Great Yarmouth Third River Crossing

Application for Development Consent Order

Document 7.6: Economic Appraisal Report

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) ("APFP")

APFP regulation Number: 5(2)(q)

Planning Inspectorate Reference Number: TR010043

Author: Norfolk County Council

Document Reference: 7.6

Version Number: 0 – Revision for Submission

Date: 30 April 2019

Foreword

This document accompanies an application ('the Application') submitted by Norfolk County Council ('the Applicant') to the Secretary of State for a Development Consent Order ('DCO') under the Planning Act 2008.

If made by the Secretary of State, the DCO would grant development consent for construction, operation and maintenance of a new bascule bridge highway crossing of the River Yare in Great Yarmouth, and which is referred to in the Application as the Great Yarmouth Third River Crossing (or 'the Scheme').

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) require that an application for a DCO be accompanied by the documents specified at Regulation 5(2)(a) to (r). This is one of those documents and is specified at Regulation 5(2)(q).

CONTENTS

PAGE No.

Tables

Plates

Glossary of Abbreviations and Defined Terms

AADT	Annual Average Daily Traffic
AMCB	Analysis of Monetised Costs and Benefits
AST	Appraisal Summary Table
ATC	Automatic Traffic Counter
BCR	Benefit to Cost Ratio
COBA-LT	Cost and Benefits to Accidents – Light Touch
CPI	Consumer Price Index
DCO	Development Consent Order
DfT	Department for Transport
DM	Do Minimum
DS	Do Something
EAR	Economic Appraisal Report
ES	Environmental Statement
FBC	Full Business Case
GA	General Arrangement
GDP	Gross Domestic Product
GYTRC	Great Yarmouth Third River Crossing
HE	Highways England
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle
MCC	Manual Classified Count
NCC	Norfolk County Council
NPV	Net Present Value
OBC	Outline Business Case
OGV	Other Goods Vehicle
ONS	Office for National Statistics
PA	Public Accounts

PIA	Personal Injury Accidents
PVB	Present Value of Benefits
PVC	Present Value of Costs
QRA	Quantified Risk Assessment
RSI	Road Side Interview
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SDI	Social and Distributional Impact
TA	Transport Assessment
TEE	Transport Economic Efficiency
TUBA	Transport Users Benefits Appraisal
T&T	Turner and Townsend
VfM	Value for Money
VOC	Vehicle Operating Costs
WebTAG	Web Transport Analysis Guidance
WITA	Wider Impacts in Transport Appraisal

Executive Summary

This Economic Appraisal Report has been prepared to accompany an application by Norfolk County Council ("the Applicant") for a Development Consent Order (DCO) in relation to the Great Yarmouth Third River Crossing (the "Scheme") in Great Yarmouth.

The Scheme is located at the River Yare in Great Yarmouth between the A47 at Harfrey's Roundabout on the western side and the A1243 South Denes Road on the eastern side.

The economic appraisal has been undertaken in accordance with the relevant Department for Transport (DfT) guidance documents. Industry-standard computer programmes TUBA and COBA-LT have been used to undertake the user benefit and accident appraisals respectively. All other monetised benefits have been calculated in line with the latest DfT guidance at the time. Scheme costs have been produced for both construction and maintenance and operation of the Scheme.

The result of the appraisal shows that the Benefit to Cost Ratio (BCR) for the core scenario is 2.7 (including reliability and wider benefits), therefore the Scheme offers high value for money based upon DfT guidance.

Sensitivity testing has carried out using high and low traffic growth, and applying differing levels of optimism bias to the costs. This produced a range of BCRs from 2.1 to 3.3, all of which are categorised as high value for money. This demonstrates that the Scheme's value for money is robust to lower levels of traffic growth and higher costs.

1 Study Overview

1.1 Introduction

1.1.1 This report details an economic appraisal of the Great Yarmouth Third River Crossing (GYTRC) proposals. The Scheme will provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern parts of Great Yarmouth. Specifically, it will provide a connection between the Strategic Road Network (A47) and the South Denes Business Park, Enterprise Zone, Great Yarmouth Energy Park and the Outer Harbour, all of which are located on the South Denes peninsula.

1.1.2 The purpose of this report is to outline the economic evidence used and the key assumptions made, in line with DfT WebTAG guidance, to determine the economic benefits and costs of the Scheme. Results of the COBA-LT (COst and Benefit to Accidents – Light Touch) assessment, the Social Distributional Impact (SDI) assessment, the Active Mode Appraisal (AMA) and the BCR have been used to inform the Transport Assessment (TA) which in turn feeds into the Environmental Statement (ES) and Development Consent Order (DCO) submission. The report also assesses the Value for Money (VfM) of the Scheme and details how the effects of the Scheme have been monetised and combined with the construction and maintenance costs to give an indication of the economic value of the Scheme over a 60 year appraisal period.

1.1.3 The economic appraisal of the Scheme follows the guidance outlined by the relevant WebTAG modules to ensure that a robust assessment is made. The cost benefit analysis was undertaken on the following categories:

- Transport User Benefits
- Accident Benefits
- Reliability Benefits
- Wider Benefits
- Active Mode Benefits

1.2 Structure of Report

1.2.1 This Economic Appraisal Report (EAR) is structured to include the following sections:

- Study Overview
- Economic Appraisal Approach
- Estimation of Costs

- Estimation of Benefits
- Economic Appraisal Results
- Summary and Conclusions

1.3 Scheme Objectives

1.3.1 The objectives for the Scheme were initially developed in the Outline Business Case (OBC) and have been further refined to more clearly reflect the Scheme's role in addressing the transport and regeneration needs. The Scheme objectives are detailed in the Case for The Scheme, and are as follows:

- To support Great Yarmouth as a centre for both offshore renewable energy and the offshore oil and gas industry, enabling the delivery of renewable energy NSIPs and enhancing the Port's role as an international gateway;
- To improve access and strategic connectivity between Great Yarmouth port and the national road network thereby supporting and promoting economic and employment growth (particularly in the Enterprise Zone);
- To support the regeneration of Great Yarmouth, including the town centre and seafront, helping the visitor and retail economy;
- To improve regional and local access by enhancing the resilience of the local road network, reducing congestion and improving journey time reliability;
- To improve safety and to reduce road casualties and accidents, in part by reducing heavy traffic from unsuitable routes within the town centre;
- To improve access to and from the Great Yarmouth peninsula for pedestrians, cyclists and buses, encouraging more sustainable modes of transport and also reducing community severance; and
- To protect and enhance the environment by reducing emissions of greenhouse gases and minimising the environmental impact of the Scheme.

1.4 Scheme Description

1.4.1 The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. It consists of a new dual carriageway road across the river, linking the A47 at Harfrey's Roundabout on the western side to the A1243 South Denes Road on the eastern side. It features an opening span Double Leaf Bascule Bridge across the river, which will involve the construction of two "knuckles" that extend the quay wall into the river. The new dual carriageway will also have a clear span over

Southtown Road on the western side of the river, as it rises to the centre of the new crossing.

1.4.2 The Scheme will create a new, direct link between the western and eastern parts of the town. It will substantially improve connectivity between the A47 (part of the SRN) and significant destinations on the South Denes peninsula, including the South Denes Business Park, Great Yarmouth Energy Park, the Port and Outer Harbour, including part of the Great Yarmouth and Lowestoft (New Anglia) Enterprise Zone.

1.4.3 Plate 1.1 shows the scheme masterplan.

Plate 1.1: Scheme Masterplan

1.5 Previous Economic Appraisals

1.5.1 A Stage 2 Traffic and Economic Assessment report[1] was produced in October 2009 by Mott MacDonald and which included detailed information

[1] Great Yarmouth Third River Crossing – Stage 2 Scheme Assessment Report, September 2009. Mott Macdonald for Norfolk County Council

on traffic modelling, forecast traffic flows and journey times for three scheme options (two bridge options and one tunnel option). Results showed that all scheme options produced high levels of benefits, with the two bridge options producing the highest levels with a BCR ranging from 4.5 to 4.8. The report concluded that the tunnel option provided a low value for money and should therefore be discounted from further analysis.

1.5.2 The OBC was submitted to DfT in March 2017. This included an Economic Case and supporting documentation which presented a BCR of 3.5 for the core scenario[2], and a range of 2.5 to 4.6 under sensitivity testing. The core scenario provided high value for money under DfT categorisation.[3]

1.5.3 Following the OBC submission, the DfT were contacted in November 2017 to request any comments on the traffic modelling and economic appraisal. The purpose of this was to ascertain what the DfT requirements would be for Full Business Case (FBC) approval, and to ensure there was sufficient time in which to address their comments.

1.5.4 The DfT responded with a request for further information on six areas of the appraisal. A formal response was issued to the DfT in October 2018. This response is included as Appendix H – Outline Business Case – Response to DfT Queries.

1.5.5 The DfT comments included requests that the model be updated to reflect the latest scheme design, uncertainty log, WebTAG guidance, and NTEM / RTF guidance. Thus, the model has been updated since the submission of the OBC. The main changes are:

- The Scheme design has been updated and the forecast opening schedule for the bridge openings has been amended (this results in a minor change to signal timings in the SATURN model);
- The SATURN model has been updated to produce a new 2018 base year to inform the Transport Assessment. This was carried out with reference to new traffic survey data from 2018. Further details of the SATURN

[2] The core scenario is a forecast scenario based on the most unbiased and realistic set of assumptions that will form the central case that is presented in the appraisal summary table (AST). This is defined in WebTAG M4 (May 2018).

[3] The DfT's Value for Money Framework, Section 5.6, Box 5.1 (July 2017) categorises the VfM based upon the value of the BCR. The categories are:

- Very High – BCR greater than or equal to 4
- High – BCR between 2 and 4
- Medium – BCR between 1.5 and 2
- Low – BCR between 1 and 1.5
- Poor – BCR between 0 and 1
- Very Poor – BCR less than or equal to 0

model update are given in Appendix A – Local Model Validation Report Addendum;

- The uncertainty log has been updated and used to produce new forecast models for the opening year of 2023 and future years of 2038 and 2051. Details of the uncertainty log and committed developments modelled are given in Appendix B – Traffic Forecasting Report;
- The forecast networks now include committed Highways England (HE) schemes and Vauxhall and Gapton roundabouts, details of which are given in Appendix B – Traffic Forecasting Report;
- An updated version of TUBA has been used (v1.9.10) which incorporates new values of time from the WebTAG databook v1.9.1 (December 2017);
- Updated calculation of reliability benefits using updated reliability ratio parameter from WebTAG Unit A1.3 (March 2017); and
- A more comprehensive estimate of wider impacts has been undertaken. Full details are given in Wider Impacts Benefits Technical Note, August 2018. This is provided in Appendix F – Wider Impacts Benefits – Core Scenario.

2 Economic Appraisal Approach

2.1 Transport Model

2.1.1 The traffic data used in the economic appraisal for the OBC was derived from a 2016 SATURN model built by WSP and formed a fully WebTAG compliant update of the earlier work by consultant Mott MacDonald (MM). This model has been updated to 2018 base year to inform the Transport Assessment (TA) and it is forecasts from the 2018 base year that now inform the economic appraisal. An addendum to the OBC Local Model Validation Report has been produced and is included as Appendix A – Local Model Validation Report Addendum.

