been tested with and without the developer link roads.

1.1.6 The series of sensitivity tests has been undertaken primarily to test the robustness of the economic appraisal of the Scheme to changes in parameters, forecast assumptions and methodology. The traffic flow forecasts of the Scheme in these test scenarios have also been reviewed and where appropriate operational performance has been assessed.

1.1.7 The sensitivity test results indicate that BCR ranges from 3.68 – 5.36 (inclusive of accident benefits) and 4.75 – 6.86 when WEBs and JTR are included as can be seen from summary table below. Both of these represent high/very high value for money for all sensitivity tests (BCR above 3 / 4) according to DfT's VfM criteria.

Scenario	BCR (including accidents)	BCR (also including WEBs and JTR)
DCO submission	4.17	5.33
Sensitivity tests		
New WebTAG parameters	4.26	5.42
New WebTAG – non work VOT reduced by 25%	3.68	4.75
New WebTAG – non work VOT increased by 25%	4.85	6.07
New WebTAG – work VOT reduced by 25%	4.02	5.13
New WebTAG – work VOT increased by 25%	4.51	5.69
Low growth	3.76	4.75

Scenario	BCR (including accidents)	BCR (also including WEBs and JTR)
High growth	4.55	5.73
Postwick in DM	5.29	6.77
Dependent development_link roads included*	4.76	5.99
Dependent development_link roads excluded*	4.73	5.99

Notes: *This dependent development BCR excludes very high additional GVA benefits of £422.4m and development benefits (includes planning gain and transport external costs) of £1,146m

1.1.8 It is therefore concluded that the transport benefits reported in the submission are robust and that the Scheme would deliver high or very high value for money.

1.1.9 In addition to the transport benefits the testing using the dependent development methodology shows that the completion of the NDR would deliver very high development benefits amounting to £1,146m. In addition the business development dependent on completion of the NDR could realise £422m of GVA benefits, though these should not simply be added to development benefits.

2 Introduction

2.1 Background

2.1.1 Mott MacDonald (MM) has been appointed by Norfolk County Council (NCC) to assist with the development and appraisal of the Norwich Northern Distributor Road, known as the NDR or referred to as the Scheme.

2.1.2 The Scheme would be a dual carriageway all-purpose strategic distributor road, to be classified as the A1270 Principal Road, which would link the A1067 Fakenham Road near Attlebridge, to the A47(T) Trunk Road at Postwick. This will be over a length of approximately 20.4km.

2.1.3 The NDR is a project of national significance which requires a Development Consent Order (DCO) under the Planning Act 2008 and this formal planning process began in early 2013. It is currently anticipated that the process will be completed in time for the Scheme to start construction in 2015 and to be opened in 2017.

2.1.4 This document is one of a number that support the DCO, each of which has its own unique document reference number, and should therefore be read in conjunction with the other documentation. The proposed layout of the NDR is shown in the General Arrangement Plans contained in document ref. 2.6, whilst the full needs case for the NDR is explained in the Statement of Reasons (document ref. 4.1) and the Environmental Statement (document ref. 6.1).

2.1.5 Funding approval for the NDR was sought in 2011 through the Department for Transport's (DfT) Development Pool process. A business case was developed and submitted in accordance with the guidance in the Treasury Green Book. Ministerial decisions were made in December 2011 to award funding.

2.1.6 The NDR DCO submission was submitted on 8th January 2014 and has been accepted for examination by the planning inspectorate on 4th February 2014.

2.2 Purpose and Layout of Report

2.2.1 This report presents the results of sensitivity testing that would provide additional information for the examination. These tests address changes since the submission that include:

- Revised WebTAG guidance was made definitive at the end of January 2014 after the Scheme submission; and
- The Joint Core Strategy (JCS) that was reviewed and approved at Examination in 2013 has been formally adopted by the GNDP authorities; and
- The Postwick Scheme orders have been approved by the Secretaries of State and Ministerial approval of funding was confirmed in April 2014.

2.2.2 The report sets out to provide, where appropriate:

- A review of the flow and operational assessment of the Scheme under sensitivity tests where appropriate.
- An assessment of safety benefits of the scheme under the sensitivity test
- An assessment of economic benefits for consumer and business users from several sensitivity tests based on the variable demand model (VDM) forecasts and the likely expenditure profile during the assessment period where appropriate.
- An assessment of the scheme Value for Money (VfM) under these sensitivity tests based on the corresponding VDM model outputs and the latest available scheme costs where appropriate. The Guidance on Value for Money describes the criteria used to determine the VfM of various types of schemes.

2.2.3 The methodology used to produce the safety and economic appraisal is described in detail in DCO submission document ref. 5.7. This methodology was mainly retained for these sensitivity tests. More information is given where a different methodological approach has been applied.

2.2.4 This report contains the following sections after the current introductory section:

- Section 3 – describes details of the sensitivity tests;
- Section 4 – contains scheme costs excluding Postwick costs and will be used in scenarios where Postwick is included in the Do Minimum.;
- Sections 5 to 8 – present the results of the flow, operational, safety and economic appraisal for each sensitivity test separately;
- Section 9 – presents conclusions from the sensitivity test appraisals.

2.2.5 Supporting information is included in Appendix A in Section 10.

2.2.6 Sections 11 and 12 contain Abbreviations and Glossary.

3 Description of Sensitivity Tests

3.1 Overview

3.1.1 In order to test the impact of the changes described in the previous section and to provide additional information on further WebTAG requirements, several sensitivity tests were carried out. More details on these tests can be found in later sections.

3.1.2 The economic appraisal complies with the latest guidance in WebTAG. It has been assumed in the appraisal that the benefits of the scheme do not change for each year beyond 2032 although traffic will continue to grow which suggests that the PVB and the NPV presented for the scheme and each sensitivity test will be conservative.

3.1.3 For each sensitivity test economic and safety appraisals have been carried out. As with the DCO submission, the economic appraisal calculates TUBA benefits, wider economic benefits (using WITA) and journey time reliability benefits. Safety appraisal was based on COBA. In addition to the above benefits, dependent development benefits such as Transport External Costs (TEC), Planning Gain (PG) and Gross Value Added (GVA) benefits are calculated for dependent development scenarios (see below for more information on this sensitivity test).

3.1.4 The costs of the scheme are shared between local authority and central government.

3.1.5 In addition a review of traffic flow impacts and the operational assessment of the Scheme have been carried out where necessary.

3.2 New WebTAG Guidance Sensitivity Test

3.2.1 The DCO submission transport modelling and appraisal has been developed in accordance with then definitive WebTAG guidance (last updated in August 2012). However revised WebTAG guidance became definitive at the end of January 2014 after the Scheme DCO submission. This included a number of changes that were published in Draft Units in October 2013. The new WebTAG guidance has been reorganized and was released on a new website. It describes the new guidance as being ‘retrenched’ which it is understood means it is simplified. Sometimes the new guidance is referred to as WebTAG2.

3.2.2 The main changes that need to be addressed with the new WebTAG guidance are due to changes in parameter values and additional sensitivity testing of ranges for the values. Changes in values include new Values of Time (VOT) and growth rates for working and non-working trip purposes. Car business VOTs have been reduced by about 20%. Non-business VOTs have increased by about 5% and now increase in line with GDP per capita (previous assumption was they increased by 0.8 of the GDP per capita increase). In addition, due to the findings of the latest research on these values, there is a requirement to test changes in base values by +/-25%.

3.2.3 There are also changes to fuel costs, CO2 emissions factors and CO2 values which would have a relatively small impact but are taken into account in the sensitivity test analysis.

3.2.4 These new parameter values that became definitive in WebTAG2 were used to produce a revised economic appraisal.

3.2.5 In addition, to comply with WebTAG2 guidance on new VOT parameters, tests were undertaken with variations of +/-25% for either the working or non-working base VOTs.

3.2.6 The new guidance includes a unit on proportionate updating of appraisal. This requires agreement of the sponsoring authority, which in this case requires DfT and NCC agreement. Following discussions it was agreed that base model calibration and validation is checked with new WebTAG parameters. Also 2032DS forecasts will be re-run with new parameters and forecast assignments are compared against the DCO.

3.2.7 These tests, assumptions and appraisal required are summarised in Table 3.1 below.

Table 3.1: Summary of Requirements – New WebTAG Guidance

Scenario	Modelling required	Appraisal required	Additional requirements
Existing DCO scheme with WebTAG2 revised parameters for economic appraisal	No	Economic and safety appraisal with revised parameters	None
DCO Scheme with +/-25% to base VOTs (four tests)	No	Economic appraisal with revised base VOTs	None
Base validation check with new WebTAG2 parameters	Revised VOT parameters used in base model re-assignment	Comparison of assignment validation with DCO	As agreed with DfT
Forecasts with new WebTAG2 parameters	Revised growth in VOT used in re-forecast using DIADEM for 2032DS	Compare resulting forecast assignment with DCO submission	As agreed with DfT

3.3 Low and High Growth Scenario Sensitivity Tests

3.3.1 The current DCO submission is based on central growth forecasts and there is a WebTAG requirement to assess the uncertainty in growth by carrying out low and high growth forecasts. Table 3.2 summarises the key assumptions and appraisal required.

Table 3.2: Summary of Requirements – Low and High Growth

Scenario	Modelling required	Appraisal required	Additional requirements
Existing DCO scheme with low growth	Revised forecast reference growth demand matrices for 2017 and 2032. Run through demand model for 2017 and 2032 DM and DS.	Economic appraisal. Safety appraisal. Traffic forecast changes with DCO	None
Existing DCO scheme with high growth	Revised forecast reference growth demand matrices for 2017 and 2032. Run through demand model for 2017 and 2032 DM and DS.	Economic appraisal. Safety appraisal. Traffic forecast changes with DCO	None

3.4 Postwick Scheme in the Do Minimum Sensitivity Test

3.4.1 The DCO submission appraisal included the proposed improvement at Postwick as part of the NDR Scheme. The Postwick Hub Scheme was subject to an Public Inquiry in mid-2013 and the Orders have since been approved by the Secretaries of State in January 2014, coincident with the DCO submission, and full approval was granted in April 2014. This sensitivity test therefore assesses the economic benefits of the remainder of the NDR Scheme in isolation from the Postwick improvements. It also looks at the operational performance of Postwick junctions in 2032. Table 3.3 summarises key assumptions and appraisal required.

Table 3.3: Summary of Requirements – Postwick Scheme in the DM

Scenario	Modelling required	Appraisal carried out	Additional requirements
DCO scheme with the Postwick improvement included within the Do Minimum.	Recoding of the DM network to include the Postwick Scheme. Running recoded DM network and DCO reference matrices through demand model for 2017 and 2032.	Economic and safety appraisal. Traffic forecast changes with DCO Operational assessment of Postwick junctions	Revised costs required for scheme to exclude Postwick Improvement costs.

3.5 Dependent Development Sensitivity Tests

3.5.1 The DCO submission appraisal was based on full spatial allocation of JCS development for both with and without the scheme scenarios. This means that

the performance of the Scheme is assessed with the full JCS development allocation which is expected to represent the maximum Scheme impact. However, in the without Scheme scenario it could be argued that the full spatial allocation could not be achieved although growth is still required to be controlled to similar growth across the GNDP area (known as controlled to NTEM or TEMPRO). An approach to dealing with this is set out in WebTAG2 A2-3 by dealing with the development that can be unlocked by the Scheme as dependent development. In the context of the approval that has been confirmed for the Postwick scheme then the development that can be considered as dependent is that development that would be unlocked by NDR in addition to that unlocked by Postwick. These sensitivity tests therefore assume that certain developments are dependent only on the NDR scheme (i.e. over and above those unlocked by Postwick). Table 3.4 summarises key assumptions and the appraisals required.

Table 3.4: Summary of Requirements – Dependent Development Scenario

Scenario	Modelling required	Appraisal required	Additional requirements
Existing DCO scheme with dependent development growth scenario.	Develop dependent development matrices for 2032 (there are no NDR dependent developments in 2017). Run DM (with Postwick included in DM) and DS networks with dependent development matrices through demand model for 2032.	Economic appraisal using a fixed reference demand, and appraisal using a dependent development approach. Safety appraisal. Calculation of Planning Gain, Transport External Costs and GVA. Traffic forecast changes with DCO Operational assessment of NDR and Postwick junctions	Revised costs required for scheme to exclude Postwick Improvement costs.
Scenario as above but with developer link roads removed* from 2017 DM (with Postwick included) and DS networks	Run 2017 DM and DS networks with DCO 2017 reference matrices (there are no NDR dependent developments in 2017)	Economic appraisal using a fixed reference demand, and appraisal using a dependent development approach. Safety appraisal. Calculation of Transport External Costs	Revised costs required for scheme to exclude Postwick Improvement costs. Planning Gain and GVA from above 2032 assignments from above

Notes *In the scenario where the dependent development is not implemented then the corresponding developer link roads would not exist. Therefore the tests have been carried out with and without the developer link roads.

3.5.2 In accordance with dependent development guidance set out in WebTAG A2-3, the economic appraisal was carried out in two parts, as follows:

- Assessment of the NDR transport scheme in isolation.
- Assessment of the development benefits associated with dependent developments.

3.5.3 The former is calculated with reference traffic levels that exclude the development that is dependent upon the completion of the NDR.

3.5.4 Benefits of land use development assuming the implementation of the transport intervention are equal to the Planning Gain (PG) arising from the development less the Transport Externality Cost (TEC) and Other Externalities (OE). Here the TEC is produced by the extra congestion for existing transport users, whilst the OE refers to the loss or gain in amenity value of the land compared to its existing use.

3.5.5 The TEC can be positive when the land use development imposes costs on existing users in the absence of a transport scheme improvement, but with an improvement in place it is likely to be negative, especially when the trips are constrained to NTEM. This occurs as the TECs with the specified land use development and the transport improvement are lower than with wider distributed development implied by NTEM without the dependent development. Put another way, with the implementation of the NDR Scheme the transport externalities are lower with the spatially allocated NDR dependent developments than with a wider distribution of developments. This outcome is consistent with the WebTAG A2-3 guidance.

3.5.6 NDR dependent housing and business developments are summarised in Table 3.5 below. All these developments are located in the Broadland district.

Table 3.5: Summary of NDR Dependent Housing and Business Developments – 2017 to 2032

Development type	Development	Units/m2	Additional details
Housing	Hellesdon Golf Course	729	
	Hellesdon Hospital	225	
	Drayton	151	
	Spixworth	39	
	Rackheath Eco Community*	3,070	
	Brundall	111	
	Biofield	144	
	Sprowston	45	
	Horsham	38	
	Salhouse	14	
	West of North Walsham Road (Beyond Green)*	1,000	
	Between Wroxham and North Walsham Road (Beyond Green)*	1,100	
	Between Salhouse and Wroxham Road (W House Farm)	680	
	Between Plumstead and Salhouse Road	280	
Business	Rackheath Eco Community*	87,500m2	B1/B2/B8

Development type	Development	Units/m2	Additional details
	Airport*	105,000m2	B1/B2/B8

Notes: *A conservative assumption was made to calculate planning gain benefits for Rackheath Eco Community and Beyond Green housing developments only. Both business developments are considered for planning gain in addition to GVA calculations.

3.5.7 The transport scheme will enable the commercial developments at the above locations to take place which will contribute GVA to the local economy as a result of additional jobs. GVA benefits of JCS developments are reported in detail in DCO Document Reference 10.3. For the purpose of this sensitivity test GVA benefits of dependent business developments are directly available from above report.

4 Revised Scheme Costs with Postwick in DM

4.1.1 Revised scheme costs with Postwick costs excluded were provided by NCC and summary costs are given below in Table 4.1. Costs were adjusted as per Document Reference 5.7. The adjusted costs were used in the sensitivity test scenarios where Postwick Scheme is in the DM.

Table 4.1: Summary Costs of NDR Excluding Postwick Costs

Cost type	Cost (£m) in 2013Q1 prices	
	DCO Scheme	NDR only
Investment costs		
Construction	110.2	88.5
Land	22.0	21.9
Preparation	7.8	8.3
Supervision	1.3	0.9
Total investment Cost	141.3	119.6
Other costs		
Maintenance	27.8	24.2
Operation	15.9	14.5

Notes: These are initial costs before adjusting for construction price inflation and optimism bias

5 New WebTAG Guidance Sensitivity Test Results

5.1 Flow Analysis Results

5.1.1 Base flow calibration and validation results with new WebTAG parameters are compared with DCO results in Table 5.1 to Table 5.4. The comparison indicates that the results are very similar.

Table 5.1: Summary of Screenline Flow Calibration Results (All Vehicles)

Criteria	Cases	AM	IP	PM	Target
Total screenline within 5% of observed	15/ 16 IP	12 (13)	12 (11)	13 (13)	All or nearly all screenlines
Total screenline flow GEH<4	15/ 16 IP	13 (12)	14 (16)	14 (13)	All or nearly all screenlines
Individual link flows (proximity)	171	91% (91%)	98% (98%)	94% (94%)	>85% of cases
Individual link flows GEH<5	171	85% (86%)	93% (94%)	91% (90%)	>85% of cases

Notes: Values in (xx) refer to corresponding DCO values

Table 5.2: Summary of Screenline Flow Calibration Results (Cars)

Criteria	Cases	AM	IP	PM	Target
Total screenline within 5% of observed	15/ 16 IP	14 (14)	13 (13)	13 (14)	All or nearly all screenlines
Total screenline flow GEH<4	15/ 16 IP	14 (14)	14 (16)	15 (14)	All or nearly all screenlines
Individual link flows (proximity)	171	93% (93%)	98% (98%)	97% (96%)	>85% of cases
Individual link flows GEH<5	171	87% (87%)	95% (95%)	92% (92%)	>85% of cases

Notes: Values in (xx) refer to corresponding DCO values

Table 5.3: Summary of Screenline Flow Validation Results (All Vehicles)

Criteria	Cases	AM	IP	PM	Target
Total screenline within 5% of observed	6	4 (4)	4 (4)	5 (5)	All or nearly all screenlines
Total screenline flow GEH<4	6	4 (4)	5 (5)	5 (5)	All or nearly all screenlines
Individual link flows (proximity)	58	84% (84%)	84% (84%)	83% (84%)	>85% of cases
Individual link flows GEH<5	58	84% (81%)	78% (78%)	86% (86%)	>85% of cases

Notes: Values in (xx) refer to corresponding DCO values

Table 5.4: Summary of Screenline Flow Validation Results (Cars)

Criteria	Cases	AM	IP	PM	Target
Total screenline within 5% of observed	6	5 (5)	5 (4)	4 (5)	All or nearly all screenlines
Total screenline flow GEH<4	6	5 (5)	5 (5)	5 (5)	All or nearly all screenlines
Individual link flows (proximity)	58	88% (86%)	86% (84%)	83% (84%)	>85% of cases
Individual link flows GEH<5	58	86% (86%)	79% (81%)	84% (86%)	>85% of cases

Notes: Values in (xx) refer to corresponding DCO values

5.1.2 Base journey time validation results with new WebTAG parameters are compared with DCO results in Table 5.5. Again the comparison indicates that the results are very similar.

Table 5.5: Journey Time Validation Summary

Time period	Number of routes	Number achieving validation criteria	Percentage achieving validation criteria
AM Peak	22	17 (17)	77% (77%)
Inter Peak	22	22 (22)	100% (100%)
PM Peak	22	17 (17)	77% (77%)

Notes: Values in (xx) refer to corresponding DCO values

5.1.3 Based on revised flow calibration and validation results and journey time validation results, it can be concluded that new WebTAG parameters do not have a significant impact on base year calibration and validation.

5.1.4 The revised base model was then used with DCO reference forecast matrices but with updated networks for revised generalised cost parameters (based on new WebTAG parameters) to run demand model for 2032DS.

5.1.5 In Table 5.6 below a comparison of AADT figures is made between the Updated VOT assignment and the DCO submission assignment. There is a small decrease on the majority of the NDR links, with a small increase at A71, which is the NDR link between Plumstead Road and Salhouse Road. The changes overall suggest that using the revised VOTs in the modelling would produce similar forecast traffic flows on the NDR and thus similar Scheme impacts.