2.1.2 The Fixed and Variable Demand SATURN models have been developed for the following time periods[4]:

- AM peak (08:00 – 09:00)
- Average interpeak (10:00 – 15:30)
- PM peak (16:30 – 17:30)

2.1.3 This is consistent with advice presented in WebTAG Unit M3.1, Section 2.5 (January 2014).

2.1.4 The traffic assignments were carried out with the following vehicle and user classes:

- UC1: Car – Commuting
- UC2: Car – Employer's Business
- UC3: Car – Other
- UC4: LGV
- UC5: HGV

2.1.5 The model forecast years are 2023 (assumed scheme Opening Year), 2038 (Design Year) and 2051 (Horizon Year). Full details of forecasting process are detailed in the Traffic Forecasting Report which is included as Appendix B – Traffic Forecasting Report.

[4] The time periods are defined based both on guidance given in WebTAG M3.1, Section 2.5 (January 2014), and traffic count data collected in 2016. The demand profile showed two clear peak hours for AM (08:00-09:00) and PM (16:30-17:30), and a period of relatively consistent flow between these peaks, beginning at 10:00 and finishing at 15:30. An average hour of this period was taken to represent the inter-peak period.

Travel Demand Scenarios

2.1.6 The principal requirement of the traffic model was the provision of traffic forecasts for the Scheme Opening year (2023), Design year (2038) and Horizon year (2051). Future travel demands take into account the existing traffic flows together with the effects of traffic growth and the additional traffic that is expected to arise from new development activity in the town.

2.2 Economic Appraisal Process

2.2.1 The process of economic appraisal for the Scheme consists of several steps, as follows.

User Benefits (TUBA)

2.2.2 User benefits including time savings, fuel-related vehicle operating costs (VOC), non-fuel VOC, and operator and Government revenues typically form the major element of benefit attributable to highway schemes. The appraisal detailed within this report uses the Department for Transport's (DfT) Transport Users Benefit Appraisal tool (TUBA) Version 1.9.10.

2.2.3 The software provides the DfT standard approach to appraising changes in demand, travel time and operating costs. Demand, average time and average distance matrix skims from the Do Minimum and Do Something tests for the opening and design years are fed into TUBA generating the following economic outputs:

- Time savings
- Vehicle Cost Operating savings
- Greenhouse gases
- Taxes

2.2.4 Analysis of the benefits has been carried out:

- By year, over the 60 year appraisal period
- By trip purpose/ vehicle type/by time period (AM/IP/PM periods)
- By sector of origin and destination

2.2.5 The appraisal area for estimating user benefits includes the full SATURN model area (as detailed in Appendix A – Local Model Validation Report Addendum), and analysis at an aggregated sector level provides a summary of the findings.

Accident Benefits (COBA-LT)

2.2.6 Benefits associated with accident savings were calculated using the DfT's Cost and Benefit to Accidents – Light Touch Programme (COBA-LT) which assesses the safety impacts of schemes using detailed inputs of link and junction accident rates and traffic flow forecasts from the traffic model. Accident benefits were calculated over a 60 year period for a limited subset of the model.

Other Benefits

2.2.7 In addition to the benefits calculated by TUBA and COBA-LT, monetised benefits were also calculated for the following:

- Reliability;
- Wider Impacts; and
- Active Modes.

Annualisation of Benefits

2.2.8 Benefits of the Scheme have been converted from the weekday traffic model period outputs to annual totals over a 60 year appraisal period. Annualisation factors for conversion of period model outputs are explained in detail in Appendix G – TUBA Annualisation Factors.

Appraisal Period

2.2.9 The economic appraisal was carried out for a 60-year period, from 2023 (Opening Year), in accordance with DfT guidance. The final year in which benefits were calculated was 2082.

Value for Money Assessment

2.2.10 A full cost benefit appraisal was undertaken to assess the Scheme's value for money. The results from TUBA, COBA-LT and other benefits were combined to calculate the overall economic benefits of the Scheme. By comparing the construction, operation and maintenance costs with the traffic benefits of the Scheme over a 60 year appraisal period, a BCR was calculated, which represents the value for money afforded by the Scheme.

Sensitivity Tests

2.2.11 As recommended in WebTAG Unit M4, Section 4 (May 2018), sensitivity tests have been carried out whereby high and low growth projections are applied in addition to the core scenario forecast.

2.2.12 Additional sensitivity tests have been carried out which adjust the level of Optimism Bias applied to the costs, and apply different annualisation factors to the TUBA input matrices.

2.3 Non-Standard Procedures and Economic Parameters

2.3.1 The economic appraisal has adopted procedures, economic parameters and values recommended in current DfT and HE guidance.

3 Estimation of Costs

3.1 Overview

3.1.1 The estimation of costs for the Scheme has been carried out following the principles set out in WebTAG Unit A1.2 (July 2017). The costs have been estimated under three broad headings – investment, operating and maintenance costs.

3.1.2 The base cost of the Scheme is made up of investment, maintenance and operating costs, for a given price base. This includes estimates for construction, land, preparation, supervision. It incorporates a realistic assumption of changes in real costs over time (e.g. cost increases or reductions relative to the rate of general inflation). The base cost also takes into account the cost of land compensation.

3.1.3 The Scheme cost estimate is based upon the forecast expenditure presented in the OBC Addendum to 2017 Financial, Commercial and Management Case, May 2018. This report was prepared by NCC at the request of the DfT. The OBC Addendum is included in Appendix I – OBC Addendum.

3.1.4 The construction contract was awarded in January 2019. The tendered cost was within the construction cost budget allocation.

3.2 Investment Cost

Works Cost

3.2.1 All costs have been estimated using a Quarter 3, 2016 price base (given the conclusions of the work set out in 3.1 above) and are detailed in Table 3.1. The total cost exclusive of risk and inflation amounts to £85.9 million.

Table 3.1: Great Yarmouth Third River Crossing Scheme Cost Estimate

Cost Area	Costs (£000)
Construction	57,387
Utilities	2,500
Land	14,134
Fees	11,943
Total work cost (exclusive of risk)	85,937

Adjustment for Risk

3.2.2 Prior to the submission of the OBC a Risk Management Workshop was held on 30th January 2017 to consider risks associated with the preferred scheme at the time.

3.2.3 A structured and systematic process for identifying, assessing and managing risk has been established for the Scheme. A risk log has been generated which identifies risks that may occur during the planning, design and construction phases and outlines any unrealised issues that have the potential to adversely impact on the Scheme delivery, programme or cost. The Risk Register and Quantified Risk Assessment (QRA) were submitted as part of the Outline Business Case.

3.2.4 The scheme risks will be managed in line with the risk management strategy set out in Chapter 6.10 of the March 2017 OBC.

3.2.5 Table 3.2 shows the Scheme costs inclusive of risk. The total work cost including risk amounts to £111.6 million.

Table 3.2: Scheme Cost Estimate (£000, 2016 Q3 prices) (inclusive of risk)

Cost Area	Cost (£000)
Base Cost at 2016 Q3 prices	85,964
Quantified Risk (85th percentile value)	25,714
Risk-adjusted Base Cost at 2016 Q3 prices	111,678

Scheme Cost Profile

3.2.6 The Scheme cost profile based on the current scheme programme is set out in Table 3.3 and adjusted for risk.

Table 3.3: Scheme Cost Profile (£000, 2016 Q3 prices)

Scheme Element	Pre 2017-18	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Cost
Construction				2,000	19,000	26,000	10,387	57,387
Utilities				960	1,200	190	150	2,500
Land	2,700	20	1,867	3,206	3,260	1,493	1,588	14,134
Fees		1,851	3,241	4,330	1,140	710	671	11,943
Base Cost	2,700	1,871	5,108	10,496	24,600	28,393	12,796	85,964
QRA			2,057	3,343	10,029	9,000	1,286	25,714

Scheme Element	Pre 2017-18	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Cost
Risk Adjusted Base Cost	2,700	1,871	7,166	13,839	34,628	37,393	14,081	111,678

Inflation – Financial Case

3.2.7 Inflation will mean that the actual amount of money to be spent on the Scheme will differ from the 2016 Q3 estimates. An allowance for inflation has therefore been calculated for each future year.

3.2.8 The 2016 prices have been inflated through the delivery and construction period based on the Bank of England CPI latest forecasts of general inflation as set out in Table 3.4. These are the inflation forecasts released at the time of the OBC submission. They were also used for the OBC Addendum.

Table 3.4: Inflation Rates

Factors applied to 2016 Q3 to Give Outturn Prices	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
General Inflation Rate	2.44%	2.69%	2.48%	2.36%	2.36%	2.36%
Factor	1.024	1.052	1.078	1.103	1.129	1.156

Outturn Cost Estimate

3.2.9 The £120,653k "scheme cost" as defined by DfT, is the out-turn capital cost of the scheme excluding costs incurred prior to completion of the OBC. The inflation factors in Table 3.4 have been applied to the forecast costs shown in Table 3.3 to produce the total scheme out-turn spend profile given in Table 3.5.

Table 3.5: Outturn Spending Profile (£000)

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Cost
Construction			2,156	20,965	29,366	12,008	64,496
Utilities			1,035	1,324	215	173	2,747

Scheme Element	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Cost
Land	20	1,964	3,456	3,597	1,686	1,836	12,560
Fees	1,851	3,409	4,668	1,257	802	775	12,763
Base Cost	1,871	5,373	11,315	27,144	32,069	14,793	92,566
QRA		2,164	3,604	11,066	9,768	1,486	28,088
Risk adjusted Base Cost	1,871	7,537	14,918	38,210	41,836	16,280	120,653

3.2.10 The funding request is given in Table 3.6.

Table 3.6: Funding Request and Profile (£000)

Source	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	Cost
DfT funding requested		3,941	4,668	31,362	41,837	16,280	98,088
LA (NCC) contribution	189	3,278	10,250	6,848	0	0	20,565
LEP contribution	1,682	318					2,000
Total	1,871	7,537	14,918	38,210	41,836	16,280	120,653

3.2.11 As presented within the March 2017 OBC, some of the land acquisition costs were incurred prior to 2017-18. This is £2,700 for land acquisition and is shown in Table 3.3.

3.3 Operating and Maintenance Costs

3.3.1 The assessment of traffic related maintenance costs focuses on the plan for non-routine reconstruction and resurfacing of the carriageway. The aim of the process is to calculate the net maintenance and operating cost impact of the Scheme to ensure that this is robustly captured in the present value of costs.

3.3.2 It is assumed that major maintenance would take place every few years for resurfacing of the new built sections of carriageway and for reconstruction works.

3.3.3 Operating costs of the Bridge structure are known, and professional experience of similar infrastructure has informed the costs associated with the operation and maintenance activities. For these reasons an additional 'risk' factor has not been applied to the Operation and Maintenance tasks.

3.3.4 The exact profile of maintenance spend will not be confirmed until the detailed design stage but because this is a bridge structure that requires constant operation, the assumed maintenance profiles for both the bridge and the roads have been calculated over a 60 year period and then combined with the bridge operating costs to arrive at an average annual cost.

3.3.5 All maintenance and operation costs have been estimated at 2016 Q3 prices for the same reasons as given above.

3.3.6 Inflation over and above GDP deflator has not been applied to maintenance and operation costs due to the uncertainty in forecasting economic conditions far in the future.

Bridge Maintenance Cost

3.3.7 The through-life maintenance cost of the bridge has been calculated at a 2016 Q3 price base. The elements included within this cost are:

- Routine servicing costs;
- Exceptional repairs and maintenance; and
- Re-painting and refurbishment.

3.3.8 The total cost over a 60 year appraisal period amounts to £5,533,462.

Bridge Operating Cost

3.3.9 The operating cost for 24/7 operation of the bridge has been calculated at a 2016 Q3 price base, amounting to a total cost of £5,946,334 over a 60 year appraisal period.

Road Operating and Maintenance Cost

3.3.10 The operating and maintenance cost for the road sections of the Scheme has been calculated at 2016 Q3 prices. Included within this cost are the following:

- Highways maintenance liabilities including communications equipment, drainage clearance, road and street lighting operation, winter maintenance (i.e. application of salt and snow clearance) and infrastructural and safety inspections.

- Longer term highways renewals, including re-surfacing and renewing the new bridge approaches and bridge surface (included in the annual average cost)

3.3.11 The total cost amounts to £3,866,976 over a 60 year appraisal period.

3.4 Present Value Cost (PVC)

Overview

3.4.1 In line with WebTAG Unit A1.1 Cost Benefit Analysis (May 2018) and Unit A1.2 Scheme Costs (July 2017), all future investment and operating costs, estimated over the appraisal period, should be converted to Present Value Cost (PVC).

3.4.2 This involves three key steps:

- Re-basing to the DfT's Base Year;
- Discounting to the DfT's Base year; and
- Converting to Market Prices.

3.4.3 Before these three steps, inflation, risk and Optimism Bias were applied to the total scheme cost.

Inflation- Economic Case

3.4.4 The cost of the Scheme should include the effect of forecast construction inflation relative to general inflation as measured by the GDP deflator. Table 3.7 summarises the inflation rates given by WebTAG data book v1.11 (November 2018) and the Office for National Statistics (ONS) construction output price indices (2018 Q4 release, February 2019). These rates were subsequently used to calculate the inflation factors listed in Table 3.8, to account for the difference between construction inflation and general inflation. The factors shown in Table 3.8 have been applied to the construction cost of the Scheme in line with the spend profile.

Table 3.7: General Inflation Rates – Economic Case

Index	2017/ 18	2018/ 19	2019/ 20	2020/ 21	2021/ 22	2022/ 23
GDP deflator	2.0%	1.9%	1.7%	1.9%	1.9%	1.9%
Construction Inflation Rate	2.6%	3.6%	3.6%	3.6%	3.6%	3.6%

Table 3.8: Inflation Factors – Economic Case

Index	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Construction Inflation Factor	1.005	1.023	1.042	1.059	1.076	1.094

3.4.5 Inflation has not been applied to the non-construction elements of the Scheme costs. The change per annum in forecast GDP deflator is higher than the Real GDP growth per annum (WebTAG databook v1.11 (November 2018)). It is therefore assumed that all other costs of the Scheme are not subject to any inflation above the GDP deflator.

Table 3.9: Inflation Adjusted Sub-Total (£000, 2016 Q3 prices)

Component	Scheme Cost
Total Investment Cost	85,964
Inflation	4,305
Inflation Adjusted Sub-Total	90,269

Risk

3.4.6 As outlined above, a structured and systematic process for identifying, assessing and managing risk has been established for the Scheme. The total risk associated cost of the Scheme is £25.7 million as shown in Table 3.10.

Table 3.10: Risk Adjusted Sub-Total (£000, 2016 Q3 prices)

Component	Scheme Cost
Sub-Total	90,269
Risk	25,715
Risk Adjusted Sub-Total	115,984

Optimism Bias

3.4.7 An Optimism Bias was applied to costs to reflect the uncertainty of the current cost estimates, based on guidance in WebTAG Unit A1-2, Section 3.5, Table 8 (July 2017). This figure is derived from a weighted average, calculated, based on the proportions of bridge and road costs (69.7:30.3) giving an overall optimism bias allowance of 21% which is applied to the total risk-adjusted costs as shown in Table 3.11.

Table 3.11: Scheme Cost with Optimism Bias (£000, 2016 Q3 prices)

Component	Scheme Cost (£000)
Risk Adjusted Sub-Total	115,984
Optimism Bias (21%)	24,357
Total	140,340

Re-basing

3.4.8 WebTAG Unit A1.1 (May 2018) explains that, when applying monetary values to impacts over a long appraisal period, it is very important to take the effects of inflation into account. Failure to do so, would distort the results by placing too much weight on future impacts, where values would be higher simply because of inflation.

3.4.9 For Cost Benefit Analysis purposes, all values should be in real prices (including inflation) to stop the effects of inflation distorting the results. To convert nominal prices (not including inflation) to real prices, a price base year and an inflation index are needed.

3.4.10 The real price in any given year is then the nominal price deflated by the change in the inflation index between that year and the Base year (2010).

3.4.11 The GDP price deflator contained in the WebTAG databook v1.11 (November 2018) has been used to convert prices from the 2016 Q3 price year base to 2010 costs (2010 index = 100, 2016 = 110.01).

Discounting

3.4.12 WebTAG Unit A1.1 (May 2018) outlines that all monetised costs (and benefits) arising in the future need to be adjusted to take account of 'social time preference', that is peoples preference to consume goods and services now, rather than in the future. The technique used to perform this adjustment is known as discounting.

3.4.13 A Discount Rate which represents the extent to which people prefer current over future consumption, is applied to convert future costs (and benefits) to their present value which is the equivalent value of a cost (or benefit) in the future occurring today.

3.4.14 As such, the cost estimate has been discounted to the DfT's Base year (2010) using the discount rates outlined in WebTAG databook v1.11, A1.1.1 (November 2018) summarised in Table 3.12.

Table 3.12: Discount Rates

Years from Current Year	Discount Rate
0-30	3.50%
31-75	3.00%
76-125	2.50%

Market Prices

3.4.15 The final stage in preparing the package cost for appraisal is to convert the cost to the 'market price' using the indirect tax correction factor of 1.19, which reflects the average rate of indirect taxation in the economy.

Present Value Cost Summary

3.4.16 Table 3.13 summarises the investment and operating costs which have been adjusted to 2010 prices and values. It demonstrates that the total PVC estimate over the 60 year appraisal period for the Scheme is £111.1 million.

Table 3.13: Summary of Scheme Costs

Cost Categories	Costs £000
Investment Cost (2016 Prices inc Optimism Bias)	140,340
Investment Cost deflated to 2010 prices	127,270
Investment Cost discounted to 2010 base year	89,865
Present Value of Investment Cost (2010 Market Prices)	106,939
Operation and Maintenance Costs (2016 Prices)	15,347
Present Value of Operation and Maintenance Costs (2010 Market Prices)	4,172
Total Present Value of Costs (2010 Market Prices)	111,112

4 Estimation of Benefits

4.1 Introduction

4.1.1 The following scheme benefits were calculated for the Core Scenario forecast and the Low and High Growth Scenarios:

- User Benefits (time, vehicle operating cost and tax savings);
- Accident Cost Savings; and
- Other Benefits (reliability, wider impacts, regeneration, active mode appraisal and environment)

4.2 User Benefits

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

4.2.2 TUBA 1.9.10 was used to carry out an appraisal of the ‘user benefits’ for the Scheme.

4.2.3 The Transport Economic Efficiency (TEE) benefits arise from time and vehicle operating cost savings over the 60 year appraisal period and are evaluated from the difference in costs between the Do Minimum and Do Something forecasts.

Scheme Parameters

4.2.4 Table 4.1 shows the main parameters that have been used in the TUBA scheme file.

Table 4.1: Scheme Parameters

Parameter	Option
TUBA Version	v1.9.10
Opening Year	2023
Design Year	2038
Horizon Year	2051 (final NTEM forecast year)
Final Appraisal Year	2082
Modelled Years	2023, 2038 and 2051

Time Slices

4.2.5 TUBA is able to provide user benefits for up to 8,760 hours within a year and it allocates each hour into one of five time slices as shown in Table 4.2.

Table 4.2: TUBA Time Slices

Period	Time
Weekday AM Period	(07:00-10:00)
Weekday Inter-Peak Period	(10:00-16:00)
Weekday PM Period	(16:00-19:00)
Weekday Off-Peak Period	(19:00-07:00)
Weekend + Bank Holiday	(24-hours)

4.2.6 The traffic models developed for the Scheme, consists of the three distinct time periods: AM peak hour (08:00-09:00), Inter-peak (average of 10:00-15:30), and PM Peak (16:30-17:30). Non-modelled hours should therefore be included in the TUBA analysis either by expanding the modelled hour to the relevant period or by adopting "donor" models. (Detail of the method of annualisation is provided in Appendix G – TUBA Annualisation Factors). The TUBA analysis periods and the corresponding modelled hours are summarised in Table 4.3.

Table 4.3: TUBA Analysis Periods and Corresponding Model Input Hours

TUBA Analysis Periods	Model Input Periods
AM Peak Period (0700-1000)	AM Peak Hour (08:00-09:00)
Inter-Peak Period (1000-1600)	Average Inter-Peak Hour (10:00-15:30)
PM Peak Period (1600-1900)	PM Peak Hour (16:30-17:30)
Off-Peak Period (1900-0700)	Average Inter-Peak Hour (1000-1600)
Weekend + Bank Holiday	Average Inter-Peak Hour (1000-1600)

Vehicle Type and Trip Purpose

4.2.7 In accordance with the WebTAG Unit A1.3, Section 4 (March 2017), TUBA benefits are required to be assessed with disaggregation to vehicle type and journey purposes. Seven user classes are defined in the TUBA standard economic file, representing 3 distinct trips purposes for car, two for LGV's and two for HGV's that is based on different values of time (VoT), vehicle occupancies and fuel consumptions for each vehicle types and purposes:

- Car – Employer Business;
- Car – Commuting;
- Car – Other;
- LGV – Personal;
- LGV – Freight;
- OGV 1; and
- OGV 2.

4.2.8 The traffic models developed for the Scheme however consist of five user classes:

- UC1 Car – Employer Business;
- UC2 Car – Commuting;
- UC3 Car – Other;
- UC4 LGV; and
- UC5 HGV.

4.2.9 The user classes from the Great Yarmouth traffic forecast variable demand models were therefore converted to the standard TUBA user classes, using the adjustment factors applied for each modelled user class as provided in Table 4.4.

Table 4.4: Modelled User Classes to TUBA User Classes

Model User Class	TUBA User Class	TUBA Input Vehicle / Submode	Trip Purpose	Demand Factor
1	1	1 (Car)	1 (Business)	1.00
2	2	1 (Car)	2 (Commuting)	1.00
3	3	1 (Car)	3 (Other)	1.00
4	4	2 (LGV personal)	0 (Commuting and Other)	0.12
4	5	3 (LGV freight)	0 (Business)	0.88
5	6	4 (OGV1)	0 (Business)	0.17

Model User Class	TUBA User Class	TUBA Input Vehicle / Submode	Trip Purpose	Demand Factor
5	7	5 (OGV2)	0 (Business)	0.26

4.2.10 The split between LGV personal and LGV freight is given in WebTAG databook v1.11, A1.3.4 (November 2018). The demand adjustment factors for HGVs are based upon the vehicle split assumed for the OBC, and include an additional factor to convert from PCUs to vehicles.