Table 5.6: NDR Locations AADT Comparison

Location	Link	Direction	Updated VOT	DCO Submission	Difference	% Difference
A66	Holt Road - Cromer Road Link	WB/EB	28,500	30,400	-1900	-6%
A67	Cromer Road - Airport Link	NEB/SWB	28,200	29,800	-1600	-5%
A68	Airport - North Walsham Road Link	WB/EB	28,200	29,800	-1600	-5%
A69	North Walsham Road - Wroxham Road Link	WB/EB	38,500	39100	-600	-2%
A70	Wroxham Road - Salhouse Road Link	NWB/SEB	42,800	43900	-1100	-3%
A71	Salhouse Road - Plumstead Road Link	NWB/SEB	46,600	46000	600	1%
A72	Plumstead Road - Postwick Hub Link	NB/SB	46,200	46400	-200	0%
A73	Postwick Hub - A47 Link	NB/SB	41,800	42900	-1100	-3%
A79	Fakenham Road - Fir Covert Road Link	NEB/SWB	15,900	16500	-600	-4%
A90	Fir Covert Road - Reepham Road Link	NEB/SWB	19,400	20800	-1400	-7%
A91	Reepham Road - Holt Road Link	WB/EB	24,600	26400	-1800	-7%

5.2 Safety Analysis Results

5.2.1 Accident benefits were calculated using the same approach reported in Document Reference 5.7. Table 5.7 reports summary accident benefits using local accident rates for this sensitivity tests.

5.2.2 For the purpose of WebTAG sensitivity test only parameters related to accident casualty costs and compound growth rates have been changed compared to DCO. Both these are lower in the latest WebTAG. As a result the accident benefit valuation reduces substantially although there are no changes to number of personal injury accidents or casualty numbers saved by the Scheme.

Table 5.7: Accident Benefits of WebTAG Sensitivity Test

60 Year Appraisal Period		Scenario	
		DCO	WebTAG
		Do Minimum	
Number of PIAs		70,984	70,984
Casualties	Fatal	1,890	1,890
	Serious	12,597	12,597
	Slight	91,490	91,490
Accident Costs		5,999,332	4,833,201
		Do Something	
Number of PIAs		69,944	69,944
Casualties	Fatal	1,898	1,898
	Serious	12,488	12,488
	Slight	90,226	90,226
Accident Costs		5,958,113	4,806,333
		Accident Benefits	
Number of PIA savings		1,041	1,041
Casualties	Fatal	-7	-7
	Serious	109	109
	Slight	1,263	1,263
Accident Savings		41,219	26,868

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

5.3 Economic Analysis Results

5.3.1 Table 5.8 below compares monetised costs and benefits including accident benefits for new WebTAG parameters sensitivity test against the DCO scheme.

Table 5.8: Analysis of Monetised Costs and Benefits – New WebTAG Parameters

Item	Accidents included (£000)	
	DCO	New WebTAG
Accidents (not assessed by TUBA)*	41,219	26,868
Greenhouse Gases	-22,756	-23,153
Economic Efficiency: Consumer Users (Commuting)	51,164	63,007
Economic Efficiency: Consumer Users (Other)	380,623	438,270
Economic Efficiency: Business Users and Providers	267,797	220,621
Wider Public Finances (Indirect Taxation Revenues)	55,270	65,187
Present Value of Benefits (PVB)	773,317	790,800
Broad Transport Budget Present Value of Costs (PVC)	185,542	185,542

Item	Accidents included (£000)	
	DCO	New WebTAG
OVERALL IMPACTS		
Net Present Value (NPV)	587,775	605,258
Benefit to Cost Ratio (BCR)	4.168	4.262

Notes: All monetary values are expressed in 2010 prices discounted to 2010 and calculated using TUBA1.9.3.
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7.

5.3.2 The results show that the Present Value of Benefits (PVB) for this sensitivity test is estimated to be £791m (inclusive of accident benefits), outweighing the £186m Present Value of Costs (PVC).

5.3.3 The Benefit Cost Ratio (BCR) of the scheme for this sensitivity test is 4.26 including accidents. Under the DfT's value for money criteria, this represents a Very High value for money category.

5.3.4 Table 5.9 below compares summary economic appraisal results including wider impacts and journey time reliability for new WebTAG parameters sensitivity test against the DCO scheme.

Table 5.9: Summary of Economic Appraisal including Wider Benefits – New WebTAG Parameters

Item	Scenario also including WEBs and JTR (£000)	
	DCO	New WebTAG
Present Value of Benefits (PVB)	989,063	1,004,921
Present Value of Costs (PVC)	185,542	185,542
Net Present Value (NPV)	803,521	819,379
Benefit to Cost Ratio (BCR)	5.331	5.416

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

5.3.5 The BCR for this sensitivity test is improved further to 5.42 once journey time reliability benefits (£28m) and wider economic benefits (£186m) are included in the appraisal. These additional benefits amount to £214m (2010 prices discounted to 2010). The inclusion of these benefits increases the BCR to a higher level within the Very High value for money category.

5.3.6 Table 5.10 below summarises monetised costs and benefits including accident benefits of four sensitivity test results for +/-25% VOT.

Table 5.10: Analysis of Monetised Costs and Benefits – VOT Sensitivity Tests

Item	Accidents included (£000)			
	Non-work VOT -25%	Non-work VOT +25%	Work VOT -25%	Work VOT +25%
Accidents (not assessed by TUBA)*	26,868	26,868	26,868	26,868

Item	Accidents included (£000)			
	Non-work VOT -25%	Non-work VOT +25%	Work VOT -25%	Work VOT +25%
Greenhouse Gases	-23,153	-23,153	-23,153	-23,153
Economic Efficiency: Consumer Users (Commuting)	44,615	81,399	63,007	63,007
Economic Efficiency: Consumer Users (Other)	348,285	528,847	438,270	438,270
Economic Efficiency: Business Users and Providers	220,621	220,621	175,006	266,291
Wider Public Finances (Indirect Taxation Revenues)	65,187	65,187	65,187	65,187
Present Value of Benefits (PVB)	682,423	899,769	745,185	836,470
Broad Transport Budget Present Value of Costs (PVC)	185,542	185,542	185,542	185,542
OVERALL IMPACTS				
Net Present Value (NPV)	496,881	714,227	559,643	650,928
Benefit to Cost Ratio (BCR)	3.678	4.849	4.016	4.508

Notes: All monetary values are expressed in 2010 prices discounted to 2010 and calculated using TUBA1.9.3.
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7.

5.3.7 The Benefit Cost Ratio (BCR) of the scheme varies between 3.68 and 4.85 including accidents for these sensitivity tests. Under the DfT's value for money criteria, these represent High / Very High value for money categories.

5.3.8 Table 5.11 below provides summary economic appraisal results including wider impacts and journey time reliability for +/-25% VOT sensitivity tests.

Table 5.11: Summary of Economic Appraisal including Wider Benefits – VOT Sensitivity Tests

Item	Scenario also including WEBs and JTR (£000)			
	Non-work VOT -25%	Non-work VOT +25%	Work VOT -25%	Work VOT +25%
Present Value of Benefits (PVB)	881,218	1,125,384	952,360	1,056,344
Present Value of Costs (PVC)	185,542	185,542	185,542	185,542
Net Present Value (NPV)	695,676	939,842	766,818	870,802
Benefit to Cost Ratio (BCR)	4.749	6.065	5.133	5.693

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

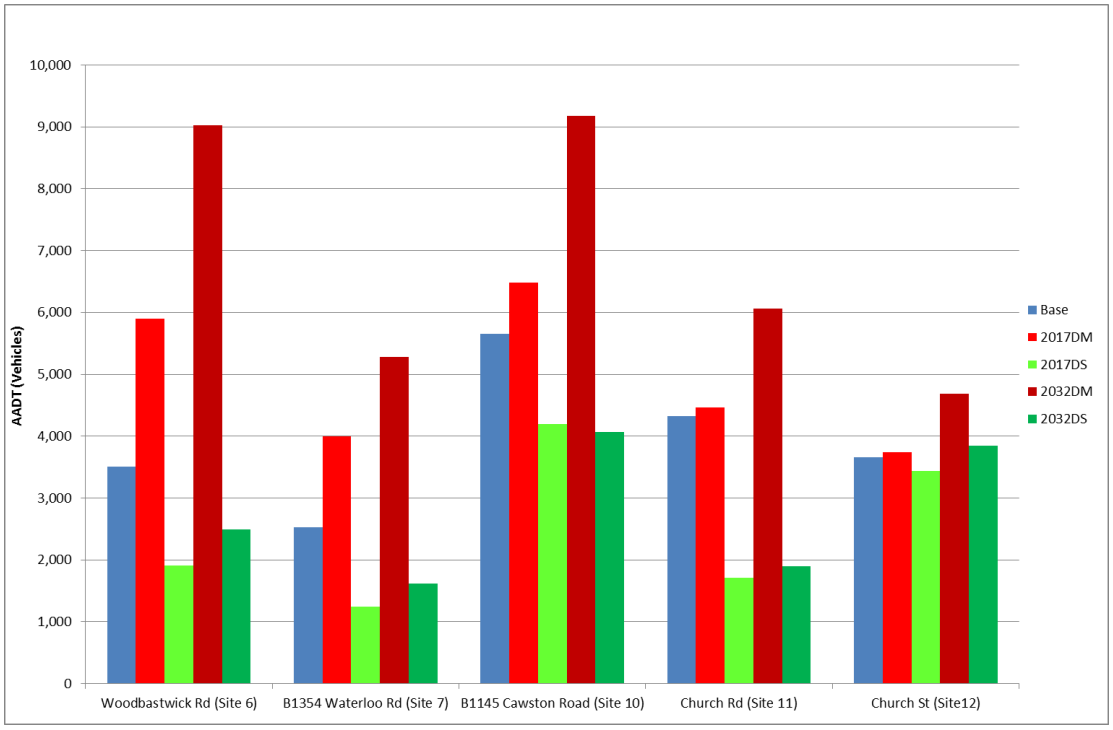
5.3.9 The BCRs range between 4.75 and 6.07 once journey time reliability benefits and wider economic benefits are included in the appraisal. The inclusion of these benefits increases the BCR to a higher level within the Very High value for money category.

6 Low and High Growth Sensitivity Test Results

6.1 Flow Analysis Results

6.1.1 Low growth scenario results in reduced traffic levels over the network. However even with low growth traffic flows on inappropriate routes would increase substantially without the Scheme. Figure 6.1 below shows that for the low growth scenario the Scheme will produce substantial traffic reductions on inappropriate routes.

Figure 6.1: Comparison of Traffic Flows on Inappropriate Routes_Low Growth



6.1.2 Traffic flow analysis plots for low growth scenario are shown in Figure 10.1 to Figure 10.5 of Appendix A. This comparison shows a reasonable distribution of decreased growth across the network in all forecast years and time periods as expected.

6.1.3 Traffic flow analysis plots for high growth scenario are shown in Figure 10.6 to Figure 10.10 of Appendix A. This comparison shows a reasonable distribution of increased growth across the network in all forecast years and time periods, as expected.

6.2 Safety Analysis Results

6.2.1 Low and High growth COBAs are based on same accident parameters as the DCO. The only change is the corresponding flows. The results in Table 6.1 indicate that number of personal injury accidents and casualty numbers decrease or increase for low and high growth scenarios respectively (hence the accident costs) for both DM and DS scenarios as expected. The difference between the figures for low growth produce a similar level of savings to that for the DCO submission, but this difference increases with high growth, though the savings are very much of a similar order.

Table 6.1: Accident Benefits of Low and High Sensitivity Test Scenarios

60 Year Appraisal Period		Scenario		
		DCO	Low	High
		Do Minimum		
Number of PIAs		70,984	65,448	76,449
Casualties	Fatal	1,890	1,739	2,041
	Serious	12,597	11,594	13,596
	Slight	91,490	84,389	98,495
Accident Costs		5,999,332	5,537,051	6,456,500
		Do Something		
Number of PIAs		69,944	64,415	75,501
Casualties	Fatal	1,898	1,746	2,050
	Serious	12,488	11,486	13,498
	Slight	90,226	83,128	97,353
Accident Costs		5,958,113	5,495,141	6,422,172
		Accident Benefits		
Number of PIA savings		1,041	1,033	948
Casualties	Fatal	-7	-7	-9
	Serious	109	108	98
	Slight	1,263	1,261	1,142
Accident Savings		41,219	41,910	34,328

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

6.3 Economic Analysis Results

6.3.1 Table 6.2 below compares monetised costs and benefits including accident benefits for low and high growth sensitivity tests against the DCO scheme.

Table 6.2: Analysis of Monetised Costs and Benefits – Low and High Growth

Item	Accidents included (£000)		
	Low growth	DCO	High growth
Accidents (not assessed by TUBA)*	41,910	41,219	34,328
Greenhouse Gases**	-23,060	-22,756	-25,145
Economic Efficiency: Consumer Users (Commuting)	43,164	51,164	63,031
Economic Efficiency: Consumer Users (Other)	337,245	380,623	410,054
Economic Efficiency: Business Users and Providers	233,031	267,797	299,450
Wider Public Finances (Indirect Taxation Revenues)	56,286	55,270	60,879
Present Value of Benefits (PVB)	688,576	773,317	842,597
Broad Transport Budget Present Value of Costs (PVC)	182,798	185,542	187,910
OVERALL IMPACTS			
Net Present Value (NPV)	505,778	587,775	654,687
Benefit to Cost Ratio (BCR)	3.767	4.168	4.484

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7,
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

6.3.2 The results show that overall benefits are reduced with low growth and increased with high growth which is the usual outcome of low and high growth sensitivity tests. The Benefit Cost Ratios (BCR) of the scheme are 3.77 and 4.48 including accidents for low and high growth scenarios respectively. Under the DfT's value for money criteria, these represent High / Very High value for money categories respectively.

6.3.3 Table 6.3 below compares summary economic appraisal results including wider impacts and journey time reliability for low and growth sensitivity tests against the DCO scheme.

Table 6.3: Summary of Economic Appraisal including Wider Benefits – Low and High Growth

Item	Scenario also including WEBs and JTR (£000)		
	Low growth	DCO	High growth
Present Value of Benefits (PVB)	867,854	989,063	1,063,924
Present Value of Costs (PVC)	182,798	185,542	187,910
Net Present Value (NPV)	685,056	803,521	876,014
Benefit to Cost Ratio (BCR)	4.748	5.331	5.662

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

6.3.4 The BCRs are improved further to 4.75 and 5.66 respectively for low and high growth once journey time reliability benefits and wider economic benefits are

included in the appraisal. The inclusion of these benefits increases the BCRs to higher levels within the Very High value for money category.

7 Postwick Scheme in the Do Minimum Sensitivity Test Results

7.1 Flow Analysis Results

7.1.1 Traffic flow analysis plots for Postwick in DM scenario are shown in Figure 10.6 to Figure 10.15 of Appendix A. AADT flow comparisons between DCO DM and Postwick in DM indicate that changes are localised to Postwick area and there are very small changes on the wider network.

7.2 Operational Analysis Results

7.2.1 Table 7.1 to Table 7.3 compare maximum RFC/DoS, maximum queue and delay for Postwick junctions between DCO DS and Postwick in DM scenario for 2032 AM and PM peaks. It should be noted that the comparison is between a DS scenario (DCO DS) and a DM scenario (Postwick scheme in Do Minimum, referred to as Postwick in DM in the tables below). A direct comparison of the two DM scenarios is not possible because the new Postwick junctions do not exist in DCO DM. The results indicate that there are some differences in junction operational performance between these two scenarios mainly because of the absence of NDR in Postwick in DM scenario.

Table 7.1: Junction Operational Assessment Results: DCO DS / Postwick in DM – 2032 Max RFC/DoS

Junction	AM		PM	
	DCO DS	Postwick in DM	DCO DS	Postwick in DM
Online junctions				
Business Park	0.87	0.56	0.95	0.44
Postwick junctions				
Broadland Gate	0.95	0.76	0.55	0.63
Peachman Way	1.01	0.91	0.67	0.95
Postwick North West	0.88	0.98	1.06	1.13
Postwick North East	1.02	0.29	0.69	0.50
Oaks Lane	0.75	0.57	0.34	0.30
Park and Ride*	94.8%	94.8%	120.0%	118.7%

Notes: *This is a signalised junction while all other junctions are roundabouts/priority junction
The Ratio of Flow to Capacity (RFC) output from ARCADY/PICADY is the primary measure of a junction arm performance of a roundabout/priority junction. RFC less than 0.85 indicates that a junction arm operates within capacity. RFC greater than 0.85 but less than 1.0 indicates that a junction arm is over its desired capacity but below theoretical capacity. Any RFC greater than 1.0 indicates that a junction arm is in excess of its theoretical capacity. Degree of Saturation (DoS) output form LINSIG is the primary measure of performance of a signalised junction. DoS less than 90% indicates that a junction arm operates within capacity. DoS greater than 90% but less than 100% indicates that a junction arm is over its desired capacity but below theoretical capacity. Any DoS greater than 100% indicates that a junction arm is in excess of theoretical capacity.

Table 7.2: Junction Operational Assessment Results: DCO DS / Postwick in DM – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO DS	Postwick in DM	DCO DS	Postwick in DM
Online junctions				
Business Park	7	1	17	1
Postwick junctions				
Broadland Gate	13	3	1	2
Peachman Way	31	9	2	13
Postwick North West	7	19	19	26
Postwick North East	45	0	2	1
Oaks Lane	3	1	1	0
Park and Ride*	24	23	57	53

Notes: *This is a signalised junction while all other junctions are roundabouts/priority junction

Table 7.3: Junction Operational Assessment Results: DCO DS / Postwick in DM – 2032 Max Delay (sec/PCU)

Junction	AM		PM	
	DCO DS	Postwick in DM	DCO DS	Postwick in DM
Online junctions				
Business Park	14	3	23	3
Postwick junctions				
Broadland Gate	34	10	5	6
Peachman Way	71	26	7	44
Postwick North West	20	61	166	228
Postwick North East	74	3	7	4
Oaks Lane	21	11	7	7
Park and Ride*	115	83	383	366

Notes: *This is a signalised junction while all other junctions are roundabouts/priority junction

7.2.2 Most junctions tend to perform better in the Postwick in DM Scenario. This is due to the Postwick junctions being used to access this area and not to also perform the function of a feeder route for NDR as in the DCO DS. This is particularly evident for Postwick North East junction. The more western Postwick junctions however (Peachman Way and Postwick North West) attract significant traffic without the NDR in place.

7.2.3 The results show that in the AM peak, all junctions perform within their theoretical capacity in the Postwick in the DM scenario with overall queues and delays being lower than in the DCO DS scenario.

7.2.4 The results also show that in the PM peak, the same two junctions as in the DCO DS are operating above their theoretical capacity. For the remaining junctions, the results are mixed with the eastern junctions showing a better

performance and the western junctions showing a worse performance than in the DCO DS scenario.

7.3 Safety Analysis Results

7.3.1 Postwick in the DM safety analysis results in Table 7.4 indicate that there would be a small increase in the number of personal injury accidents and the casualty types hence overall there are more benefits compared to the DCO Scheme submission analysis. It should be noted here that Postwick in the DM accident costs are based on the reference JCS matrices as per DCO DM.

Table 7.4: Accident Benefits of Postwick in DM Sensitivity Test Scenario

60 Year Appraisal Period		Scenario	
		DCO	Postwick in DM
		Do Minimum	
Number of PIAs		70,984	71,004
Casualties	Fatal	1,890	1,896
	Serious	12,597	12,623
	Slight	91,490	91,510
Accident Costs		5,999,332	6,009,164
		Do Something	
Number of PIAs		69,944	69,944
Casualties	Fatal	1,898	1,898
	Serious	12,488	12,488
	Slight	90,226	90,226
Accident Costs		5,958,113	5,958,113
		Accident Benefits	
Number of PIA savings		1,041	1,060
Casualties	Fatal	-7	-2
	Serious	109	135
	Slight	1,263	1,284
Accident Savings		41,219	51,051

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

7.4 Economic Analysis Results

7.4.1 Table 7.5 below compares monetised costs and benefits including accident benefits for Postwick in DM sensitivity test against the DCO scheme.

Table 7.5: Analysis of Monetised Costs and Benefits – Postwick in DM

Item	Accidents included (£000)	
	DCO	Postwick in DM
Accidents (not assessed by TUBA)*	41,219	51,051
Greenhouse Gases**	-22,756	-22,349
Economic Efficiency: Consumer Users (Commuting)	51,164	51,806
Economic Efficiency: Consumer Users (Other)	380,623	419,949
Economic Efficiency: Business Users and Providers	267,797	297,406
Wider Public Finances (Indirect Taxation Revenues)	55,270	54,256
Present Value of Benefits (PVB)	773,317	852,119
Broad Transport Budget Present Value of Costs (PVC)	185,542	161,046
OVERALL IMPACTS		
Net Present Value (NPV)	587,775	691,073
Benefit to Cost Ratio (BCR)	4.168	5.291

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7.
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

7.4.2 The results show that the Present Value of Benefits (PVB) is estimated to be £852m (inclusive of accident benefits), outweighing the £161m Present Value of Costs (PVC).

7.4.3 The Benefit Cost Ratio (BCR) of the scheme is increased to 5.29 including accidents. Under the DfT's value for money criteria, this represents a Very High value for money category.