4.2.11 A TUBA appraisal was then undertaken using the parameters described above, with demand and skimmed time and distances for Do Minimum and Do Something forecast models to produce the user benefits for the 60 year appraisal period.

Analysis of User Benefits

4.2.12 User benefits including time savings, fuel-related vehicle operating costs (VOC), non-fuel VOC, and operator and Government revenues, typically form the major element of benefit attributable to highway schemes. The appraisal reported here uses TUBA Version 1.9.10.

4.2.13 The software provides the DfT standard approach to appraising changes in demand, travel time and operating costs. Demand, average time and average distance matrix skims from the Do Minimum (DM) and Do Something (DS) tests for the Opening and Design years are fed into TUBA, generating the following types of economic outputs:

- User Time Savings
- Vehicle Operating Cost Savings
- Greenhouse Gases
- Indirect Taxes

4.2.14 Analysis of the benefits has been carried out:

- By year, over the 60 year appraisal period
- By trip purpose/ vehicle type/ by time period (AM/ IP/ PM periods); and
- By sector of origin and destination

4.2.15 The appraisal area for estimating user benefits includes the full model area, although analysis at sector level provides the facility to assess benefits within only part of the modelled area.

Annualisation Factors and Non-Modelled Hours

4.2.16 The forecast model consists of three distinct peak hours: AM peak hour (08:00-09:00), average inter-peak hour (10:00-15:30), and PM peak hour (16:30-17:30). TUBA analysis is, however, required to be carried out for all the hours for the whole year.

4.2.17 For non-modelled hours (i.e. AM Peak shoulders (07:00-08:00 and 09:00-10:00), PM peak shoulders (15:30-16:30 and 17:30-18:30), off-peak and weekend and Bank Holidays), it is only appropriate to calculate benefits for hours in which traffic levels are similar to the modelled hours.

4.2.18 For example, in the appraisal it would not be appropriate to expand the AM peak hour to the AM period in the event that observed traffic was significantly lower in the peak shoulders. In reality, this would result in significantly less actual delays caused by traffic in the peak shoulders as opposed to the peak hour, thus resulting in overestimating the modelled benefits of the Scheme if the peak shoulders were included in the calculation of benefits.

4.2.19 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 the changes in the modelled hours.

4.2.20 It is often considered good practice that the peak shoulder traffic exceeding 90% of that in the peak hour should be included in the derivation of the annualisation factors as the change in travel time between the Do Minimum and Do Something in the peak shoulders would be close to the changes experienced in the peak hour. The 90% threshold was used in the initial analysis.

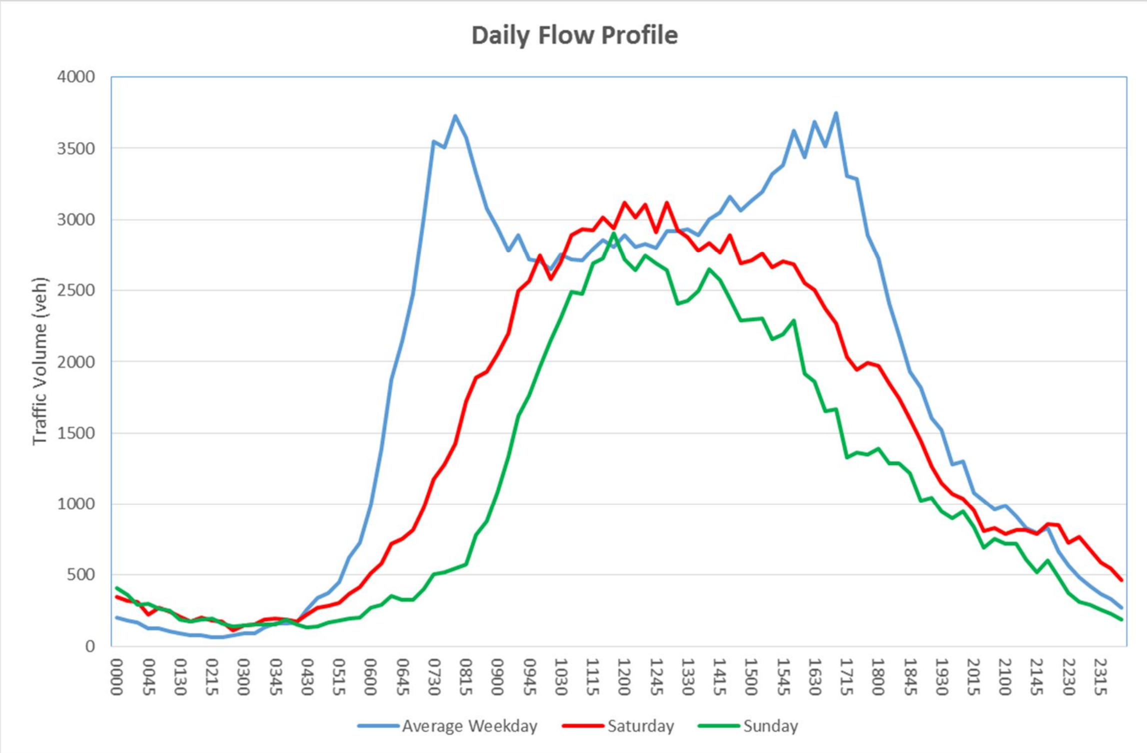
4.2.21 Observed traffic counts from nine Automatic Traffic Counts (ATC) at the RSI locations in Great Yarmouth that were collected over two weeks in November 2016, for the purpose of the base year model validation, were used to identify this profile.

4.2.22 The locations of the nine ATC counts can be found within Appendix G – TUBA Annualisation Factors.

4.2.23 Additional ATC and MCC data was collected in 2018 for the purpose of constructing a micro-simulation model for operational assessment of the Scheme. Examination of the 2018 ATC data, the 2016 ATC data and long term traffic counts along the A47, showed that traffic flow profiles have remained fairly static from 2016. As such this annualisation analysis is still applicable and provides consistency with the OBC submission.

4.2.24 Plate 4.1 provides a summary of the daily traffic flow profile that was produced from the ATC sites.

Plate 4.1: Traffic Flow Profile



4.2.25 As can be seen from Plate 4.1, weekday traffic volume peaks between 08:00-09:00 before reducing significantly to the inter-peak. Peak conditions re-emerge at 15:30 and continue to 17:30 before receding into the off-peak period. During weekend, the traffic volume shows similarly to the inter-peak period on Saturday with slightly lower flow on Sunday. It is therefore suggested that only about 1.5 hours for the AM and just over 2 hours for the PM period that will be used for the calculation of the benefits of the Scheme. This was based on the assumption that traffic volume in the peak shoulders of more than 90% of the peak hour volume is deemed to be appropriate to be included in the derivation of the annualisation factors. Further detail on the annualisation and non-modelled hours is provided in Appendix G – TUBA Annualisation Factors.

4.2.26 The following factors were applied to the relevant modelled hours to include the non-modelled hours in the calculation of the TUBA benefits, and to derive the annualisation factors as provided in Table 4.5. The source of these calculations can be found in Tables 1 to 3 in Appendix G – TUBA Annualisation Factors.

Table 4.5: Annualisation Factors

No	Time Slice	Duration (min)	Traffic Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1.51 x 253 = 383
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7.23 x 253 = 1,828
3	Weekday PM Period	60	PM Peak Hour model	2.20 x 253 = 556
4	Weekday Off-Peak period	60	Inter-Peak hour model	0.00 x 253 = 0
5	Weekend	60	Inter-Peak hour model	8.06 x 52 = 419
Total Annual Hours				**3,186 hours**

4.2.27 Around 36% of annual hours are reflected in the annualisation. It is noted that the ATC counts were collected for two weeks during November 2016. They therefore do not represent the whole year of traffic travelling within the area, particularly during the summer seasons where weekend traffic volumes are likely to be higher than those in November.

4.2.28 Furthermore, the ATC counts during November do not include any Bank Holidays, therefore these benefits are also excluded. The annualisation factors derived for the weekends using November are therefore considered conservative in the calculation of the benefits for the Scheme.

Benefits at Sector Level

4.2.29 The geographic distribution of benefits has been assessed through an analysis of sector-based cost changes. A 10 by 10 sector system was defined for the study area to provide an overview of the distribution of benefits derived from the transport model. These sectors are illustrated in *Plate 4.2* and listed in Table 4.6 below.

Plate 4.2: Sector Locations

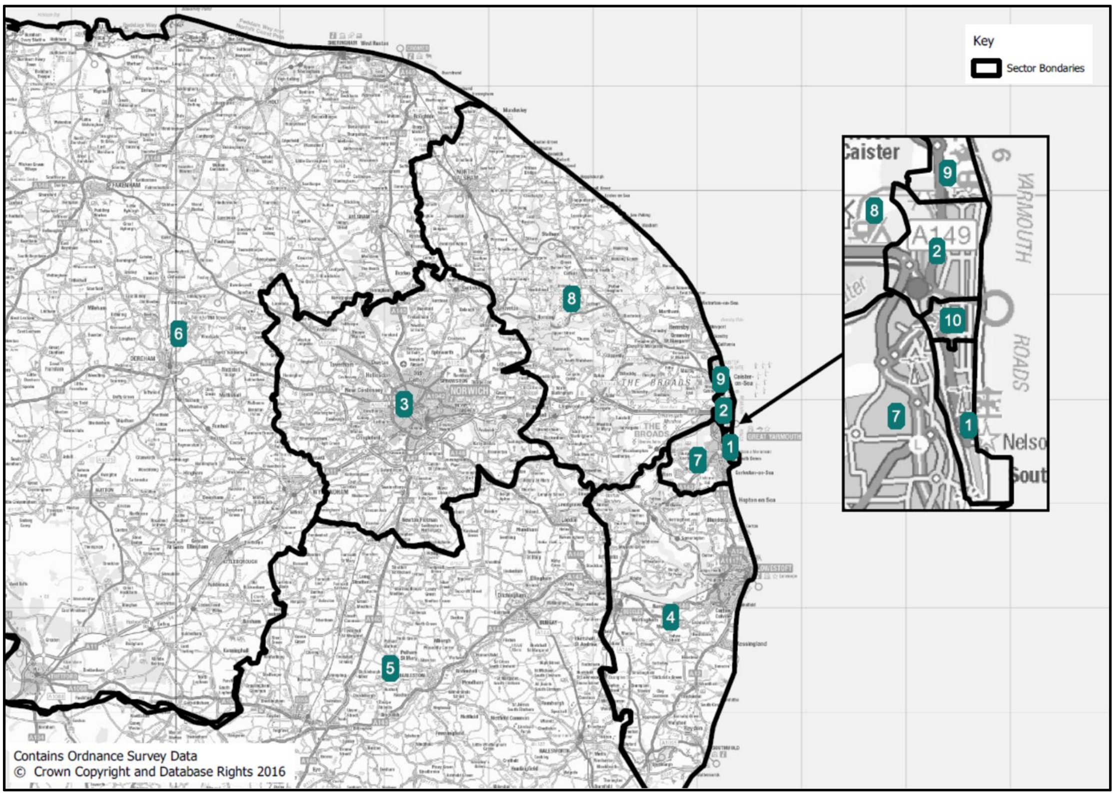


Table 4.6: Sector System

Sector	Description
Sector 1	Great Yarmouth Peninsula
Sector 2	Great Yarmouth north town
Sector 3	Norwich
Sector 4	Lowestoft
Sector 5	South (London, Ipswich, etc.)
Sector 6	North/West (Midlands, Northwest, Northeast, etc.)
Sector 7	Rural areas south of Great Yarmouth
Sector 8	North of Great Yarmouth (Winterton-on-Sea, Horsey Corner, North Walsham)
Sector 9	Caister-on-Sea
Sector 10	Great Yarmouth mid-town

4.3 Accident Savings

4.3.1 The anticipated number of accidents and casualties saved as a result of the introduction of the Scheme were calculated using the DfT's software Cost and Benefit to Accidents – Light Touch (v2013_02COBA-LT).

4.3.2 As defined in the COBA-LT 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 Accidents (PIA) per million vehicle kilometres travelled. 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.

4.3.3 The savings in the number of accidents / casualties as a result of the Scheme were calculated from the difference between accident and casualty costs in 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.

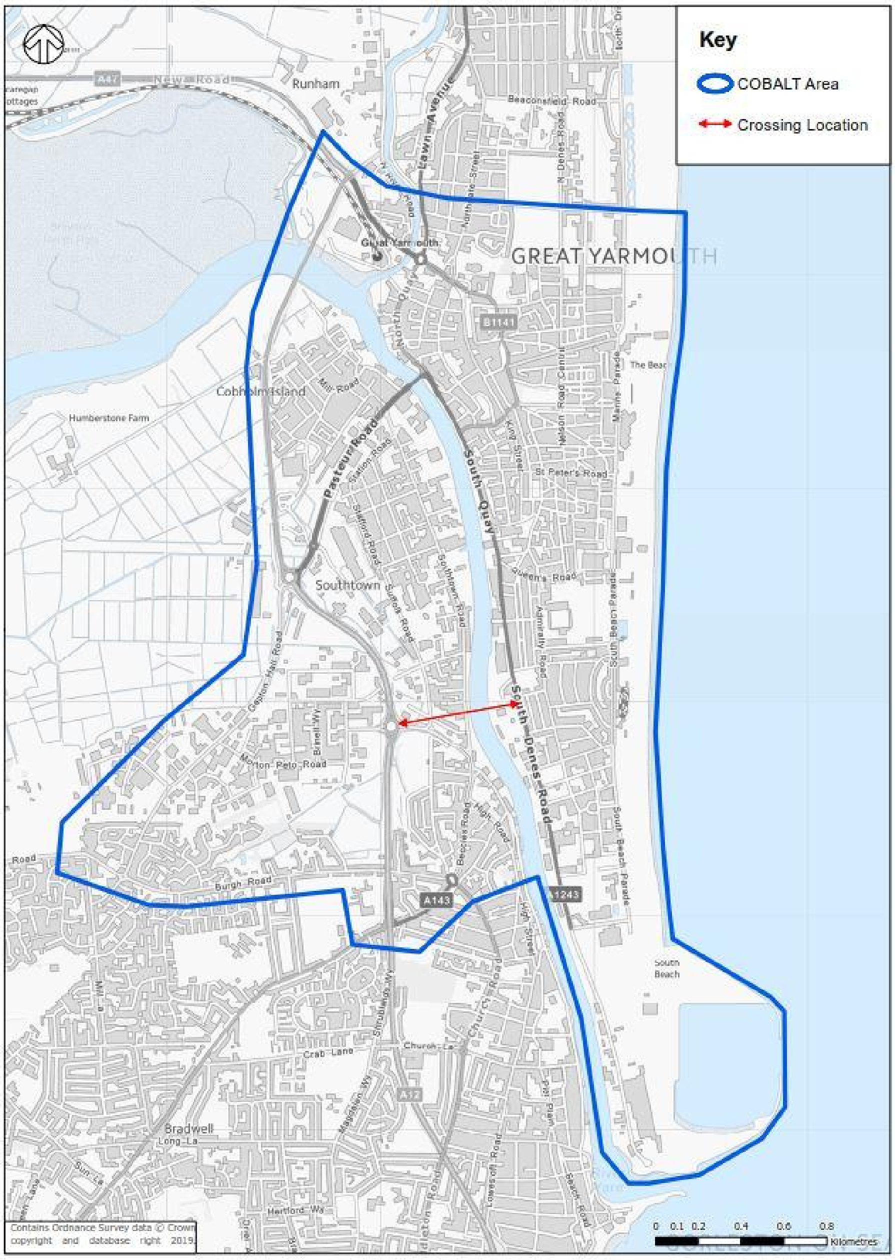
4.3.4 The latest standard economic parameter file was used which contains a series of data tables of standard parameters required to calculate accident impacts in line with WebTAG guidance. These data tables provide the inputs required to calculate accident and casualty numbers and costs by year using:

- Costs per accident type
- Rates of accidents and casualties of different severities by link type; and
- Junction class and allowance for changes in accident and casualty rates through time using change factors (known as beta factors).

4.3.5 Alongside the economic parameter file, the Scheme specific input file is used to produce the output file. This contains comparable information for links and junctions, setting out the classification of types, traffic flows and historical accident data.

4.3.6 The extent of the study area was based on links with differences in AADT flow of over 5% between the Do Minimum and Do Something scenarios. The resulting study area is illustrated in Plate 4.3.

Plate 4.3: COBA-LT Study Area



4.3.7 COBA-LT has the ability to run the analysis using two different modes as summarised as follows:

- Separate mode – accident benefits are calculated separately for links and junctions (defined as those accidents occurring within 20m of a junction); or
- Combined mode – accident benefits are calculated for links in such a way that the junction accidents are included.

4.3.8 The Scheme is likely to result in a considerable redistribution of traffic thus impacting flows on a number of links and junctions. It is considered appropriate to assess links and junctions separately within COBA-LT. Default accident rates were used across the COBA-LT network.

4.3.9 For each link within the study area (for both the Do Minimum and Do Something scenarios), a COBA link type was assigned from the default set of 15 available within COBA-LT. Link lengths, speed limits and AADT flows were also extracted for each link from the forecast models.

4.3.10 The COBA-LT study area includes a considerable number of junctions, including a number of minor junctions where safety is unlikely to be impacted by the Scheme. The junctions included in the assessment were selected using the following methodology:

- All junctions where at least one Personal Injury Accident (PIA) was recorded in the 6-year period between 2010 and 2015 were included. This assessment of observed accidents was undertaken for selection purposes only. No observed accidents were included in the COBA-LT input file;
- Any other major junctions likely to be impacted by the Scheme;
- The existing priority junction at Sutton Road/South Denes Road on the Peninsula (to be replaced by the new signalised junction) was included with flows in the Do Minimum scenario only; and
- The new roundabout and traffic signal junctions on the west and eastern side of the new bridge respectively were included with flows in the Do Something scenario only.

4.3.11 The locations of the junctions that were included in the COBA-LT assessment can be found in Appendix C – COBA-LT Links and Junctions.

4.3.12 For each junction a COBA-LT junction type was assigned from the default set of eight available. The AADT flows for each approach arm were extracted from the forecast models.

4.3.13 A summary of the COBA-LT parameters is presented in Table 4.7.

Table 4.7: Accident Benefits Calculation General Parameters

Parameter	Value
First Year of Appraisal	2023
Evaluation Period	60 Years
Traffic Flow Input Format	AADT
Type of Accident Calculations	Link and Junction Separate (SEP)
Traffic Flow Input Year	2023, 2038, 2051
Traffic Growth Assumption	Default Central (DEFC)
Economic Growth Assumption	Default Central (DEFC)
Fuel Cost Growth Assumption	Default Central (DEFC)

4.4 Other Benefits

Reliability Benefits

4.4.1 The term reliability refers to variation in journey times that individual drivers are unable to predict (journey time variability). Such variation could come from recurring congestion at the same period each day (day-to-day variability), or from non-recurring events such as incidents. It however excludes predictable variation relating to varying levels of demand by time of day, day of week, and seasonal effects which travellers are assumed to be aware of.

4.4.2 Different methods to estimate reliability impacts have been developed for public transport and private vehicle trips on inter urban motorways and dual carriageways, urban roads, and other roads. All require a unit to measure travel time variability and this is generally the standard deviation of travel time (for private travel) or lateness (for public transport).

4.4.3 For inter-urban motorways and dual carriageways, impacts of journey time variability and incident delays is estimated using the HE’s bespoke tool namely Motorways Reliability and Incident Delays (MyRIAD). For motorways and dual carriageways, alternative routes avoiding particular sections usually have limited capacity making it difficult for large number of drivers to divert if they encounter delays due to an incident, therefore, in the absence of significant demand exceeding capacity, it may be sufficient to assume that incidents are the main source of unpredictable variability.

4.4.4 For urban areas, alternative routes are more readily available than on the motorways and there are many ways for drivers to divert away from incidents which reduce capacity on a particular route.

4.4.5 Building on previous research, a model has been developed to forecast changes in the standard deviation of travel time from changes in journey time and distance, as provided in the WebTAG Unit A1.3, Section 6 (March 2017):

$$\Delta\sigma_{ij} = 0.0018(t_{ij2}^{\ 2.02} - t_{ij1}^{\ 2.02})d_{ij}^{\ -1.41}$$

where:

$\Delta\sigma_{ij}$	is the change in standard deviation of journey time from i to j (seconds)
t_{ij1} and t_{ij2}	are the journey times, before and after the change, from i to j (seconds)
d_{ij}	is the journey distance from i to j (km).

4.4.6 To estimate the monetised benefits of changes in journey time variability, monetary values are needed. The reliability ratio enables changes in variability of journey time to be expressed in monetary terms. The reliability ratio is defined as:

Reliability Ratio = Value of SD of travel time / Value of travel time

4.4.7 The recommended value for the reliability ratio for all journey purposes by car, based on evidence compiled, is 0.4 as stated in the WebTAG Unit A1.3, Section 6.3.4 (March 2017). The reliability benefits are then can be estimated using the "rule of half" formula:

$$Benefit = -\frac{1}{2}\sum_{ij}\Delta\sigma_{ij} * (T_{ij}^{0} + T_{ij}^{1}) * VOR$$

Note that the value of reliability (VOR) is obtained by multiplying the value of time by the reliability ratio and T_{ij}^{0} and T_{ij}^{1} are number of trips before and after the change.

4.4.8 To produce reliability benefits for each scenario, only travel time saving benefits from TUBA runs were extracted since reliability benefits are associated with travel time savings. Benefits associated with fuel, non-fuel, greenhouse gas and indirect tax revenues were not included from TUBA outputs.

Wider Impacts

4.4.9 Wider Impacts, as defined in DfT guidance, are the economic impacts of transport that are additional to transport user benefits. Transportation costs are intrinsically linked with regional economic performance. They impact on companies and residents acting in labour and product markets.

4.4.10 In perfectly competitive markets, these impacts would be fully captured by a properly specified appraisal. But in practice, most markets are not perfectly competitive and as a result, wider impacts may result as direct user impacts that are amplified through the economy. Previous schemes across the country have demonstrated that these impacts can be large, and can therefore be an important part of the overall appraisal of a transport scheme.