7.4.4 Table 7.6 below compares summary economic appraisal results including wider impacts and journey time reliability for Postwick in DM sensitivity test against the DCO scheme.

Table 7.6: Summary of Economic Appraisal including Wider Benefits – Postwick in DM

Item	Scenario also including WEBs and JTR (£000)	
	DCO	Postwick in DM
Present Value of Benefits (PVB)	989,063	1,090, 480
Present Value of Costs (PVC)	185,542	161,046
Net Present Value (NPV)	803,521	929,434
Benefit to Cost Ratio (BCR)	5.331	6.771

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

7.4.5 The BCR is improved further to 6.77 once journey time reliability benefits (£30m) and wider economic benefits (£208m) are included in the appraisal.

These additional benefits amount to £238m (2010 prices discounted to 2010). The inclusion of these benefits increases the BCR to a higher level within the Very High value for money category.

8 Dependent Development Sensitivity Test Results

8.1 Flow Analysis Results

8.1.1 Traffic flow analysis plots for two dependent development sensitivity test scenarios are shown in Figure 10.16 to Figure 10.25 of Appendix A.

8.1.2 In Table 8.1 below a comparison of AADT figures is made between the dependent development assignment and the DCO submission assignment. The changes overall suggest that dependent development sensitivity test would produce similar forecast traffic flows on the NDR and thus similar Scheme impacts.

Table 8.1: NDR Locations AADT Comparison

Location	Link	Direction	Dependent dev	DCO Submission	Difference	% Difference
A66	Holt Road - Cromer Road Link	WB/EB	30,200	30,400	-200	-1%
A67	Cromer Road - Airport Link	NEB/SWB	28,200	29,800	-1,600	-5%
A68	Airport - North Walsham Road Link	WB/EB	28,200	29,800	-1,600	-5%
A69	North Walsham Road - Wroxham Road Link	WB/EB	37,700	39,100	-1,400	-4%
A70	Wroxham Road - Salhouse Road Link	NWB/SEB	45,400	43,900	1,500	3%
A71	Salhouse Road - Plumstead Road Link	NWB/SEB	43,800	46,000	-2,200	-5%
A72	Plumstead Road - Postwick Hub Link	NB/SB	44,700	46,400	-1,700	-4%
A73	Postwick Hub - A47 Link	NB/SB	42,600	42,900	-300	-1%
A79	Fakenham Road - Fir Covert Road Link	NEB/SWB	16,500	16,500	0	0%
A90	Fir Covert Road - Reepham Road Link	NEB/SWB	20,700	20,800	-100	0%
A91	Reepham Road - Holt Road Link	WB/EB	26,800	26,400	400	2%

8.2 Operational Analysis Results

8.2.1 The dependent development scenario provides an alternative growth when Postwick Hub is in place. More details on this scenario can be found in Section 3. Table 8.2 to Table 8.4 compare maximum RFC/DoS, maximum queue and delay for online NDR and Postwick junctions between DCO and dependent development scenario (developer links included) for 2032DS AM

and PM peaks. The results indicate that there is no substantial difference in junction operational performance between these two scenarios.

8.2.2 The flows used in the DS operational assessments refer to the DM dependent development reference matrices assigned onto DS networks. These will provide an alternative development scenario where only Postwick Hub released developments are spatially allocated.

Table 8.2: Junction Operational Assessment Results_Dependent Development – 2032 Max RFC/DoS

Junction	AM		PM	
	DCO	Dependent dev	DCO	Dependent dev
Online junctions				
Fakenham Road	0.52	0.52	0.52	0.52
Fir Covert Road	0.55	0.53	0.51	0.55
Reepham Road	0.57	0.59	0.64	0.66
Drayton Lane	1.09	1.13	0.96	0.96
Holt Road/Drayton Lane	0.51	0.55	0.44	0.48
Cromer Road South	0.86	0.66	0.97	0.94
Cromer Road North	0.98	0.82	0.61	0.63
Airport	0.87	0.85	0.79	0.68
North Walsham Road	1.10	1.01	0.83	0.78
Wroxham Road	0.99	0.97	0.95	1.01
Salhouse Road	0.95	0.96	0.97	0.93
Plumstead Road North	0.40	0.29	0.40	0.50
Plumstead Road South	0.98	0.96	0.88	0.91
Business Park	0.87	0.78	0.95	0.92
Postwick junctions				
Broadland Gate	0.95	0.98	0.55	0.49
Peachman Way	1.01	1.03	0.67	0.61
Postwick North West	0.88	0.89	1.06	1.10
Postwick North East	1.02	1.03	0.69	0.73
Oaks Lane	0.75	0.72	0.34	0.37
Park and Ride*	94.8%	93.3%	120.0%	121.7%

Notes: *This is a signalised junction while all other junctions are roundabouts/priority junction

The Ratio of Flow to Capacity (RFC) output from ARCADY/PICADY is the primary measure of a junction arm performance of a roundabout/priority junction. RFC less than 0.85 indicates that a junction arm operates within capacity. RFC greater than 0.85 but less than 1.0 indicates that a junction arm is over its desired capacity but below theoretical capacity. Any RFC greater than 1.0 indicates that a junction arm is in excess of its theoretical capacity.

Degree of Saturation (DoS) output form LINSIG is the primary measure of performance of a signalised junction. DoS less than 90% indicates that a junction arm operates within capacity. DoS greater than 90% but less than 100% indicates that a junction arm is over its desired capacity but below theoretical capacity. Any DoS greater than 100% indicates that a junction arm is in excess of theoretical capacity.

Table 8.3: Junction Operational Assessment Results_Dependent Development – 2032 Max Queue (PCUs)

Junction	AM		PM	
	DCO	Dependent dev	DCO	Dependent dev
Online junctions				
Fakenham Road	1	1	1	1
Fir Covert Road	1	1	1	1
Reepham Road	1	1	2	2
Drayton Lane	39	53	13	13
Holt Road/Drayton Lane	1	1	1	1
Cromer Road South	6	2	20	13
Cromer Road North	18	4	7	2
Airport	6	6	4	2
North Walsham Road	53	25	5	4
Wroxham Road	28	19	10	40
Salhouse Road	15	18	13	9
Plumstead Road North	1	0	1	1
Plumstead Road South	26	18	7	9
Business Park	7	3	17	10
Postwick junctions				
Broadland Gate	13	21	1	1
Peachman Way	31	44	2	2
Postwick North West	7	7	19	23
Postwick North East	45	53	2	3
Oaks Lane	3	3	1	1
Park and Ride	24	21	57	61

Notes: *This is a signalised junction while all other junctions are roundabouts/priority junction

Table 8.4: Junction Operational Assessment Results_Dependent Development – 2032 Max Delay (sec)

Junction	AM		PM	
	DCO	Dependent dev	DCO	Dependent dev
Online junctions				
Fakenham Road	3	4	4	4
Fir Covert Road	7	7	7	7
Reepham Road	9	11	7	7
Drayton Lane	170	215	59	63
Holt Road/Drayton Lane	5	5	5	5
Cromer Road South	15	6	45	30
Cromer Road North	56	13	38	10
Airport	12	11	8	5
North Walsham Road	170	88	22	14
Wroxham Road	43	31	38	55
Salhouse Road	39	28	70	51
Plumstead Road North	5	4	4	6

Junction	AM		PM	
	DCO	Dependent dev	DCO	Dependent dev
Plumstead Road South	36	25	11	13
Business Park	14	8	23	47
Postwick junctions				
Broadland Gate	34	49	5	4
Peachman Way	71	94	7	7
Postwick North West	20	19	166	193
Postwick North East	74	83	7	8
Oaks Lane	21	19	7	7
Park and Ride	115	98	383	402

Notes: *This is a signalised junction while all other junctions are roundabouts/priority junction

8.2.3 Though some of the priority junctions and roundabouts are over capacity, further tests indicated that a slight adjustment of flare/ entry width can bring junction performance to an acceptable level. Such a change, where sufficient land is available, could be implemented by the highways authority should monitoring show increased delays at these junctions.

8.2.4 Postwick P&R signal junction would work above its theoretical capacity on the Yarmouth Road arm in 2032DS PM peak. Comparing these results with those reported for existing roundabout in Document Reference 5.5, however, represents a significant improvement on the Yarmouth Road arm.

8.3 Safety Analysis Results

8.3.1 These results have been produced for two scenarios, one with and one without developer link roads included. Table 8.5 shows that the two scenarios produce slightly different accident benefits compared to DCO. These scenarios include Postwick in the DM and are based on different matrices as described in Section 3.

Table 8.5: Accident Benefits of Dependent Development Sensitivity Test Scenarios

60 Year Appraisal Period		Scenario		
		DCO	Dep dev_dev links included	Dep dev_dev links excluded
		Do Minimum		
Number of PIAs		70,984	71,577	71,501
Casualties	Fatal	1,890	1,909	1,906
	Serious	12,597	12,716	12,698
	Slight	91,490	92,236	92,133
Accident Costs		5,999,332	6,052,206	6,042,491
		Do Something		

Number of PIAs		69,944	70,195	70,195
Casualties	Fatal	1,898	1,899	1,899
	Serious	12,488	12,515	12,514
	Slight	90,226	90,503	90,503
Accident Costs		5,958,113	5,971,656	5,971,037
		Accident Benefits		
Number of PIA savings		1,041	1,382	1,306
Casualties	Fatal	-7	10	7
	Serious	109	201	184
	Slight	1,263	1,733	1,630
Accident Savings		41,219	80,550	71,454

Notes: All monetary values are expressed in £000's in 2010 prices discounted to 2010

8.4 Economic Analysis Results

8.4.1 Table 8.6 below compares monetised costs and benefits including accident benefits for the dependent development sensitivity tests against the DCO Scheme. It should be noted that dependent development benefits relates to NDR in isolation.

Table 8.6: Analysis of Monetised Costs and Benefits – Dependent Development (NDR in Isolation

Item	Accidents included (£000)		
	DCO	Developer links included	Developer links excluded
Accidents (not assessed by TUBA)*	41,219	80,550	71,454
Greenhouse Gases**	-22,756	-26,011	-26,293
Economic Efficiency: Consumer Users (Commuting)	51,164	37,823	38,890
Economic Efficiency: Consumer Users (Other)	380,623	389,813	391,528
Economic Efficiency: Business Users and Providers	267,797	225,078	226,759
Wider Public Finances (Indirect Taxation Revenues)	55,270	62,057	63,523
Present Value of Benefits (PVB)	773,317	769,310	765,861
Broad Transport Budget Present Value of Costs (PVC)	185,542	161,668	161,882
OVERALL IMPACTS			
Net Present Value (NPV)	587,775	607,642	603,979
Benefit to Cost Ratio (BCR)	4.168	4.759	4.731

Notes: All monetary values are expressed in 2010 prices discounted to 2010
*Detailed summary results can be found in Section 6. The lower conservative accident benefit is included based upon the use of local accident data, as explained in section 7 of Reference Document 5.7.
**Greenhouse gas impacts were calculated using TUBA1.9.2 since there was a bug in TUBA 1.9.1

8.4.2 The Benefit Cost Ratio (BCR) of the scheme is 4.76 and 4.73 (including accidents) for developer links included and excluded scenarios respectively.

Under the DfT's value for money criteria, these represent Very High value for money category.

8.4.3 Table 8.7 below compares summary economic appraisal results including wider impacts and journey time reliability for dependent development sensitivity test again when the transport scheme is assessed in isolation against the DCO scheme.

Table 8.7: Summary of Economic Appraisal including Wider Benefits – Dependent Development (NDR in Isolation)

Item	Scenario also including WEBs and JTR (£000)		
	DCO	Developer links included	Developer links excluded
Present Value of Benefits (PVB)	989,063	968,674	969,650
Present Value of Costs (PVC)	185,542	161,668	161,882
Net Present Value (NPV)	803,521	807,006	807,768
Benefit to Cost Ratio (BCR)	5.331	5.992	5.990

Notes: All monetary values are in £000's and expressed in 2010 prices discounted to 2010

8.4.4 The BCRs are improved further to 5.99 in both instances once journey time reliability benefits and wider economic benefits are included in the appraisal. The inclusion of these benefits increases the BCRs to higher levels within the Very High value for money category.

8.4.5 As discussed in the previous section there are additional development benefits for this scenario. These are reported below and would increase the scheme benefits in total by £1,146m in terms of TECs and £422m in terms of GVA benefits in 2010 prices discounted to 2010 for both scenarios.

8.4.6 GVA benefits for NDR dependent business developments are reported in Table 8.8 below. These were direct extractions just for dependent business developments from Document Reference 10.3 of the DCO submission. Total GVA of the dependent business developments is £422.4m in 2010 prices discounted to 2010.

Table 8.8: GVA Benefits of NDR Dependent Developments

Year	GVA (£m)			
	Rackheath Eco Town	Airport Site 3	Airport Industrial State	Total
2018	1.6	1.3	0	2.9
2019	3.1	2.4	0.1	5.6
2020	4.3	3.4	0.1	7.8
2021	5.4	4.3	0.1	9.8
2022	6.4	5.1	0.1	11.6
2023	7.3	5.8	0.1	13.2

Year	GVA (£m)			
	Rackheath Eco Town	Airport Site 3	Airport Industrial State	Total
2024	8	6.4	0.2	14.6
2025	8.6	6.9	0.2	15.7
2026	9.1	7.3	0.2	16.6
2027	9.6	7.6	0.2	17.4
2028	9.9	7.9	0.2	18
2029	10.2	8.1	0.2	18.5
2030	10.5	8.3	0.2	19
2031	10.6	8.5	0.2	19.3
2032	10.7	8.5	0.2	19.4
2033	10.8	8.6	0.2	19.6
2034	10.8	8.6	0.2	19.6
2035	10.2	8.1	0.2	18.5
2036	9.6	7.7	0.2	17.5
2037	9.1	7.2	0.2	16.5
2038	8.6	6.8	0.2	15.6
2039	8.1	6.4	0.2	14.7
2040	7.6	6.1	0.1	13.8
2041	7.2	5.7	0.1	13
2042	6.8	5.4	0.1	12.3
2043	6.4	5.1	0.1	11.6
2044	6.1	4.8	0.1	11
2045	5.7	4.5	0.1	10.3
2046	5.4	4.3	0.1	9.8
2047	5.1	4	0.1	9.2
Total	232.8	185.1	4.5	422.4

Notes: All monetary values are expressed in 2010 prices discounted to 2010, directly copied form Table A-5 of Document Reference 10.3 of the DCO submission

8.4.7 Planning gain has been calculated for the Eco Town, Airport and Beyond Green developments assuming that the total development areas reported below will be unlocked on non-previously developed land in 2032 and there is a linear development profile from 2017 to 2032. Planning gain benefits for NDR dependent developments are reported in Table 8.9. The total net planning gain of the dependent developments is £121m in 2010 prices discounted to 2010.

Table 8.9: Planning Gain Benefits of NDR Dependent Developments

Site	Development type	Total development area (ha)	Value of developed work (£000)	Value of land in existing use (£000)	Net externalities (£000)	Net planning gain (£000)
Eco	Residential	141	1,600	19	838	104,739

Site	Development type	Total development area (ha)	Value of developed work (£000)	Value of land in existing use (£000)	Net externalities (£000)	Net planning gain (£000)
Town	Business	25	1,187	19	838	8,240
Airport	Business	30	1,187	19	838	9,888
Beyond Green	Residential	105	1,600	19	838	77,653
Total planning gain (£000s in 2010 prices, undiscounted)						200,520
Total planning gain (£m in 2010 prices discounted to 2010)						121

8.4.8 Transport external costs of NDR dependent developments are reported in Table 8.10 and Table 8.11 for the two scenarios. TEC was calculated for a 30 year period from 2017 to 2046 using two transport model runs namely, without the new developments but with the transport intervention and with the new developments and with the transport intervention. The negative result for TEC occurs because a transport intervention is being provided to cater for the development traffic, and both scenarios are controlled to NTEM.

Table 8.10: Transport External Costs of NDR Dependent Developments_developer links included

Scenario	User Time (£000s)	User Charges (£000)	Vehicle Operating Costs (£000)	Operator Revenues (£000)	CO2 Emissions (£000)
With the new developments and with transport intervention	50,907,354	1,907,360	36,905,802	-3,786,646	-5,191,720
Without the new developments but with the transport intervention	51,235,324	1,953,564	36,998,622	-3,878,372	-5,201,374
Development only costs	500,778	37,386	229,282	-74,240	-34,102
TEC (£000s)	-828,748	-83,590	-322,102	165,966	43,756
TEC total (£m)	-1,025				

Notes: All monetary values are expressed in 2010 prices discounted to 2010

Table 8.11: Transport External Costs of NDR Dependent Developments_developer links excluded

Scenario	User Time (£000s)	User Charges (£000)	Vehicle Operating Costs (£000)	Operator Revenues (£000)	CO2 Emissions (£000)
With the new developments and with transport intervention	50,906,846	1,907,442	36,910,506	-3,786,796	-5,192,058
Without the new developments but with the transport intervention	51,234,812	1,953,638	37,003,316	-3,878,528	-5,201,712
Development only costs	500,778	37,386	229,282	-74,240	-34,102
TEC (£000s)	-828,744	-83,582	-322,092	165,972	43,756
TEC total (£m)	-1,025				

Notes: All monetary values are expressed in 2010 prices discounted to 2010

8.4.9 Derivation of total dependent development benefits of NDR dependent developments are reported in Table 8.12. It should be noted that as the TECs are negative and they are subtracted from the planning gain, this results in positive total benefits for the developments.

Table 8.12: Derivation of Total Development Benefits of NDR Dependent Developments

Item	Benefits (£m)	
	Developer links included	Developer links excluded
Planning Gain	121	121
Transport External Costs	-1,025	-1,025
Other Externalities*	0	0
Total Development Benefits	1,146	1,146

Notes: All monetary values are expressed in 2010 prices discounted to 2010, *assumed zero

9 Conclusion

9.1.1 The series of sensitivity tests has been undertaken primarily to test the robustness of the economic appraisal of the Scheme to changes in parameters, forecast assumptions and methodology. The traffic flow forecasts of the Scheme in these test scenarios have also been reviewed and where appropriate operational performance has been assessed.

9.1.2 The submission showed that the DCO Scheme would deliver a benefit-to-cost ratio (BCR) of 4.17 (inclusive of accident benefits) and a BCR of 5.33 when WEBs and JTR are included. Both of these represent very high value for money (BCR above 4) according to DfT's VfM criteria.

9.1.3 The sensitivity test results indicate that benefit-to-cost ratio (BCR) ranges from 3.68 to 5.36 (inclusive of accident benefits) and 4.75 to 6.86 when WEBs and JTR are included. Both of these represent high/very high value for money (BCR above 3/4) for all the sensitivity test scenarios according to DfT's VfM criteria. It is therefore concluded that the transport benefits reported in the submission are robust and that the Scheme would deliver high or very high value for money.

9.1.4 In addition to the transport benefits the testing using the dependent development methodology shows that the completion of the NDR would deliver very high development benefits amounting to £1,146m. In addition the business development dependent on completion of the NDR could realise £422m of GVA benefits, though these should not simply be added to development benefits.

10 Appendices

10.1 Appendix A – Flow Diagrams

10.1.1 Figure 10.2 to Figure 10.6 contain traffic flow information for low growth scenario. Figure 10.6 to Figure 10.10 contain traffic flow information for high growth scenario.

10.1.2 Figure 10.11 to Figure 10.15 contain traffic flow information for Postwick in DM scenario. There are no changes to DS traffic flows compared to the DCO Scheme.

10.1.3 Figure 10.16 to Figure 10.20 contain traffic flow information for dependent development with developer link roads included and Figure 10.21 to Figure 10.25 contain traffic flow information for dependent development with developer link roads excluded. The flows for DS here refer to the DM dependent development reference matrices assigned onto DS networks. These provide an alternative development scenario where only developments unlocked by Postwick Hub are spatially allocated.