4.4.11 The types of wider impacts considered are:

- WI1 – Agglomeration;
- WI2 – Output change in perfectly competitive markets; and
- WI3 – Tax revenues arising from labour market impacts (from labour supply impacts and from moves to more or less productive jobs)

4.4.12 The Wider Impacts for the Scheme have been calculated using WSP's Wider Impacts in Transport Appraisal (WITA) emulation tool. The emulation tool, a macro-embedded spreadsheet that applies the methodology set out in WebTAG Unit A2.1 (May 2018) has previously been accepted for use by HE, Transport for the North and the DfT for appraisal of wider impact benefits for the Trans-Pennine Tunnel and the M60 North West Quadrant. The WITA tool assesses all three types of Wider Impacts discussed above.

4.4.13 The Wider Impacts above are referenced as Level 2 benefits, based on travel cost changes impacting the existing regional economy in a "static" manner. Land use is not expected to be impacted.

4.4.14 The likely "dynamic" impact of wider impacts and regeneration in Great Yarmouth has been reported by consultant Regeneris in "Assessment of Wider Economic and Regeneration Benefits", 2017. Their appraisal of benefits and impacts is largely qualitative but quantification is also outlined with the focus of the appraisal being on the impacts on employment land and existing sites and premises, as well as on town centre regeneration and the visitor economy. There is also a commentary on demographic change and how increased investment and development activity in Great Yarmouth will lead to requirements for, and supply of, a skilled labour market. The analysis represents additional gain to the Great Yarmouth economy based on changes to land use, primarily earlier realisation of development sites related to the availability of the Third River Crossing. This report is discussed further in the Case for The Scheme. The quantified outputs are not included in this report.

Regeneration

4.4.15 Regeneration benefits (as defined by DfT) are not included in the calculation of the adjusted BCR, and are reported here as qualitative benefits as part of the Strategic Case. This is because there is no "dependent development" associated with the Scheme, and therefore no calculable land value uplift (planning gain) that is directly attributable. It is likely that the regeneration benefits form a component of potential Level 3 "dynamic clustering" impacts, although the levels of assurance around such benefits are necessarily lower than those lodged under Level 1 (transport economic) and Level 3 (wider impact) benefits. Hence the exclusion of monetised regeneration impacts is considered a conservative approach to the calculation of scheme benefits.

Active Mode Benefits

4.4.16 As a result of the Scheme, pedestrians and cyclists will have better access to the Great Yarmouth peninsula and a more pleasant environment. Dedicated facilities on the new bridge will improve journey quality and encourage more people to walk or cycle. These impacts are expected to produce economic benefits due to:

- Increased physical activity leading to lower healthcare costs;
- Less absenteeism and fewer working days lost;
- The value placed on improved journey quality and ambience; and
- Time savings for cyclists and pedestrians.

4.4.17 To quantify these benefits, an active mode appraisal has been conducted over a 30 year appraisal period in line with WebTAG guidance. The benefits have been discounted and reported in present values using the schedule of discount rates provided in WebTAG databook v1.11, A1.1.1 (November 2018). As the appraisal has taken place in 2017, a discount rate of 3.50% per year has been applied until 2047, with a rate of 3.00% thereafter.

4.4.18 Again, in accordance with WebTAG, the values have included real growth in line with forecast GDP/capita.

4.4.19 A full report on the calculation of active modes benefits is contained in the Active Modes Appraisal Report in Appendix D – Active Mode Appraisal.

Environment

4.4.20 The Environmental Impact Assessment process which has culminated in the Environmental Statement (Document reference 6.1) does not require a WebTAG standard assessment of environmental impacts.

4.4.21 As such, the Environmental Appraisal of the Scheme, alongside the Noise and Air Quality impacts which informed the Social and Distributional Impact assessment, which were initially developed on a qualitative basis for OBC will be updated for the FBC, and will include quantified, qualitative and monetised assessments where required by WebTAG.

4.4.22 The exception to this is that Greenhouse gas benefits arising from the results of the Environmental Statement have been monetised within the TUBA appraisal and are included in the BCR calculation on that basis only.

4.5 Social and Distributional Impact (SDI) Analysis

4.5.1 The analysis of distributional impacts is mandatory in the appraisal process and is a key component of the Appraisal Summary Table (AST). The Distributional Impacts Appraisal compares the distribution of benefits arising from a transport intervention against the different social groups to assess the extent to which benefits are experienced by those groups and compared nationally.

4.5.2 Distributional impacts consider the benefits and disbenefits that transport interventions have across different social groups. For example, people with access to a car may experience less benefits to those without a car for an intervention that improves local public transport services. It is important to consider vulnerable groups and that they are not disadvantaged further by receiving a disproportionately low share of the benefits provided by the intervention, or a disproportionately high share of the disbenefits.

4.5.3 Within WebTAG unit A4.2 (December 2015), there are eight transport benefit indicators that are assessed as part of the Distributional Impacts Appraisal:

- User benefits;
- Noise;
- Air quality;
- Accidents;
- Security;
- Severance;
- Accessibility; and
- Personal affordability.

4.5.4 The appraisal approach consists of the following three steps:

- Step 1 – Screening Process:
  - Identification of likely impacts for each indicator.
- Step 2 – Assessment:
  - Confirmation of the area impacted by the transport intervention (impact area)
  - Identification of social groups in the impact area; and
  - Identification of amenities in the impact area.
- Step 3 – Appraisal of Impacts:

- Core analysis of the impacts; and
- Full appraisal of DIs and input into AST.

4.5.5 A full report on the methodology and outputs of the SDI analysis which has been updated from its original OBC submission for the purposes of this DCO application is contained in Appendix E – Social and Distributional Impacts.

5 Economic Appraisal Results

5.1 Introduction

5.1.1 This section of this report provides the results of the appraisal of user benefits and accident cost savings.

5.2 User Benefits (TUBA)

5.2.1 The user benefits derived from the Scheme in the core scenario appraisal are summarised in Table 5.1.

Table 5.1: TUBA Benefits

Cost and Benefits	Core Scenario
Consumer User (Commute)	42,650
Consumer User (Other)	98,407
Business User and Provider	78,267
Indirect Tax Revenue	-6,682
Greenhouse Gases	3,461
Present Value of Benefits (PVB)	**216,103**

5.2.2 Note: All values are in £000 at 2010 prices and are abstracted from TUBA outputs.

Benefits by Time Period

5.2.3 The contribution by type of benefit and by time period is summarised in Table 5.2 and Plate 5.1.

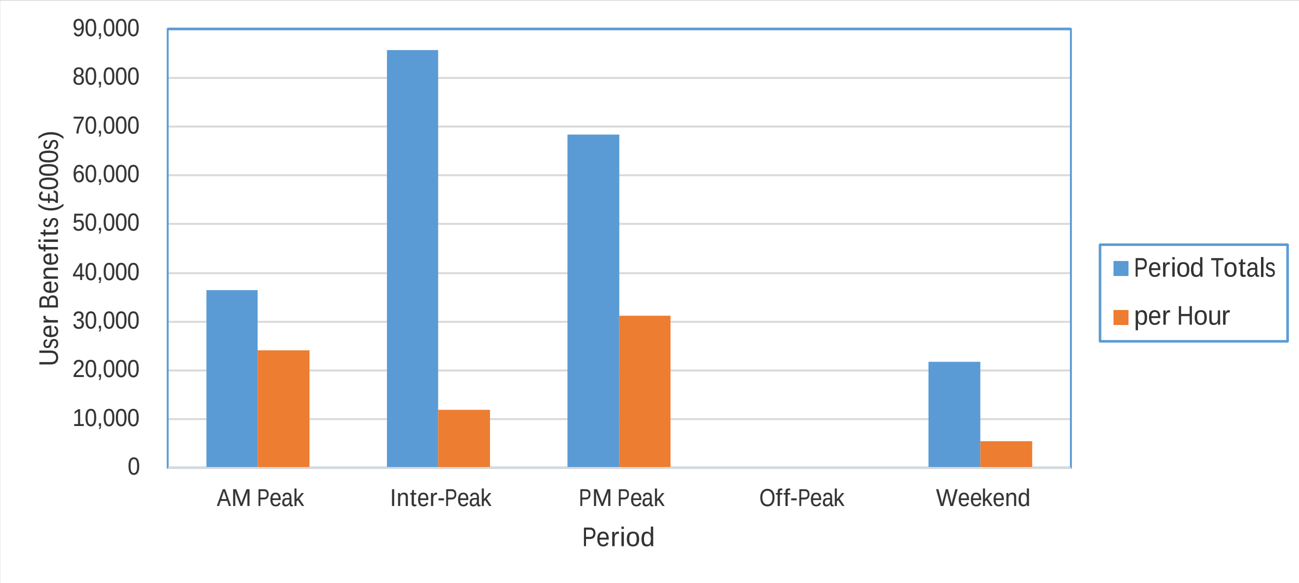
5.2.4 User Benefits (excluding costs associated with non-fuel Vehicle Operating Costs (VOC), greenhouse gases and indirect tax revenue) across the 60 year appraisal period are £212 million, of which 92% are made up of time savings, with the other 8% being made up of fuel based VOCs. It is noted that there is a significantly larger contribution in total benefits from the PM period than the AM period in years 2038, 2051 and over the appraisal period as a whole.

Table 5.2: User Benefits by Types and Time Period (£000s)

Period	Type	2023	2038	2051	60 Years
AM Period	Time Savings	419	487	697	33,773
	VOC (fuel only)	65	49	50	2,621
	Total	484	536	747	36,394
	per Hour	320	354	493	24,041
Inter-Peak Period	Time Savings	1,069	1,100	1,593	77,848
	VOC (fuel only)	214	150	139	7,707
	Total	1,283	1,250	1,732	85,555
	per Hour	178	173	240	11,841
PM Period	Time Savings	590	928	1,371	64,282
	VOC (fuel only)	78	74	84	4,055
	Total	668	1,002	1,455	68,337
	per Hour	304	456	662	31,096
Weekend	Time Savings	273	281	408	19,898
	VOC (fuel only)	49	34	32	1,766
	Total	322	315	440	21,664
	per Hour	80	78	109	5,377
Total	Time Savings	2,351	2,796	4,069	195,801
	VOC (fuel only)	406	307	305	16,149
	Total	2,757	3,103	4,374	211,950

5.2.5 Note: All values are in £000 at 2010 prices and are abstracted from TUBA outputs and may contain rounding discrepancies.

Plate 5.1: User Benefits by Time Period



5.2.6 Further to the aforementioned, it can be seen that user benefits increase over the forecast years consistently across all the time periods. The order of magnitude of benefits by time periods are plausible with the highest benefits per hour attributed to the AM and PM periods. The levels of delay in the AM and PM period hours are significantly higher than those in the Inter-peak or weekend periods.

Benefits by Trip Purpose

5.2.7 Table 5.3 summarises travel time benefits by journey purpose. Some 30% of these savings are realised by freight movements whereas 44% of benefits are accrued by 'others' journey purposes. This is expected given the nature of the area (i.e. to serve as a major attraction for tourism and as a port for freight). Around 19% of benefits are attributed to commuters and 7% to business users (car).

Table 5.3:Travel Time Savings by Trip Purpose

Purpose	Travel Time	Vehicle Operating Cost	Total	Proportion
Commuting	41,543	1,107	42,650	19.4%
Other	89,403	9,004	98,407	44.9%
Business (Car)	12,964	2,022	14,986	6.8%
Business (Freight)	51,891	11,390	63,281	28.9%
Total	195,801	23,523	219,300	100.0%

5.2.8 Note: All values are in £000 at 2010 prices and are abstracted from TUBA outputs and may contain rounding discrepancies.

User Benefits by Vehicle Type and Magnitude of Time Savings

5.2.9 Table 5.4 provides a breakdown of travel time savings by car, LGV and OGV and the size of the time savings accrued by each vehicle type.

Table 5.4: Travel Time Savings by Vehicle Type

Veh. Type	Purpose	< -5min	-5 to -2min	-2 to 0min	0 to 2min	2 to 5min	> 5min	Total
Car	Business	-13	-5	-696	5,619	4,554	3,505	12,964
Car	Commuting	0	-1	-2,124	13,141	15,416	15,112	41,544
Car	Other	-3	-18	-6,400	37,196	33,063	22,863	86,701
LGV	Personal	-2	-2	-173	906	970	1,004	2,703
LGV	Freight	-30	-27	-2,690	14,107	15,265	15,691	42,316
OGV 1	Business	-2	-5	-343	1,101	1,057	2,021	3,829
OGV 2	Business	-2	-7	-515	1,652	1,585	3,032	5,745
Total		-52	-65	-12,941	73,722	71,910	63,228	195,802

5.2.10 Table 5.4 shows that the majority of time savings are realised by those driving cars (72%). LGV's make up around 23% of savings whereas 5% of overall travel time savings are enjoyed by OGVs.

5.2.11 Benefits arise across all the time saving bands, which is expected as the objectives of the new bridge are to shorten travel time and distances for traffic to/from the Peninsula and also to relieve congestion. It is noted that a small proportion of dis-benefits are forecast and this is also expected as some of the local traffic would suffer delays as increases in traffic in the peninsula arise from traffic re-assignment.

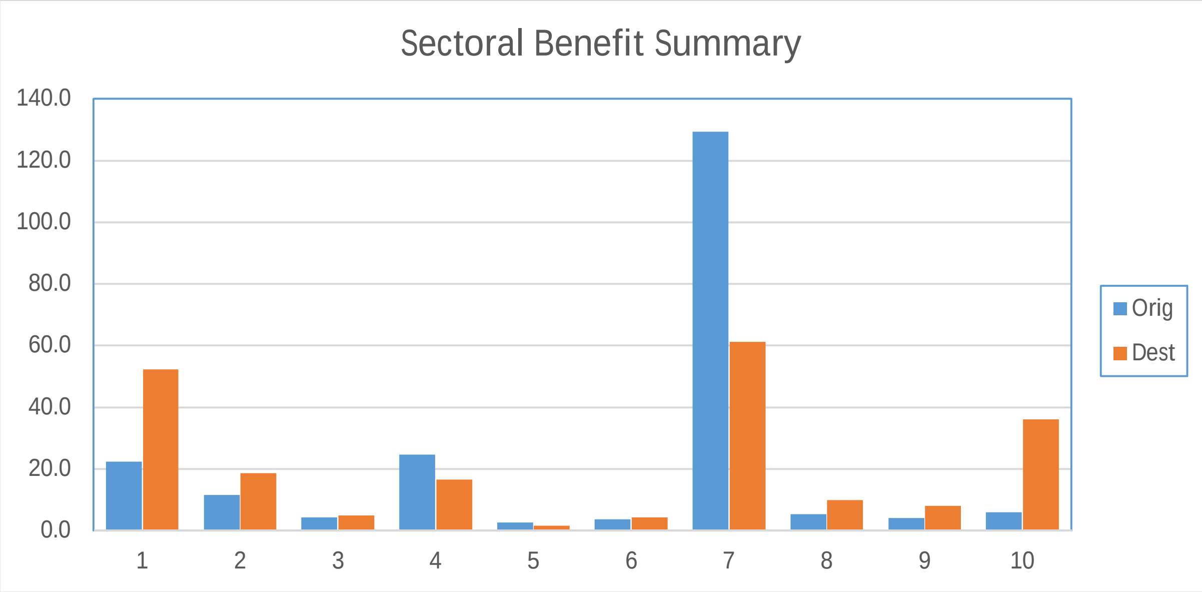
Geographical Distribution of Time Benefits

5.2.12 Guidance recommends that an aggregation of modelled zones into different geographical areas should be used in the TUBA analysis. This is to ensure that the benefits produced by the Scheme are geographically proportionate given the scale and location of the Scheme.

5.2.13 The distribution of benefits has the same sector system as described in section 4.2 of this report.

5.2.14 Plate 5.2 shows the majority of the benefits are from/to sector 7 (south of Great Yarmouth), to the Peninsula (sectors 1 and 10). It is noted that the benefits are not proportional and that there are larger benefits associated with northbound movements as opposed to southbound movements.

Plate 5.2: User Benefits by Sector



5.3 Safety Benefit Assessment

5.3.1 Table 5.5 summarises the accident benefits generated by the Scheme over the 60 year appraisal period, discounted to 2010 prices. The Scheme is forecast to save 20 accidents with a resultant benefit of £0.9 million.

Table 5.5: Scheme Accident Benefits

	DM	DS	Saving
Number of Accidents	5,174	5,154	20
Cost of Accidents (£000)	187,885	186,938	947

5.3.2 Table 5.6 summarises the savings in casualties. The Scheme is forecast to result in a saving of 54 casualties over the 60 year appraisal period.

Table 5.6: Scheme Casualty Benefit

Severity	DM	DS	Saving
Fatal	30	30	0
Serious	437	436	1
Slight	6,770	6,717	53
Total	7,237	7,183	54

5.3.3 Accident savings are broken down by links and junctions in Table 5.7. It can be seen that the accident savings are largely associated with savings at junctions. This can be attributed to the removal of trips from a number of junctions, resulting in a reduction in collisions, due to the reassignment of trips.

Table 5.7: Accident Savings (£000) over 60 Years

Location	DM
Links Only	52
Junction Only	895
Total	947

5.3.4 Over the 60 year appraisal period, the overall impact of accident cost savings is £0.9m, with accidents making up just under 1% of total scheme benefits.

5.4 Reliability Benefits

5.4.1 Table 5.8 provides a summary of the reliability benefits of the Scheme from the core scenario for each appraisal year and the total over 60 years.

5.4.2 It is calculated that the present value of the reliability benefits for the Great Yarmouth Third River Crossing over the 60 year appraisal period is £11.3 million (2010 prices).

Table 5.8: Reliability Benefits (£000s) –Core Scenario

Purpose	2023	2038	2051	Total
Business	17	19	32	1,497
Non-Business	87	110	223	9,815
Total	104	129	255	11,312

5.5 Wider Impact Benefits

5.5.1 Wider Impacts have been calculated using WSP's Wider Impacts in Transport Appraisal (WITA) emulation tool which applies the methodology set out in WebTAG Unit A2.1 (May 2018). The initial WITA benefit was £91.6 million, of which £86.0 million was attributable to agglomeration benefits, equivalent to 39% of the TUBA benefits.

5.5.2 Census Journey to Work information was used to scale the agglomeration benefits to reflect the proportion of commute trips from each local authority that would reasonably be affected by the Scheme. Using this method, it is calculated that the present value of these wider benefits for the Great Yarmouth Third River Crossing over the 60 year appraisal period is £58.7 million, of which £53.1 million is due to agglomeration, equivalent to 25% of the TUBA benefits.

5.5.3 All values are in 2010 prices discounted to 2010.

5.5.4 Full details are given in Appendix F – Wider Impacts Benefits – Core Scenario.

5.6 Active Mode Benefits

5.6.1 The Present Value of Benefits for each active mode impact are summarised in Table 5.9 It is calculated that the present value of the active modes benefits for the Scheme, over a 30 year appraisal period, is £10.2 million (2010 prices).

Table 5.9: Present Value of Active Mode Impacts over 30 Year Appraisal Period (£000) (2010 Prices)

Impact	Pedestrian	Cycle user	Total
Physical Activity (Health)	£2,152	£913	£3,065
Absenteeism	£84	£47	£131
Journey Quality/Ambience	£903	£745	£1,648
Journey Time	£5,034	£326	£5,360
Total	£8,173	£2,031	£10,204

5.6.2 A full report is included in Appendix D – Active Mode Appraisal.

5.7 Social and Distributional Impact Benefits

5.7.1 The social and distributional impact assessment has been updated, where it has been possible to do so, in line with the state of development of the Scheme. The indicators and their respective assessments are included in Appendix E – Social and Distributional Impacts and are summarised as follows:

- User Benefits – Large Beneficial;
- Accidents – Slight Adverse;
- Severance – Slight Beneficial; and
- Personal Affordability – Large Beneficial.

5.7.2 Due to limited data, potential changes to noise and air quality as a result of altered traffic flow, speed and compositions brought on by the Scheme has so far only been undertaken qualitatively. The noise indicator was scored as Slight Adverse, the air quality indicator was as Moderate Adverse.

5.7.3 A full quantitative distributional assessment of noise and air quality impacts will form part of the Full Business Case.

5.7.4 The following indicators were considered to be out of scope during the initial screening proforma:

- Security; and
- Accessibility.

5.8 Transport Economic Efficiency (TEE)

5.8.1 The results of the appraisal in terms of user costs and benefits are summarised in the Transport Economic Efficiency (TEE) table, reproduced in Table 5.10.

Table 5.10: Transport Economic Efficiency (TEE)

Non-business: Commuting	**ALL MODES**		**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars/LGVs**		**Passengers**	**Passengers**		
Travel Time	41,543		41,543					
Vehicle operating costs	1,107		1,107					
User charges	0		0					
During Construction & Maintenance	0		0					
NET NON-BUSINESS BENEFITS: COMMUTING	**42,650**	*(1a)*	**42,650**		**0**	**0**		**0**
Non-business: Other	**ALL MODES**		**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars/LGVs**		**Passengers**	**Passengers**		
Travel time	89,403		89,403					
Vehicle operating costs	9,004		9,004					
User charges	0		0					
During Construction & Maintenance	0		0					
NET NON-BUSINESS BENEFITS: OTHER	**98,407**	*(1b)*	**98,407**		**0**	**0**		**0**
Business	**ALL MODES**		**ROAD**		**BUS/COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Good Vehicles**	**Business Cars/LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	64,855		51,891	12,964				
Vehicle operating costs	13,412		11,390	2,022				
User charges	0		0	0				
During Construction & Maintenance	0		0	0				
Subtotal	**78,267**	*(2)*	**63,281**	**14,986**	**0**	**0**	**0**	**0**
Private sector provider impacts						**Freight**	**Passengers**	
Revenue	0				0			
Operating costs	0				0			
Investment costs	0				0			
Grant/subsidy	0				0			
Subtotal	**0**	*(3)*			**0**	**0**	**0**	**0**
Other business impacts								
Developer contributions	0	*(4)*				0		
NET BUSINESS IMPACT	**78,267**	*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	**219,324**	*(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)

5.9 Public Accounts

5.9.1 A summary of the Scheme costs and their allocation between providers is accounted for in the Public Accounts (PA) table, shown in Table 5.11. The apportionment of funding between local and central government is based upon the funding request contained in the OBC Addendum to 2017 Financial, Commercial and Management Case, May 2018. The Local Authority contribution is approximately 17%.