Figure 10.1: AADT Traffic Flows Western Section_Low Growth Scenario

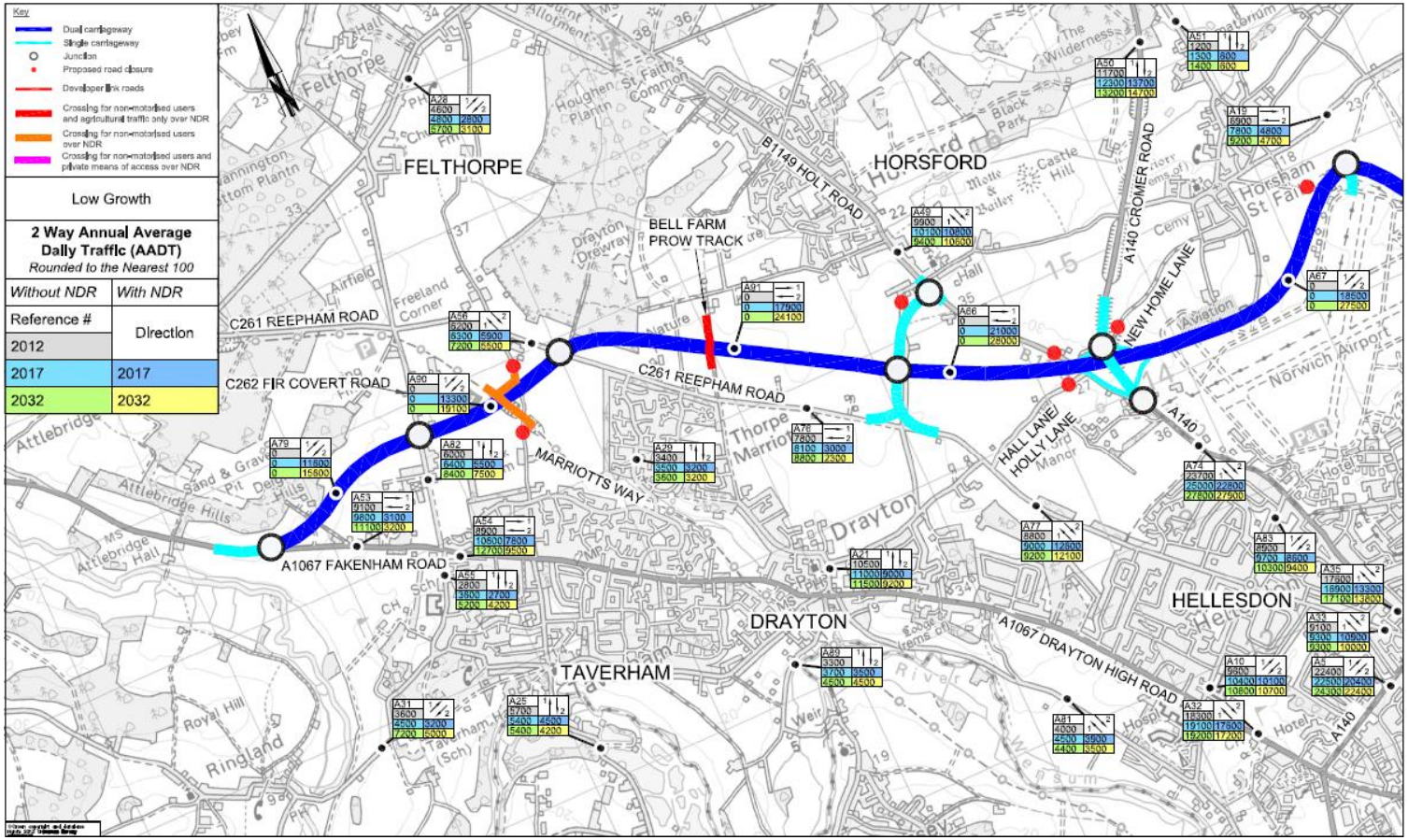


Figure 10.2: AADT Traffic Flows Eastern Section_Low Growth Scenario

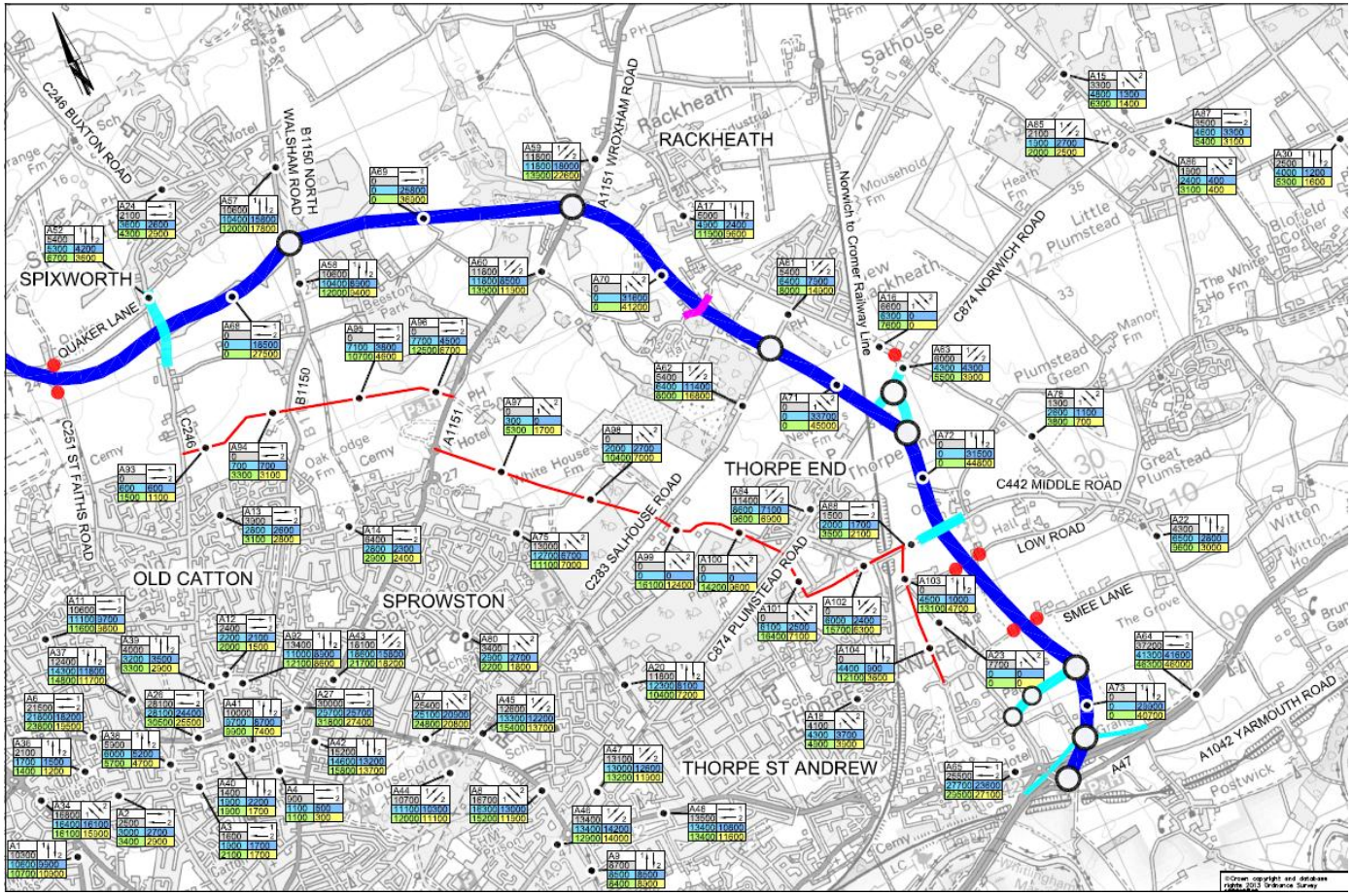


Figure 10.3: AADT Traffic Flows Wensum Valley Section_Low Growth Scenario

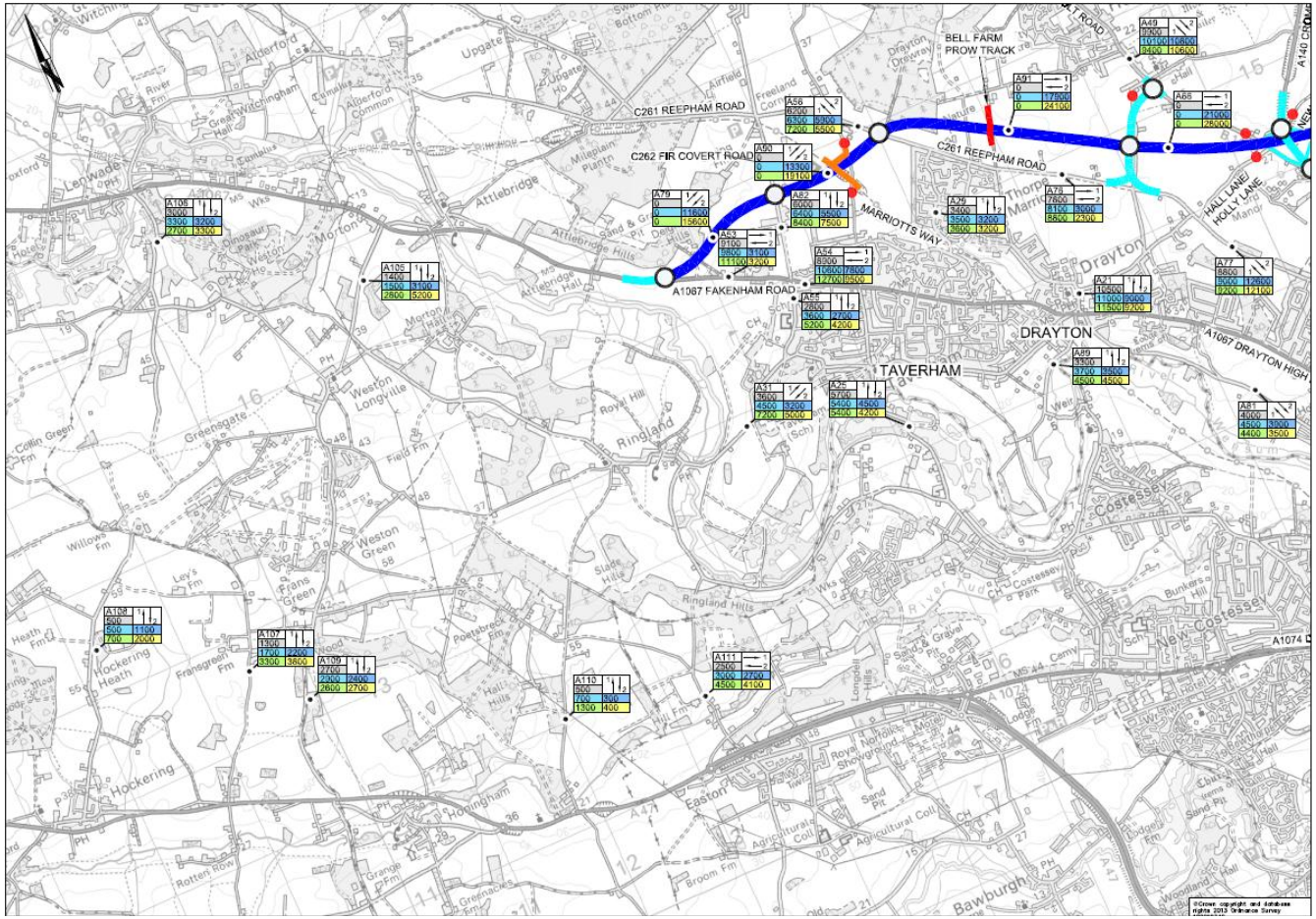


Figure 10.4: Strategic Traffic Movements_Low Growth Scenario

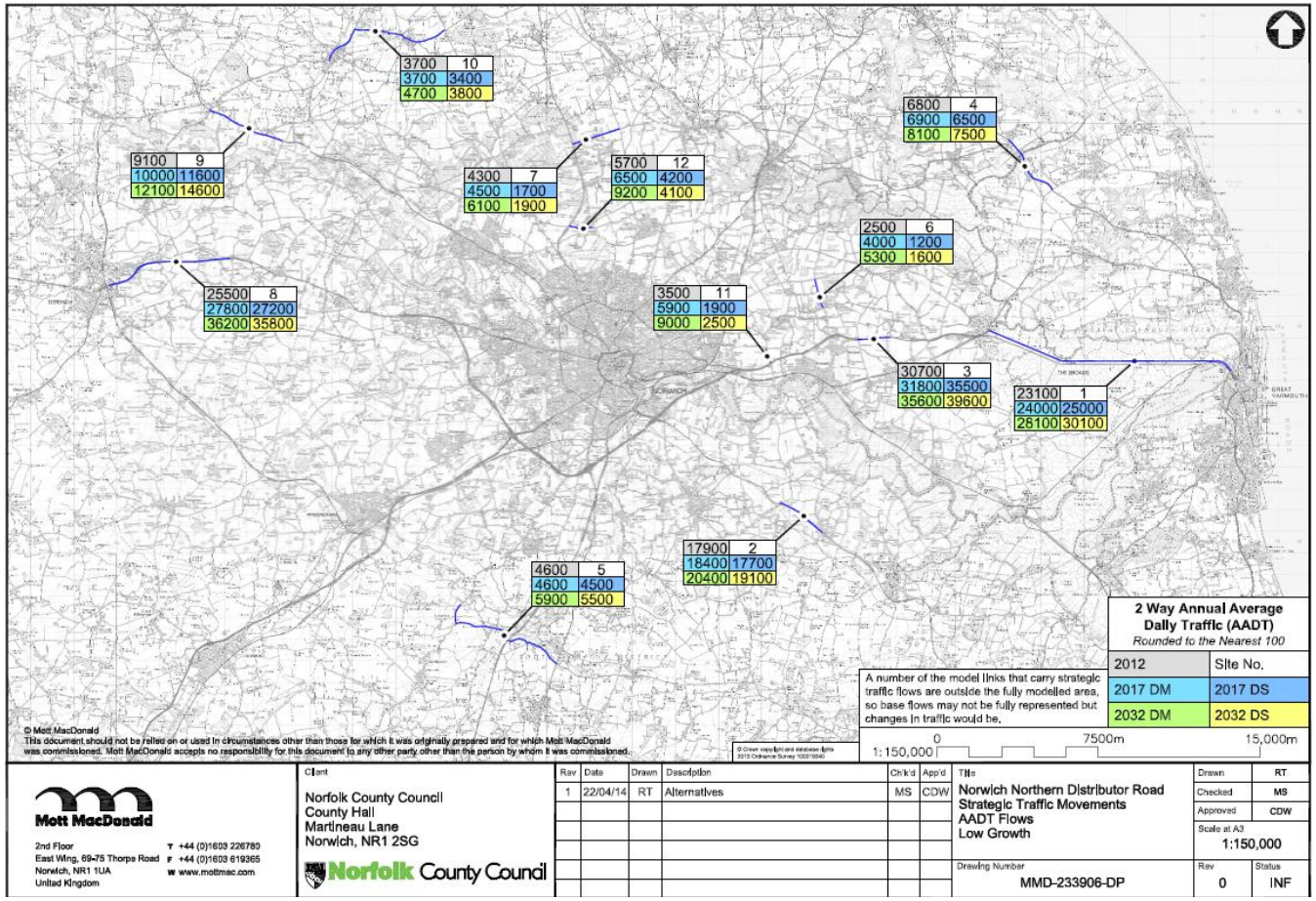


Figure 10.5: City Centre Traffic Impact_Low Growth Scenario

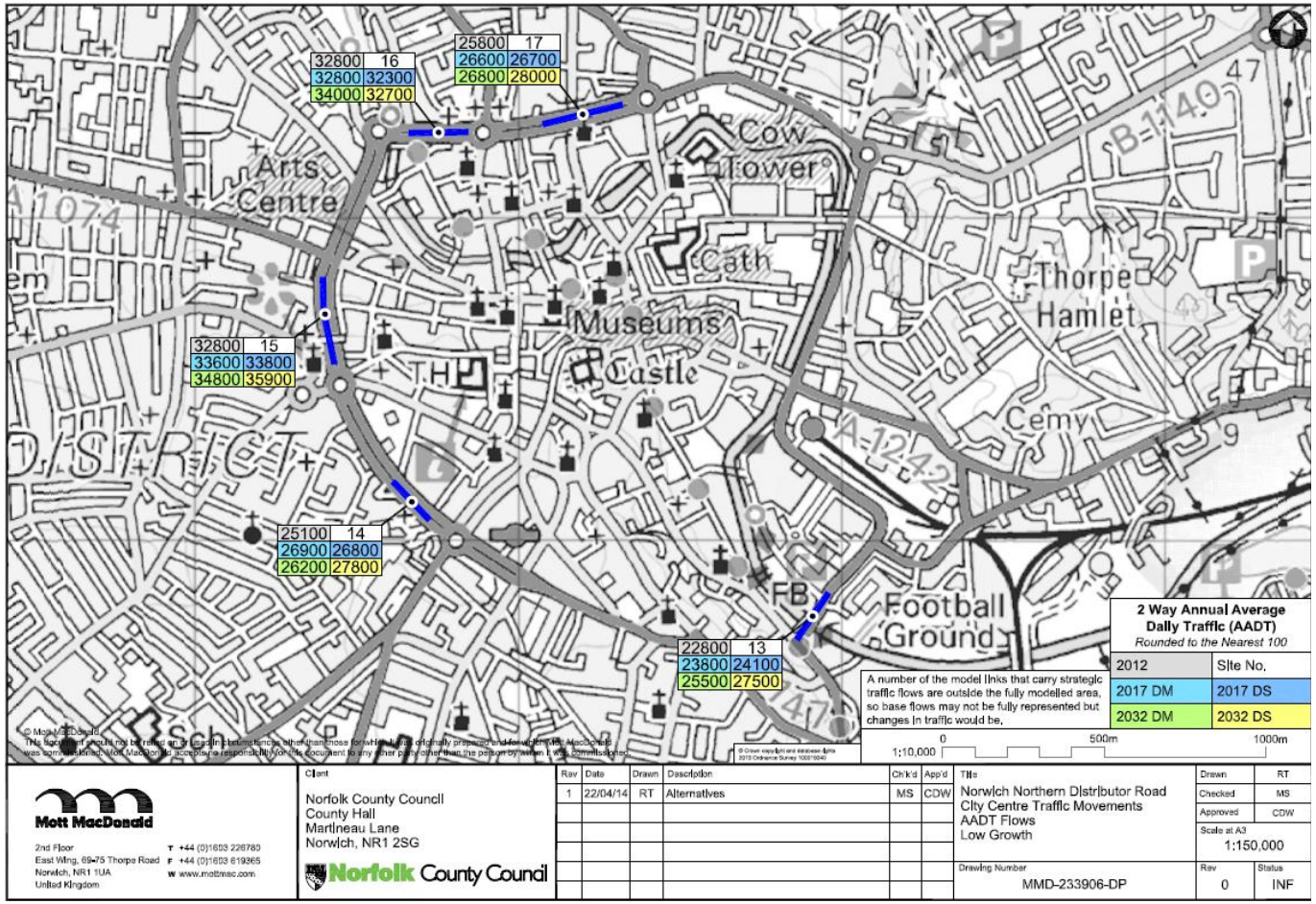


Figure 10.6: AADT Traffic Flows Western Section_High Growth Scenario

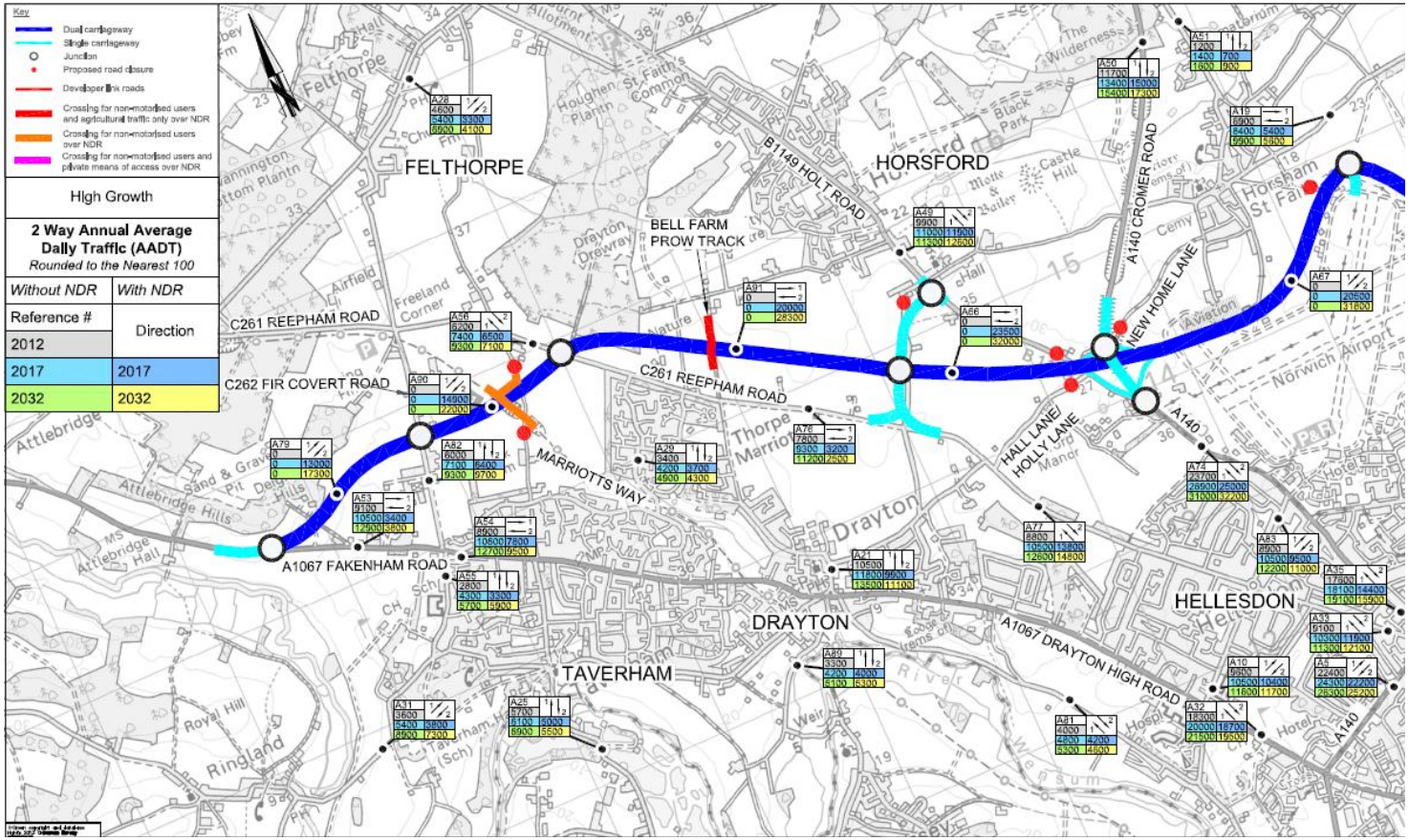


Figure 10.7: AADT Traffic Flows Eastern Section_High Growth Scenario

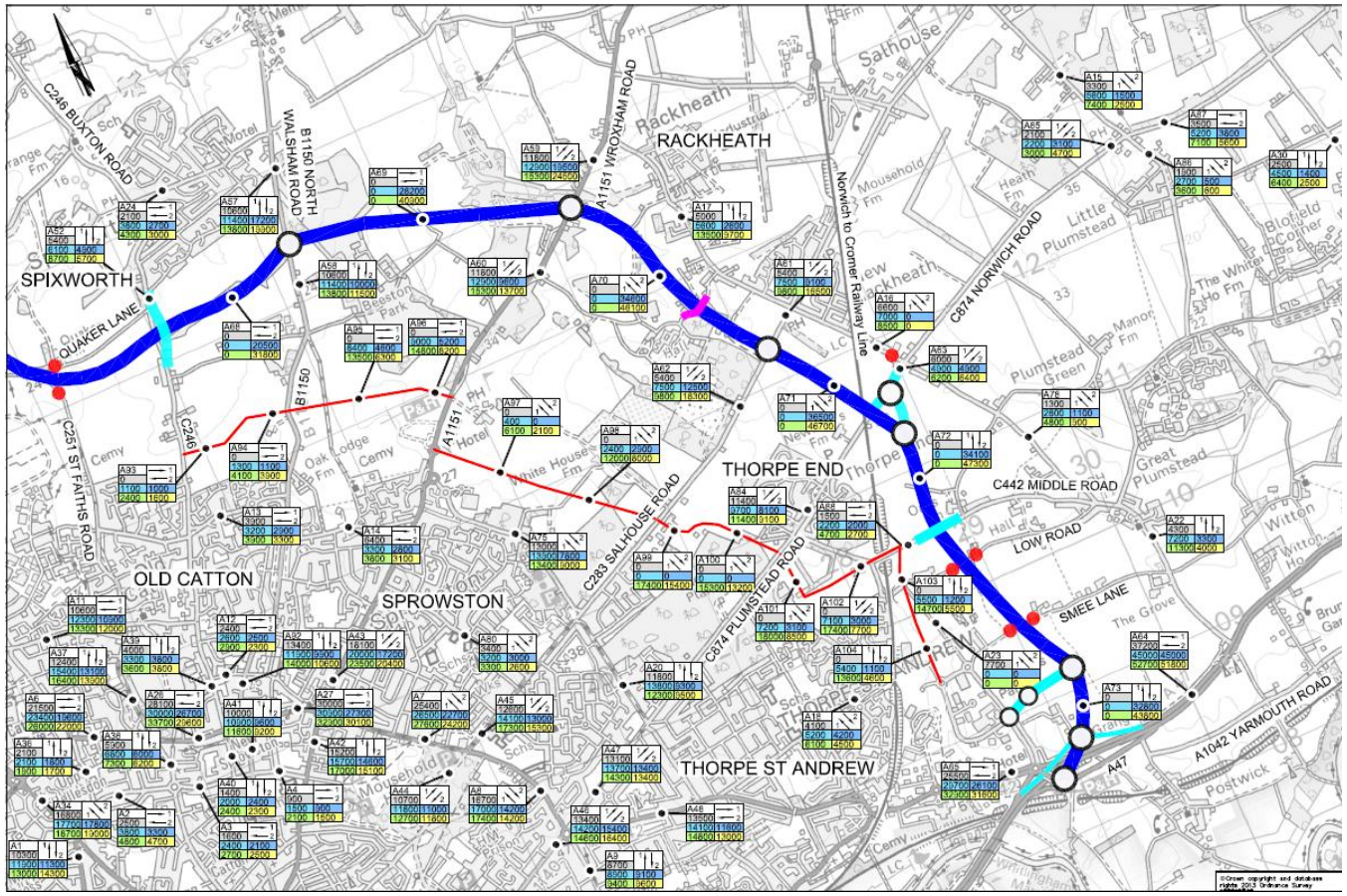


Figure 10.8: AADT Traffic Flows Wensum Valley Section_High Growth Scenario

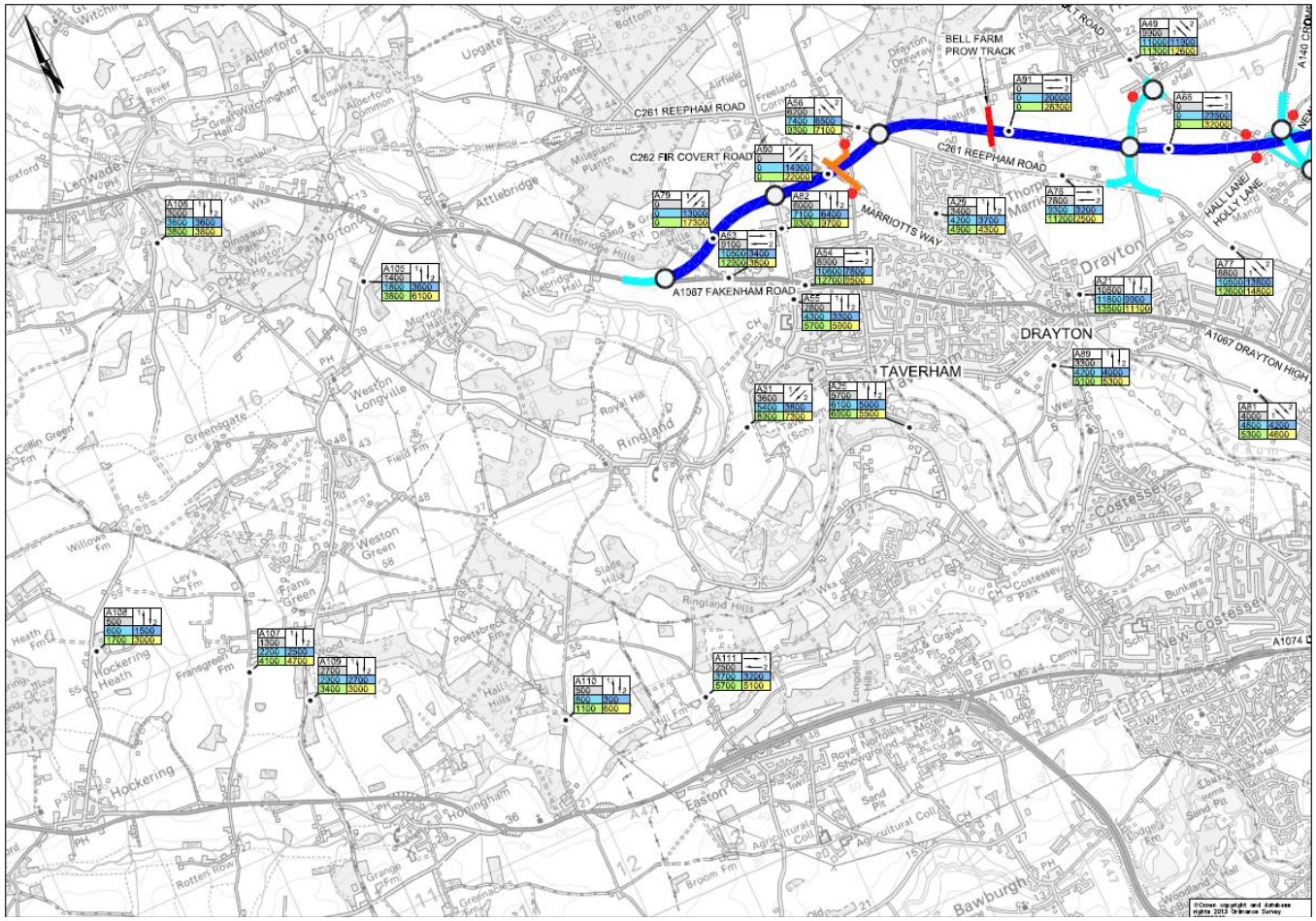


Figure 10.9: Strategic Traffic Movements_High Growth Scenario

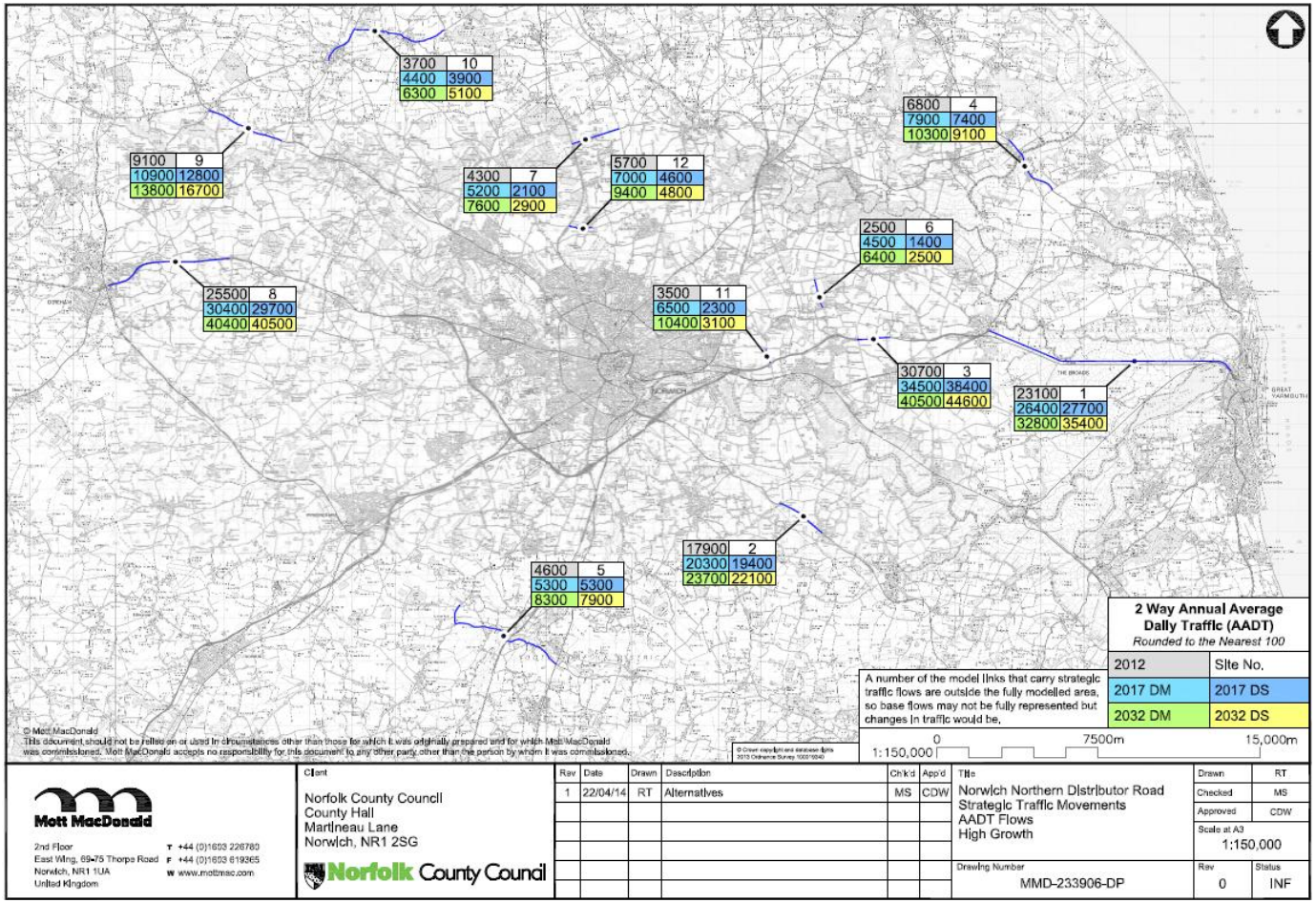


Figure 10.10: City Centre Traffic Impact_High Growth Scenario

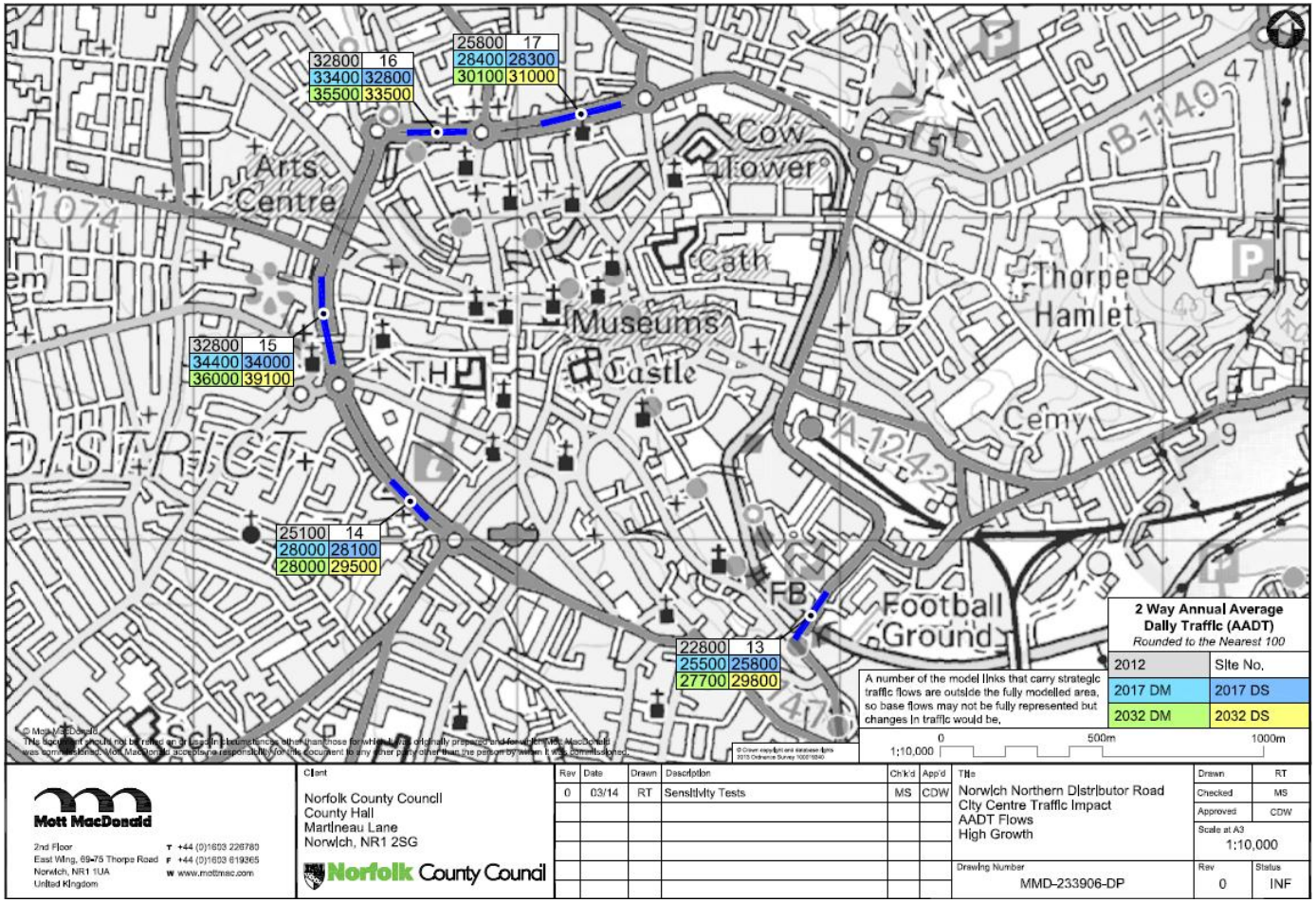


Figure 10.11: AADT Traffic Flows Western Section_Postwick in DM Scenario

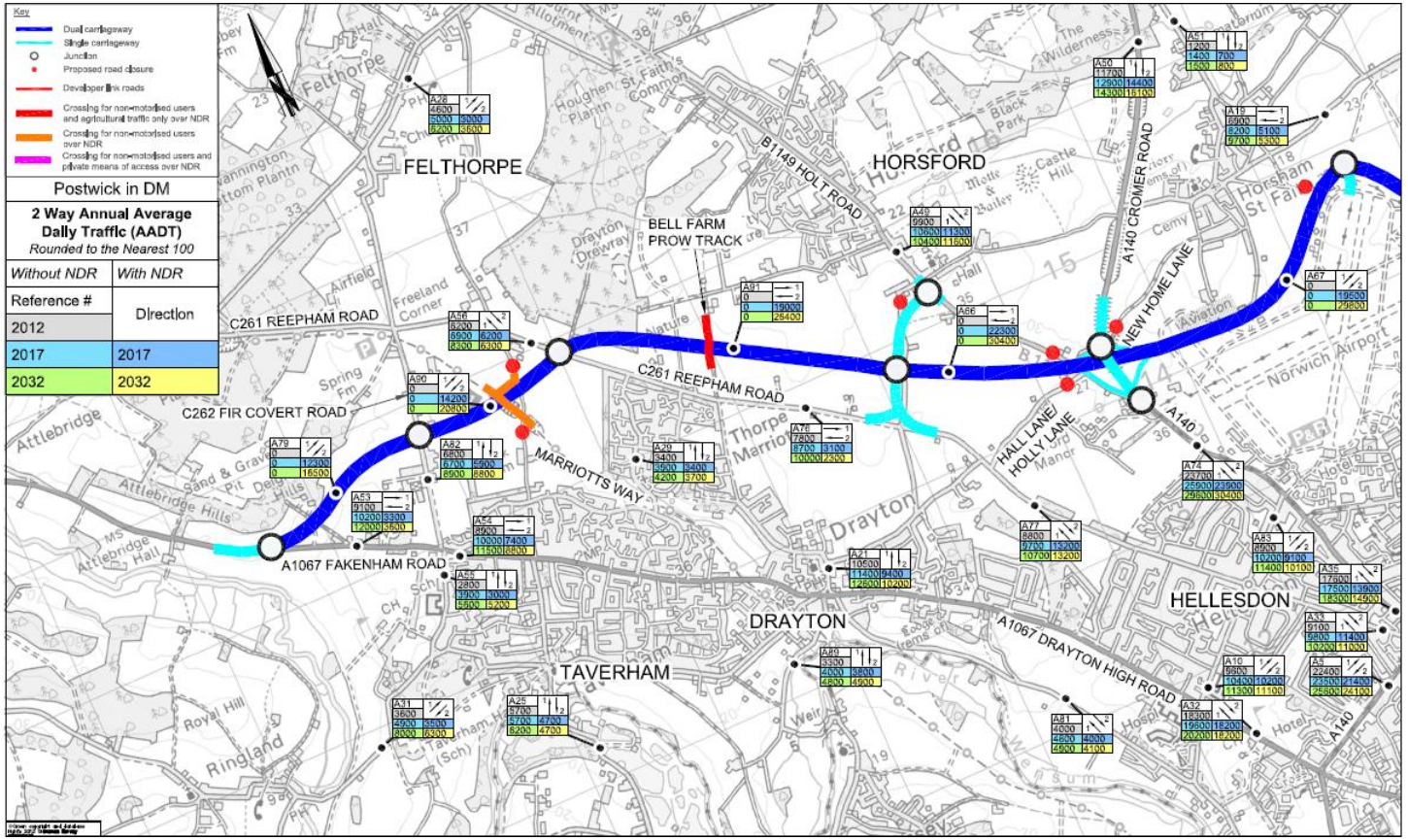


Figure 10.12: AADT Traffic Flows Eastern Section_Postwick in DM Scenario

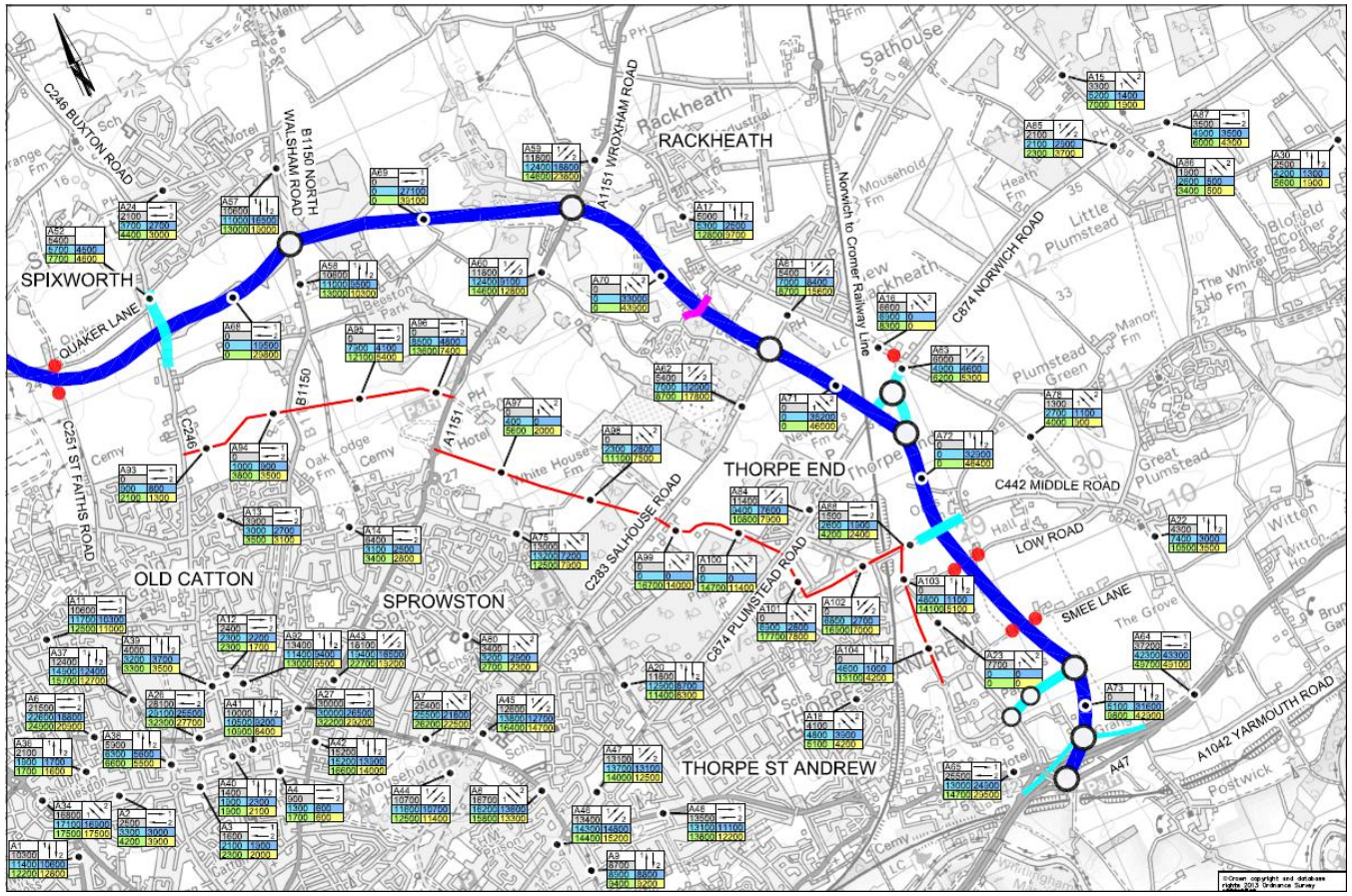


Figure 10.13: AADT Traffic Flows Wensum Valley Section_Postwick in DM Scenario

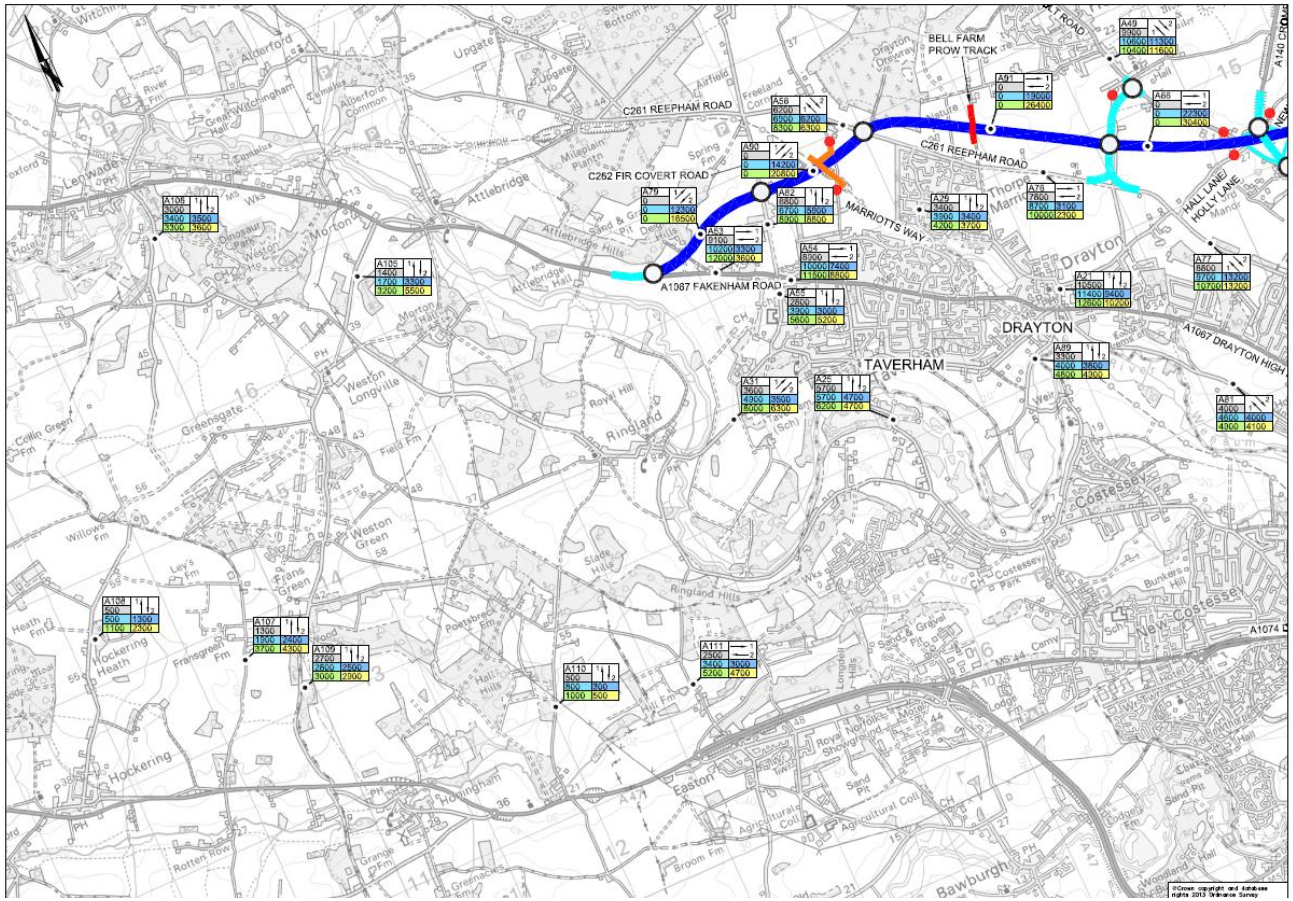


Figure 10.14: Strategic Traffic Movements_Postwick in DM Scenario

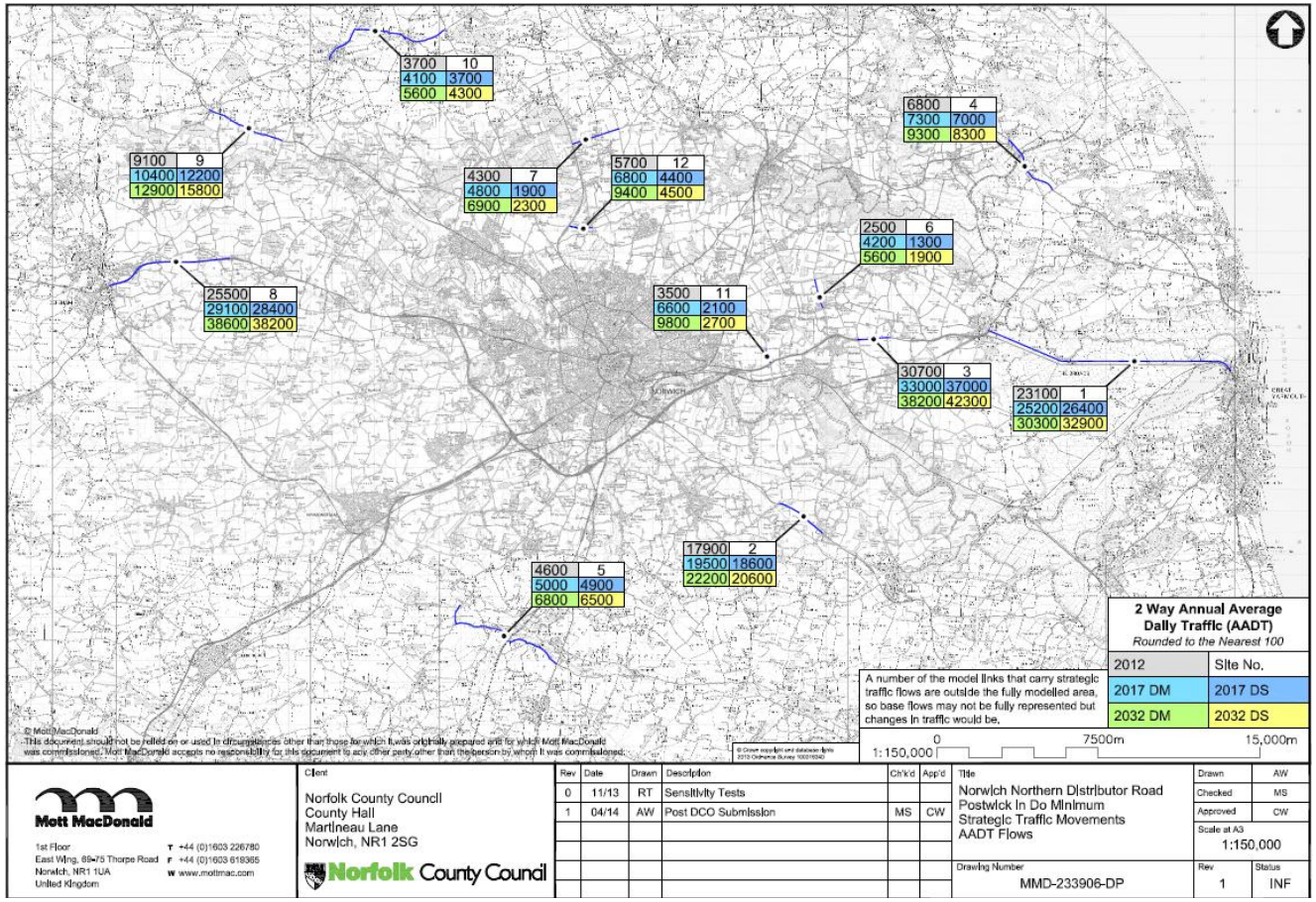


Figure 10.15: City Centre Traffic Impact_Postwick in DM Scenario

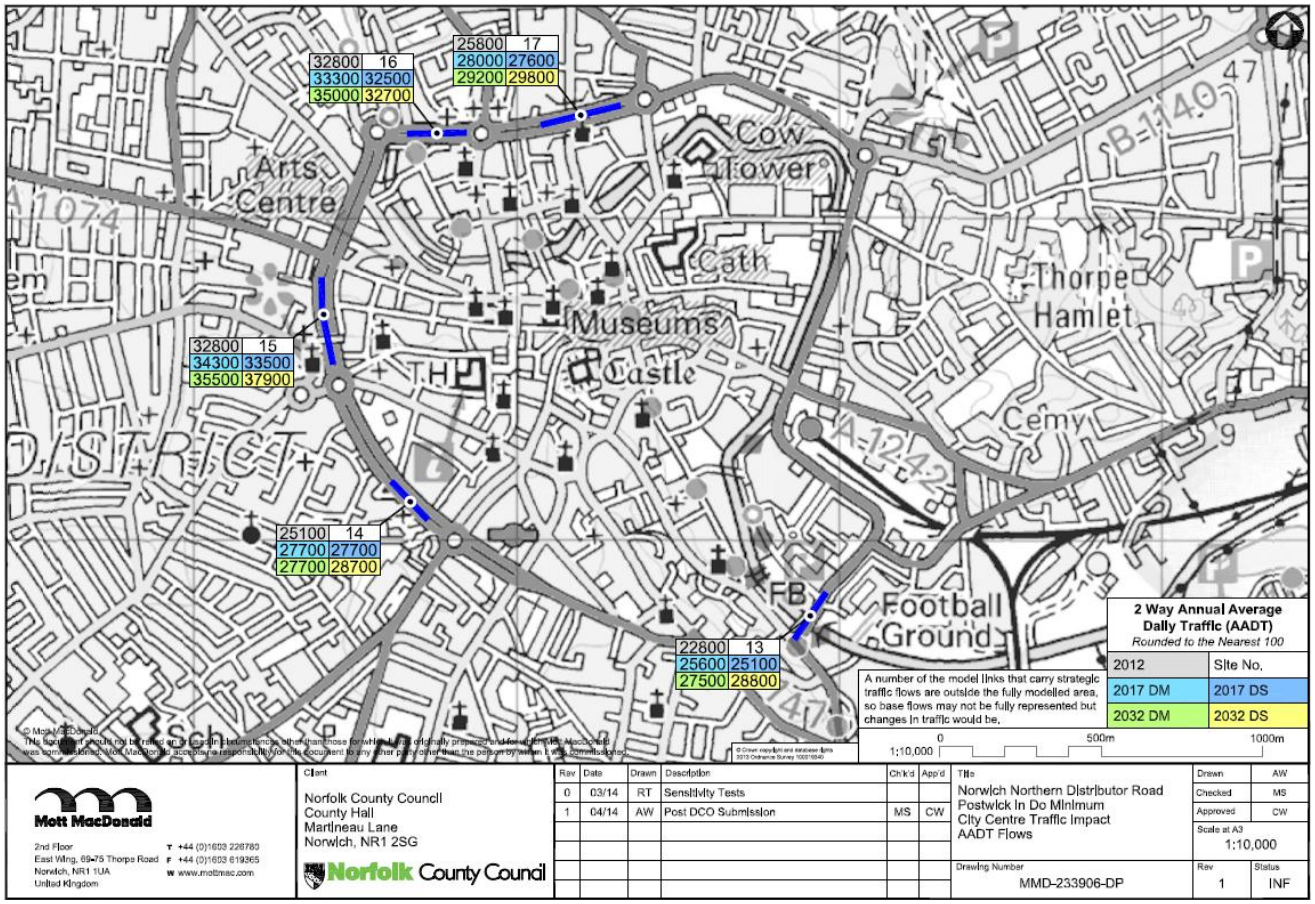


Figure 10.16: AADT Traffic Flows Western Section_ Dependent Development with Developer Links Included Scenario

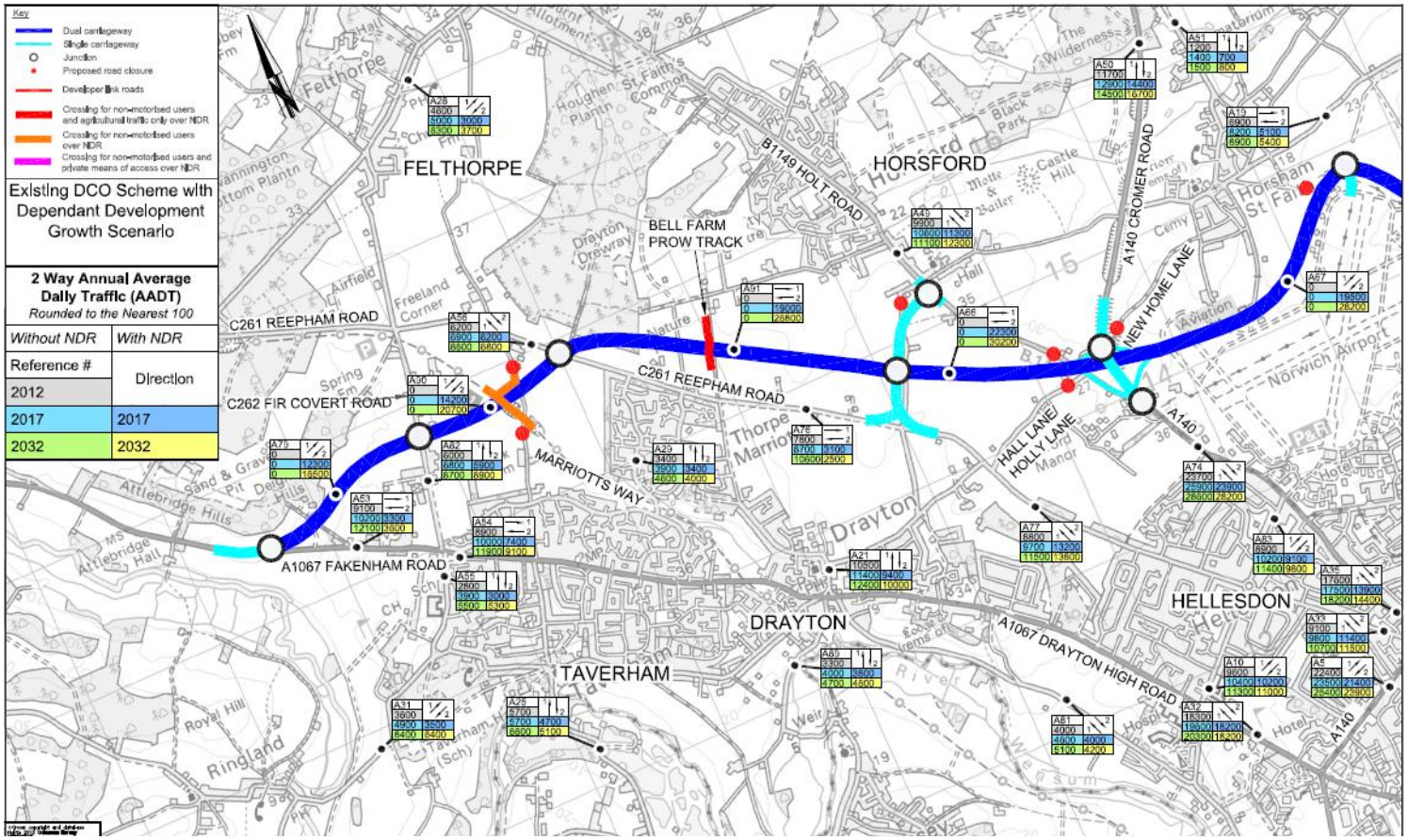


Figure 10.17: AADT Traffic Flows Eastern Section_Dependent Development with Developer Links Included Scenario

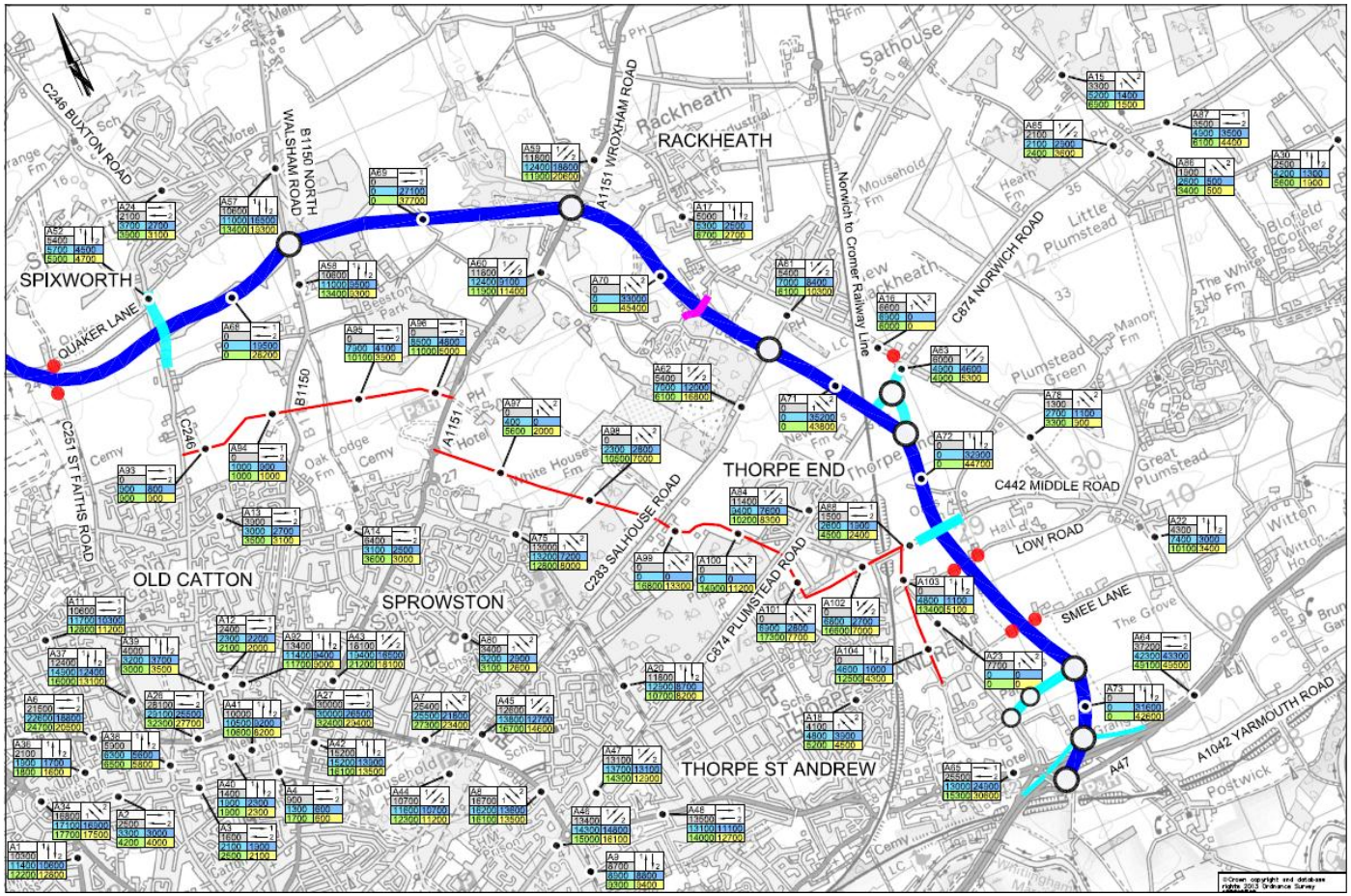


Figure 10.18: AADT Traffic Flows Wensum Valley Section_Dependent Development with Developer Links Included Scenario

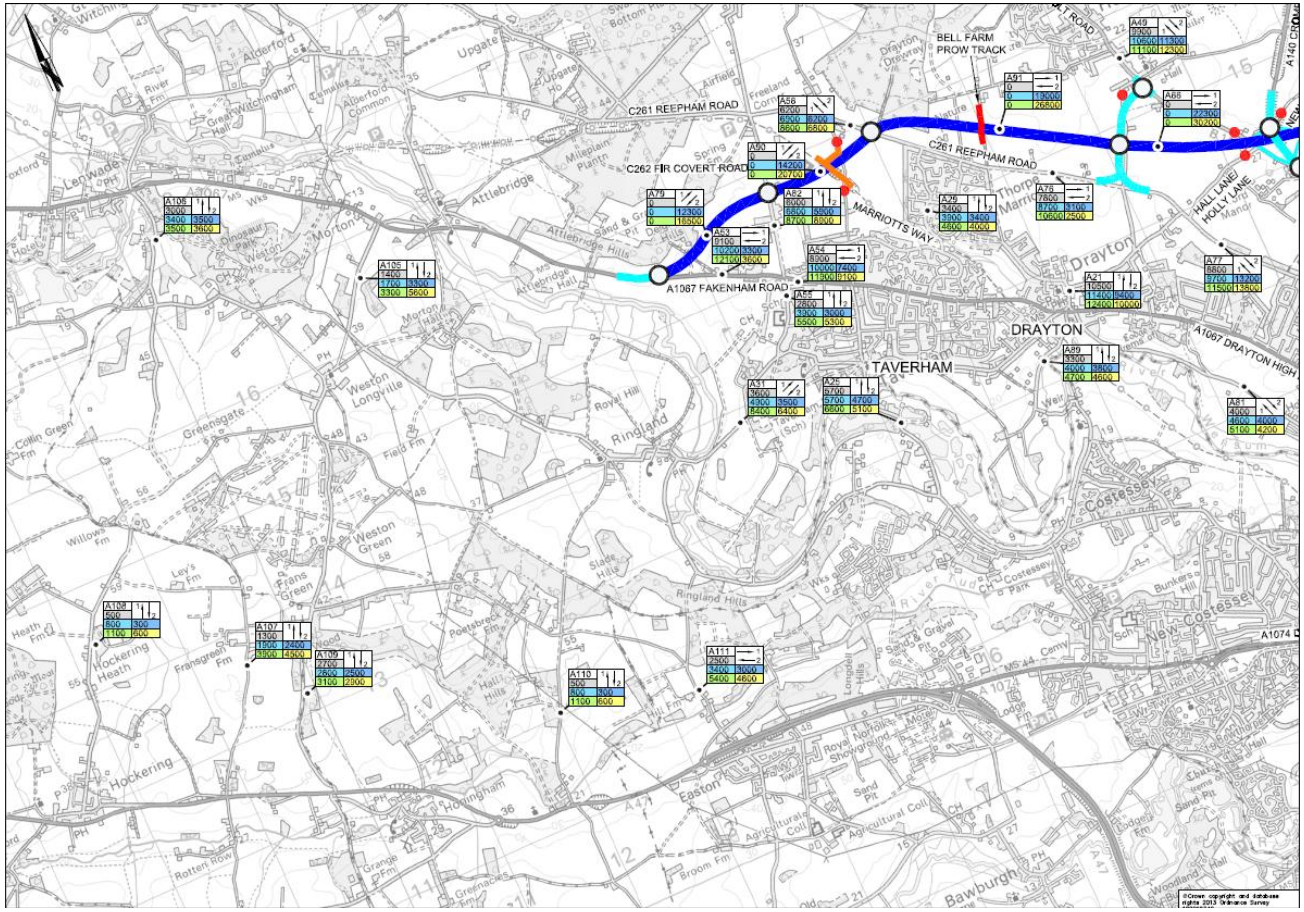


Figure 10.19: Strategic Traffic Movements_Dependent Development with Developer Links Included Scenario

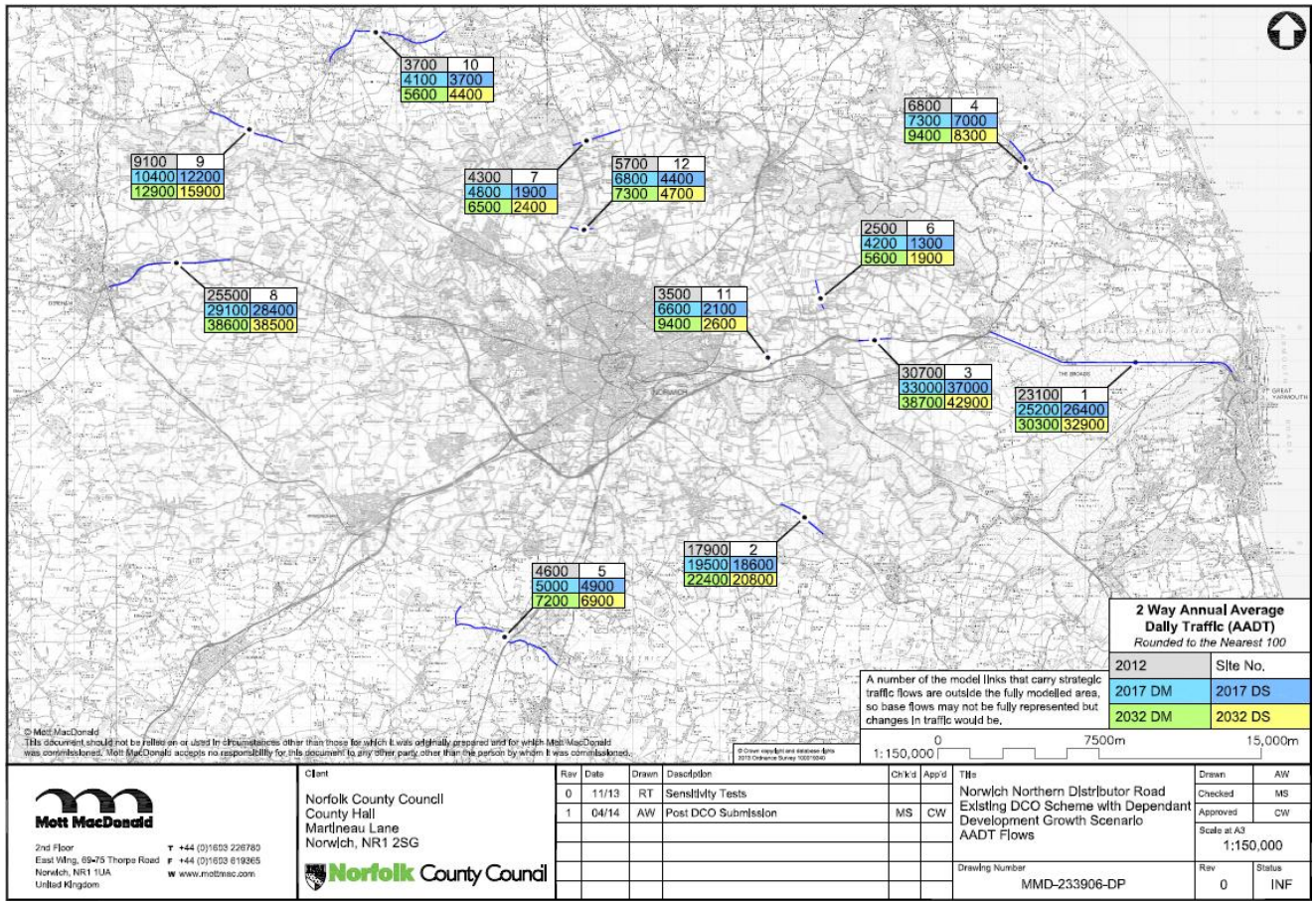


Figure 10.20: City Centre Traffic Impact_Dependent Development with Developer Links Included Scenario

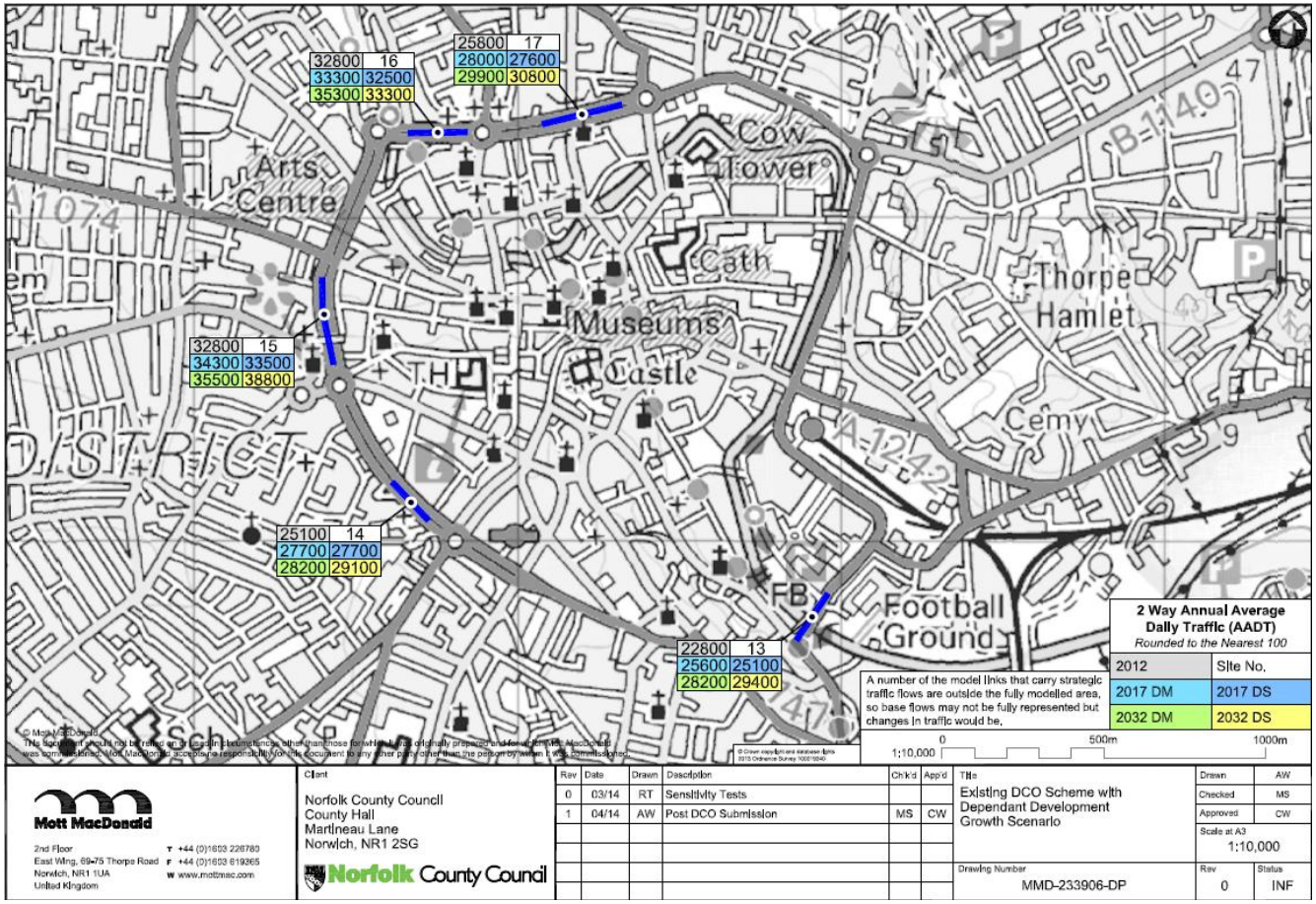


Figure 10.21: AADT Traffic Flows Western Section_Dependent Development with Developer Links Excluded Scenario

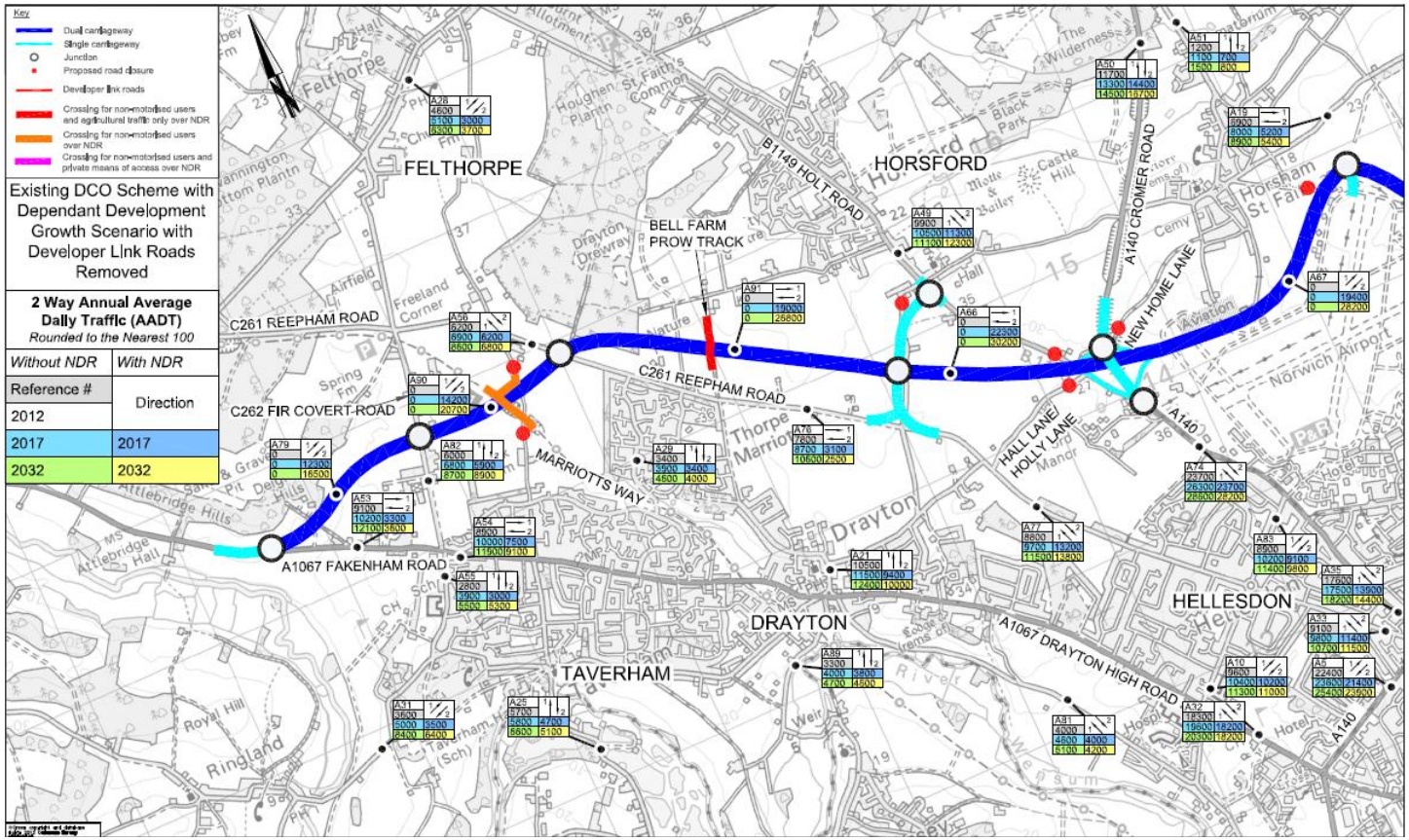


Figure 10.22: AADT Traffic Flows Eastern Section_Dependent Development with Developer Links Excluded Scenario

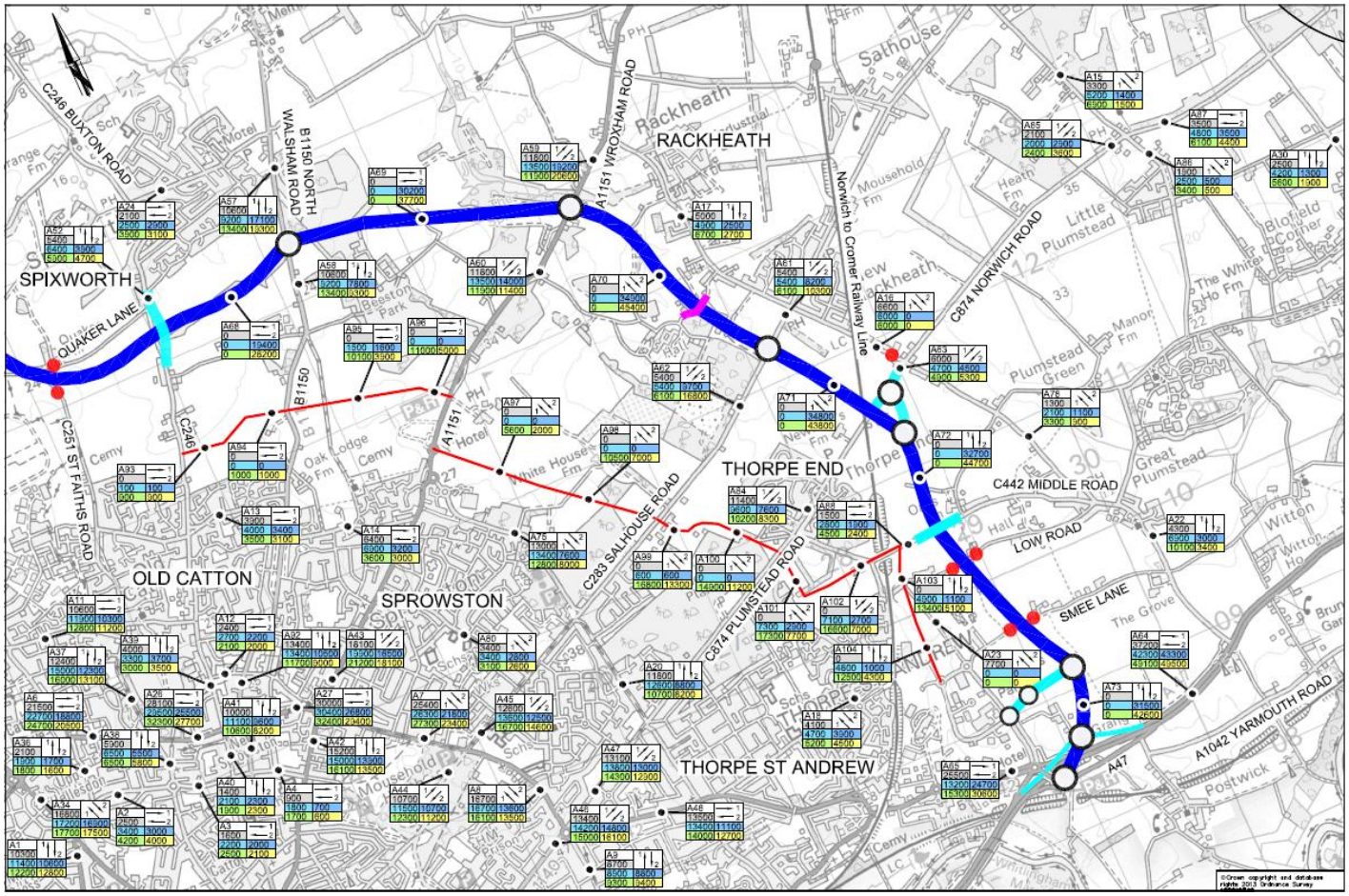


Figure 10.23: AADT Traffic Flows Wensum Valley Section_ Dependent Development with Developer Links Excluded Scenario

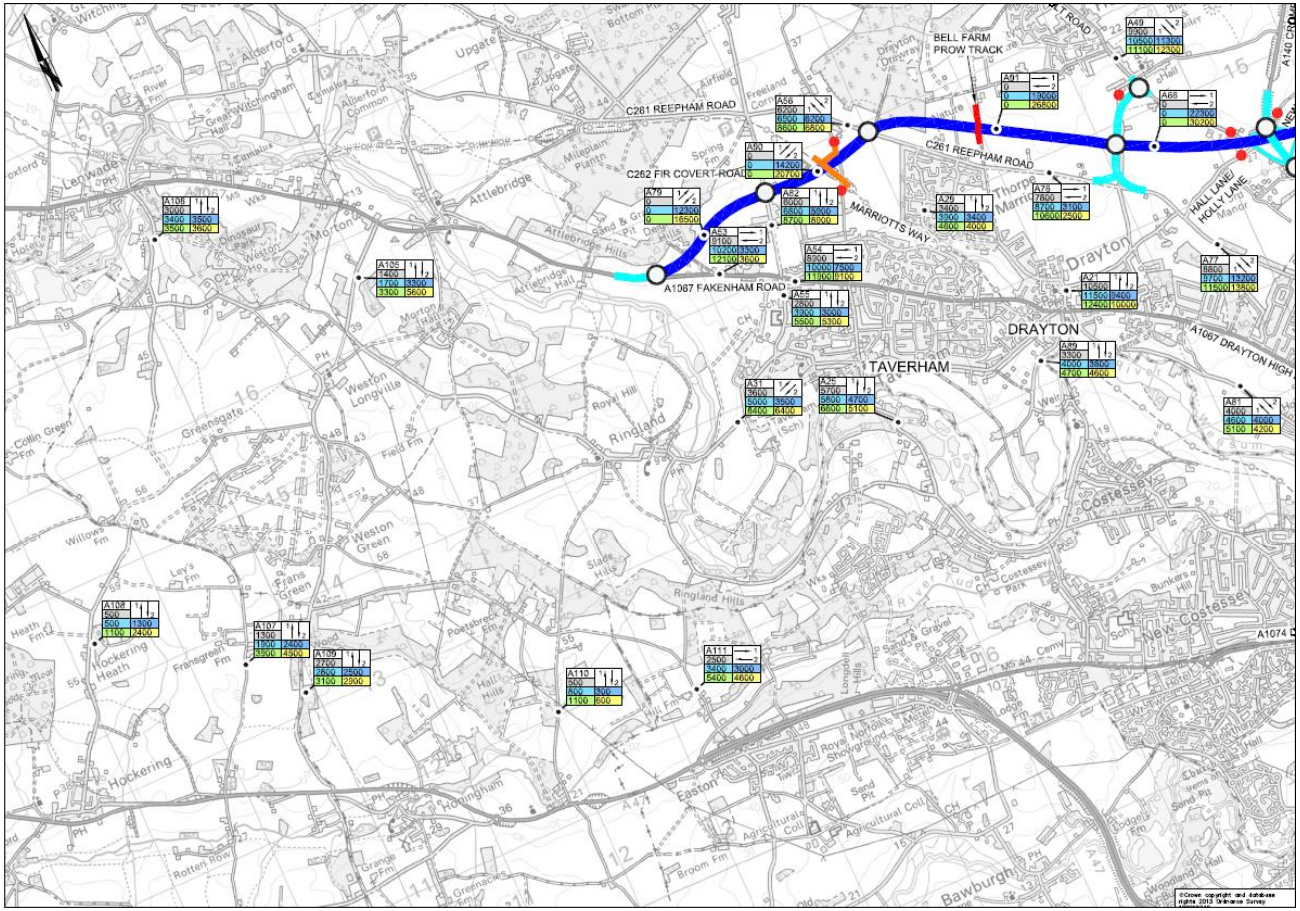


Figure 10.24: Strategic Traffic Movements_ Dependent Development with Developer Links Excluded Scenario

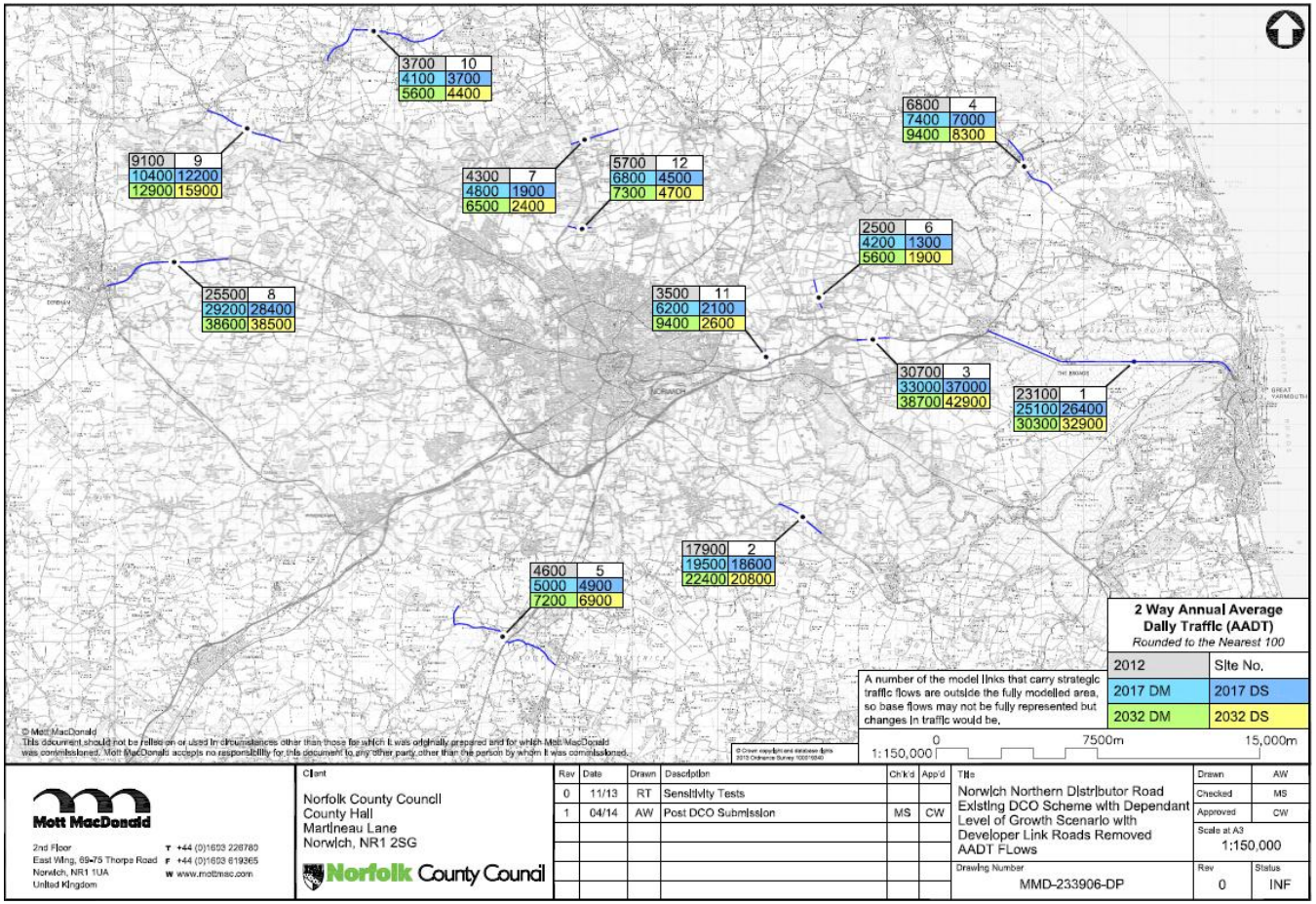
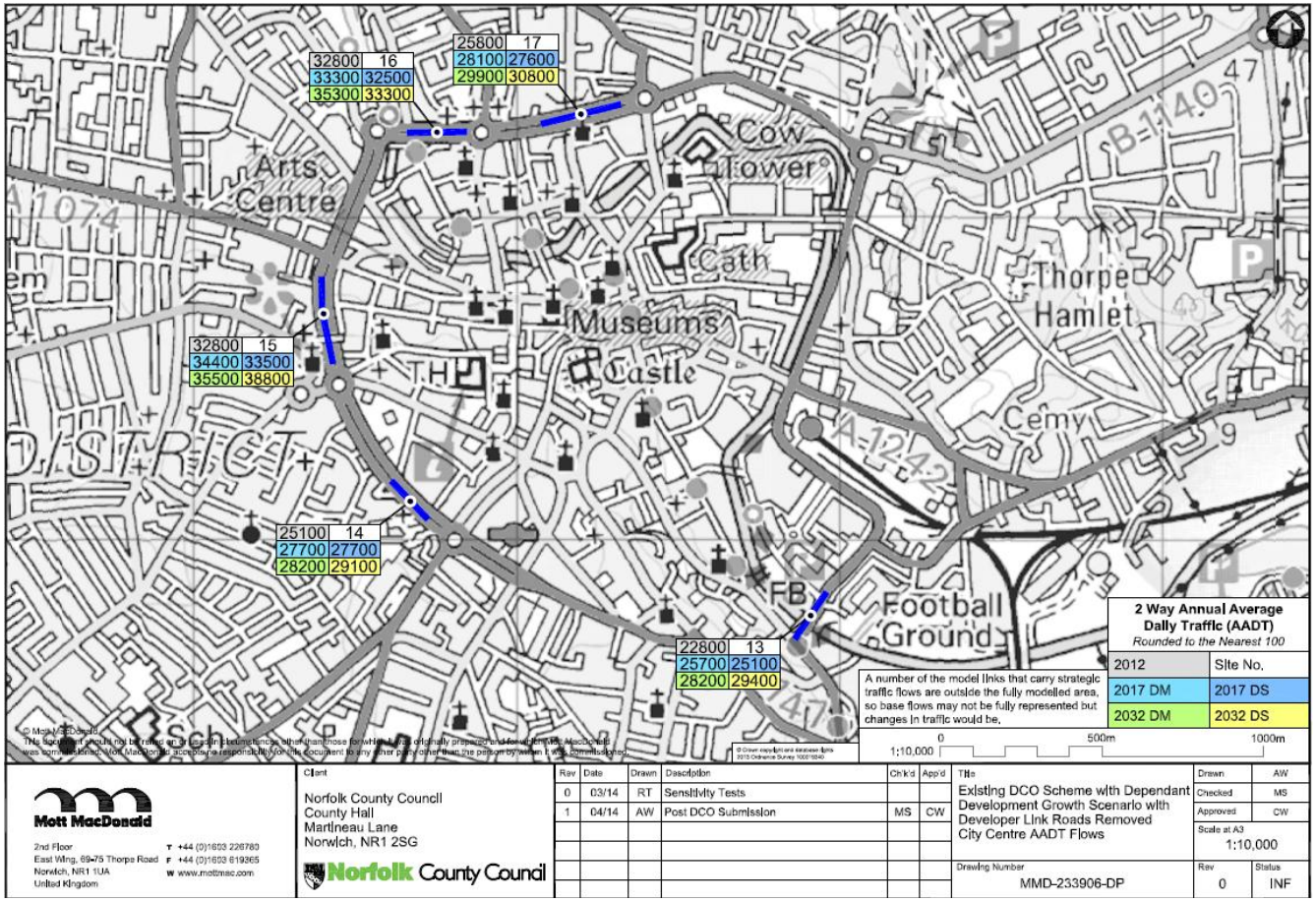


Figure 10.25: City Centre Traffic Impact_ Dependent Development with Developer Links Excluded Scenario



11 Abbreviations

AADT	Annual Average Daily Traffic
ARCADY	Assessment of Roundabout Capacity and Delay software
AST	Appraisal Summary Table
ATC	Automatic Traffic Count
B1/B2/B8	Development categories: business (including office) / general industrial / storage and distribution
BAFB	The Best And Final funding Bid submitted by Norfolk County Council to the Department for Transport in 2011 for the combined Postwick and NDR schemes
BCIS	Building Cost Information Service
BCR	Benefit Cost Ratio
BGBP	Broadland Gate Business Park development
COBA	Cost Benefit Appraisal – software released by the Department of Transport that has been used to undertake an accident appraisal
DfT	Department for Transport
DIADEM	Dynamic Integrated Assignment and Demand Modelling - software released by the Department for Transport
DM	Do Minimim
DMRB	Design Manual for Roads and Bridges – a Highways Agency publication setting out guidance and good practice for design and appraisal of road schemes
DS	Do Something
EB	Employer's Business
GAP	Minimum gap (in seconds) accepted by a vehicle which gives way at priority junctions or traffic signals. Also a measure of Wardrop equilibrium assignment convergence
GAPR	As GAP above in relation to junctions but for entry onto roundabouts
GDP	Gross Domestic Product
GEH	A comparison statistic named after GE Havers
GIS	Geographic Information System - designed to capture, store, manipulate, analyse, manage, and present all types of geographical data
GNDP	Greater Norwich Development Partnership
GPS	Global Positioning System
GVA	Gross Value Added
HA	Highways Agency
HB	Home Based (trips)
HBEB	Home Based Employers' Business (trips)
HBO	Home Based Other (trips)
HBW	Home Based Work (commuter trips)
HGV	Heavy Goods Vehicle
IP	Inter-peak

JT	Journey Time
JCS	Joint Core Strategy
JTR	Journey Time Reliability
LGV	Light Goods Vehicle
LINSIG	Traffic signal analysis software
LMVR	Local Model Validation Report
MCC	Manual Classified Count (for a link)
MCTC	Manual Classified Turning Counts
ME	Matrix Estimation
NATS	Norwich Area Transportation Strategy
NCC	Norfolk County Council
NDR	Norwich Northern Distributor Road
NHB	Non-Home Based (trips)
NHBEB	Non-home-based Employer's Business
NHBO	Non-home-based Other
NPV	Net Present Value – given by subtracting the Present Value Costs (PVC) from Present Value Benefits (PVB)
NTEM	National Trip End Model – a database containing trip-end, journey mileage, car ownership and population/workforce planning data
NTM	National Transport Model
NTS	National Travel Survey
OD	Origin Destination
OE	Other Externalities
OGV	Other Goods Vehicle (sometimes called HGV)
OGV1	A sub-category of OGV. Includes all rigid vehicles over 3.5 tonnes gross vehicle weight with two or three axles
OGV2	A sub-category of OGV. Includes all rigid vehicles with four or more axles and all articulated vehicles
OP	Off-peak
PA	Production Attraction
PCU	Passenger Car Unit
PDL	Previously Developed Land
PG	Planning Gain
PIA	Personal Injury Accident
PPK	Pence Per Kilometre
PPM	Pence Per Minute
PT	Public Transport
PVB	Present Value Benefits – the stream of benefits over the appraisal period (60 years) that are converted to 2010 prices and discounted to 2010 to give a 'present value'
PVC	Present Value Costs – the costs of the scheme over the construction period as well as maintenance and operational costs that are converted to 2010 prices and discounted to 2010 to give a 'present

	value'
PYV	Present Year Validation
P&R	Park and Ride
QRA	Quantified Risk Assessment
RFC	Ratio of Flow to Capacity
RPI	Retail Price Index
RSI	Road Side Interview
RTF	Road Transport Forecasts
SATME2	Matrix estimation module of the SATURN software
SATURN	Simulation – Assignment model of Traffic on Urban Road Networks software
SRN	Strategic Road Network
TA	Transport Assessment
TEC	Transport Externality Cost
TRADS	Traffic flow Data System – the Highways Agency's database of traffic count data
TRICS	National Trip Generation database
TEMPRO	Trip End Model presentation Program is software released by the Department for Transport to allow detailed analysis of NTEM data
TUBA	Transport User Benefit Appraisal – software released by the Department for Transport that is used to assess transport user benefits of transport schemes
VDM	Variable Demand Modelling
VfM	Value for Money
VISUM	Transport modelling software used (in this case) for public transport modelling
VOC	Vehicle Operating Costs
VOT	Value Of Time
WEBs	Wider Economic Benefits
WebTAG	Web-based Transport Appraisal Guidance produced by the Department for Transport
WITA	Wider Impacts in Transport Appraisal

12 Glossary

Assignment	A process of loading a trip matrix onto routes through a network that accounts for travel costs on the network in identifying the optimum route choice for every trip
Buffer network	The external part of a highway network in which travel is represented by speed/ flow relationships or cruise speeds
Calibration	A process of adjusting the model input data or model parameters to improve the model and its validation
Convergence	An equilibrium between model outputs, in assignment between the flows and travel costs and in demand models between the demand and the costs from the supply model
Cost matrix	A table of travel costs for journeys that may include travel time, operating costs and charges such as tolls or fares
Cruise speeds	Average travel speed along a network link
Demand model	See variable demand model
Demand segment	Travel demand is divided into a number of segments for the purposes of applying different demand modelling procedures. The division is usually by trip purpose and whether the trips are home-based or non-home-based
DMRB	Design Manual for Roads and Bridges – a Highways Agency publication setting out guidance and good practice for design and appraisal of road schemes
Dependent development	Housing or commercial development that can only proceed with the implementation of a transport intervention
Discounting	Discounting is a technique used to compare costs and benefits that occur in different time periods. It is based on the principle known as time preference that people prefer goods and services now rather than later. This preference for goods and services now rather than later applies to both individuals and society. By applying a discount rate, streams of costs and benefits are reduced to their present values.
Do Minimum	The forecast scenario without the proposed transport scheme, but that includes committed transport network improvements and developments
Do Something	The Do Minimum network but with the proposed transport scheme and developments added
Generalised cost	A combination of time and money costs (operating costs and charges) that are expressed in time or money units which are used to represent the total travel costs for a journey within the assignment or demand models
Journey purpose	Trips are divided into different travel purposes, usually work (or commute), employers' business and other. These trip purposes have different generalised costs applied and different demand model responses
Matrix estimation	A process used to adjust an initial or 'prior' matrix so that the resulting assignment of the adjusted matrix matches count data as closely as possible
Network	A mathematical representation of a transport network in a supply-side assignment model, either a highway network which represents vehicle travel, or a public transport network that represents bus and rail services
Speed / flow relationships	Relationship between traffic speed and traffic flow on a network link

Reference trip matrix	A forecast reference matrix based on applying growth from national (or other) datasets, but before the application of adjustments due to the impact of how travel costs will change with growth in travel
User classes	Trips are aggregated into several user classes for the purposes of assignment. These usually represent different types of vehicle (e.g. car, HGV) and different trip purposes
Trip matrix	A table representing travel in a model area between land areas or zones
Validation	A process of comparing the model data with independent data
Variable demand modelling	A model that forecasts changes in travel behaviour such as trip frequency, choice of mode, time of travel and trip distribution
Zone	An area of land or development which is used in a transport model to aggregate individual households or commercial premises into a manageable number of units that can be used to represent journey patterns in the study area. Usually the zone size will be relatively small in the study area, but progressively larger further away from it.