Table 5.11: Public Accounts (PA)

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS/COACH	RAIL	OTHER
Local Government Funding						
Revenue	0		0			
Operating Costs	4,172		4,172			
Investment Costs	18,228		18,228			
Developer and Other Contributions	0		0			
Grant/Subsidy Payments	0		0			
NET IMPACT	**22,400**	*(7)*	**22,400**	**0**	**0**	**0**
Central Government Funding: Transport						
Revenue	0		0			
Operating Costs	0		0			
Investment Costs	88,712		88,712			
Developer and Other Contributions	0		0			
Grant/Subsidy Payments	0		0			
NET IMPACT	**88,712**	*(8)*	**88,712**	**0**	**0**	**0**
Central Government Funding: Non-Transport						
Indirect Tax Revenues	6,682	*(9)*	6,682			
TOTALS						
Broad Transport Budget	**111,112**	*(10) = (7) + (8)*				
Wider Public Finances	**6,682**	*(11) = (9)*				

5.10 Summary of Monetised Costs and Benefits

5.10.1 A summary of all costs and benefits, providing an overall BCR for the Scheme is provided in Table 5.12. The total monetised benefits exceed the costs by £115.7 million. The initial BCR of the Scheme is 2.0. This means that the value for money category is high.

5.10.2 This initial value of BCR includes monetised benefits of accident savings, greenhouse gas reductions and indirect taxation impacts, but does not include benefits accruing from reliability or wider impacts.

Table 5.12: Analysis of Monetised Costs and Benefits (AMCB)

Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	3,461	*(14)*
Journey Quality	7,008	*(15)*
Physical Activity	3,196	*(16)*
Accidents	947	*(17)*
Economic Efficiency: Consumer Users (Commuting)	42,650	*(1a)*
Economic Efficiency: Consumer Users (Other)	98,407	*(1b)*
Economic Efficiency: Business Users and Providers	78,267	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-6,682	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Option Values		*(17)*
Present Value of Benefits (see notes) **(PVB)**	**227,254**	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) + (17) - (11)*
Broad Transport Budget	111,112	*(10)*
Present Value of Costs (see notes) **(PVC)**	**111,112**	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	**116,142**	*NPV = PVB - PVC*
Benefit to Cost Ratio (BCR)	**2.05**	*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.

5.10.3 Table 5.13 demonstrates that the inclusion of reliability benefits and wider economic impacts gives an adjusted BCR of 2.7. Businesses will benefit from reduced congestion, faster journeys and improved journey time reliability, with reduced costs and better access to markets, whilst commuters will similarly benefit from shorter, more reliable, journeys to work. These benefits, which are included in the BCR calculations will support local development and the regeneration of the Great Yarmouth economy.

Table 5.13: Adjusted BCR

Adjusted BCR	2010 prices £000
Initial Present Value of Benefits (PVB)	227,255
Wider Impacts – Reliability	11,312
Wider Impacts – Economic	58,727
Adjusted Present Value of Benefits (PVB)	297,294
Present Value of Costs (PVC)	111,112
Net Present Value (NPV)	186,182
Adjusted BCR	2.7

5.10.4 The Scheme is expected to lead to a reduction in greenhouse gas emissions based upon the TUBA output; these have been monetised and included in the BCR.

5.11 Sensitivity Tests

5.11.1 In order to understand how sensitive the benefits are to a range of alternative parameters, a number of tests have been performed:

- Alternative growth scenarios – low and high growth as defined by DfT guidance (WebTAG Unit M4 Forecasting and Uncertainty (May 2018));
- Alternative optimism bias; and
- Alternative annualisation

Alternative Growth Scenarios

5.11.2 The results of the appraisal for the low and high growth sensitivity tests are shown in Table 5.14.

5.11.3 The results show that benefits are much larger in the high growth scenario, although even the low growth scenario has significant benefits and a high BCR.

Table 5.14: Alternative Growth Scenario TUBA Benefit Sensitivity Tests

Benefits		Low Growth	Core	High Growth
TUBA	Consumer – Commuting user benefits	30,195	42,651	50,702
	Consumer – other user benefits	69,805	98,407	131,265
	Business benefits	57,519	78,267	99,503
	Indirect Tax Revenue	-5,541	-6,682	-7,806
	Greenhouse Gases	2,797	3,461	4,055
COBA-LT	Accident Benefits	3,006	947	-2,150
Active Mode Appraisal		8,467	10,204	12,138
Initial Present Value of Benefits (PVB)		**166,248**	**227,255**	**287,708**
Additional Benefits	Reliability Benefits	6,231	11,312	18,346
	Wider Impacts#	58,727	58,727	58,727
Final Present Value of Benefits (PVB)		**231,206**	**297,294**	**364,781**
PVC		**111,112**	**111,112**	**111,112**
BCR		**2.1**	**2.7**	**3.3**
VfM		High	High	High
# Low and High Growth Wider Impacts assumed to be same as Core				

Alternative Optimism Bias

5.11.4 Sensitivity tests have also been undertaken with a higher allowance for Optimism Bias of 40%, representing a mid-point between the Stage 1 and Stage 2 values. A weighted average for the Stage 1 Optimism Bias sensitivity test indicates a value of 59%.

5.11.5 The purpose of allowing for Optimism Bias is to ensure that the cost-benefit analysis is robust, reflecting the level of uncertainty associated with the Scheme at this stage of planning.

5.11.6 It is important to note that transport projects are inherently risky due to the long term planning horizon required and the complex relationships associated with each element of the Scheme. As a result the DfT require that base costs estimates are amended to account for optimism bias as well as risks and for these elements to be accounted for within the Economic Appraisal of the Scheme.

5.11.7 The Present Value of Cost relative to the level of Optimism Bias used in the Core Scenario and its sensitivity tests is shown in Table 5.15. The table also shows that regardless of the level of Optimism Bias applied, the BCR remains as ‘High’.

Table 5.15: Alternative Optimism Bias and Adjusted PVC, NPV and BCR

Optimism Bias	21%	40%	59%
Present Value of Cost (£000)	111,112	127,904	144,696
Net Present Value (£000)	186,182	169,390	152,598
BCR	2.7	2.3	2.1

Alternative Annualisation

5.11.8 Analysis of data from the two permanent WebTRIS sites on the A47 around Great Yarmouth for the whole of 2015 demonstrates that there are a high number of hours during summer weekend and Bank Holiday periods where traffic volumes are greater than or similar to the inter-peak traffic volumes derived from the November data - 717 hours can be claimed to account for the characteristics of summer weekends and Bank Holidays compared with the 419 weekend hours that has been currently adopted for the TUBA calculation.

5.11.9 Sensitivity tests were therefore undertaken with the inclusion of the additional hours for weekends and Bank Holidays in order to produce updated TUBA benefits. Table 5.16 provides a summary of the TUBA benefits with the additional hours of weekend and Bank Holidays included.

Table 5.16: Core Scenario vs Core with Additional Weekend and Bank Holiday Hours (£000)

TUBA Benefit	Core	Core with Additional Weekend and Bank Holiday Hours
Consumer – Commuting User Benefits	42,651	44,350
Consumer – Other User Benefits	98,407	106,803
Business Benefits	78,267	84,356
Indirect Tax Revenue	-6,682	-7,308
Greenhouse Gases	3,461	3,778
Total	216,104	231,979

5.11.10 The inclusion of additional hours to account for summer weekends and Bank Holidays produces approximately 7% additional TUBA benefits taking the total to £231 million, increasing the overall scheme benefit to £313 million (inclusive of active mode, accident, reliability and wider benefits).

5.11.11 It is acknowledged that the available traffic data on which this enhanced methodology has been based is limited and taken from just two sites on the strategic road network. It does however indicate that the results presented are a robust and conservative estimate of the user benefits that are likely to arise from the Scheme.

5.11.12 Further detail on alternative annualisation can be found in Appendix G – TUBA Annualisation Factors.

5.12 Appraisal Summary

5.12.1 An Appraisal Summary Table (AST) is a requirement for a WebTAG compliant business case submission. It records all the impacts which have been assessed and described above – economic, environmental, social and public account impacts – assessed using monetised, quantitative or qualitative information as appropriate.

5.12.2 The AST submitted as part of the OBC has been updated for the DCO application and is shown in Table 5.17.

Table 5.17: Appraisal Summary Table

Appraisal Summary Table	Date produced:	22	3	2019	Contact:	
Name of scheme:	River Yare Third River Crossing, Great Yarmouth				**Name**	Ian Parkes
Description of scheme:	New river crossing to connect the west and east areas of Great Yarmouth between A47 and the South Denes Peninsula which includes the Outer Harbour and local port activities. The scheme is proposed to be completed by 2023 and involves the construction of a new roundabout and traffic signal junction, approach roads and a lifting bridge able to accommodate four lanes of traffic.				**Organisation**	Norfolk County Council
					Role	Promoter/Official

	Impacts	Summary of key impacts	Assessment: Quantitative	Assessment: Qualitative	Assessment: Monetary £(NPV)	Assessment: Distributional 7-pt scale/ vulnerable grp
Economy	Business users & transport providers	Scheme primarily impacts on short journey times of less than 5 minutes within study area but also benefits longer distance travel. Access to the peninsula to the south of the town centre is improved and this reduces the amount of congestion at key junctions to the north and critically allows traffic to use an alternative river crossing between the port and the business areas to the east and the A47 to the west.	**Value of journey time changes (£)**: £64.9m **Net journey time changes (£)** 0 to 2min: £18.2m 2 to 5min: £22.4m > 5min: £24.2m	large beneficial	£78.3m	large beneficial
	Reliability impact on Business users	The proposed scheme produces small benefits in terms of reliability for private (business users) as the proportion of car business users is low relative to total car travel.		slight beneficial	£1.5m	
	Regeneration	Regeneris Report considers the GVA impacts of the scheme and assesses the attributable impacts to be of the order of 330 FTE jobs and £24m GVA by 2030.	GVA to £24m by 2030	slight beneficial		
	Wider Impacts	Wider impact calculated using WSP WITA emulation tool. The WITA appraisal shows that the scheme has significant wider impact benefits for Great Yarmouth.		large beneficial	£58.7m	

Environmental	Noise	The scheme is likely to cause some increases in noise level at the dwellings and other noise sensitive receptors in the immediate vicinity of both the new and improved sections of carriageway due to increases in road traffic generated noise. Preliminary traffic data indicates that there are road links in the immediate area of the scheme which will experience significant changes in traffic flow and hence noise level as a result of the introduction of this option.	There are 663 sensitive receptor buildings and no Defra Noise Important Areas within the 300m study area.	slight adverse	not calculated	slight adverse
	Air Quality	There are no designated AQMAs within 200m of the scheme. There is an ecologically designated site considered sensitive to air pollution situated within 200m of the affected road network - Unit 10 of the Breydon Water SSSI/Ramsar/SPA. Concentrations of NOx and Nitrogen deposition rates are not predicted to change with the Scheme in operation in the Opening Year 2023. An overall neutral local air quality impact is given based upon air quality dispersal modelling results which predict increases and decreases in NO_2, PM_{10} and $PM_{2.5}$ at different locations across the study area with receptors in the vicinity of the existing bridges improving and receptors close to the Scheme worsening in the Scheme Opening Year, with the scheme predicted to be below the relevant air quality objectives set for the protection of human health across the Local Air Quality Assessment study area . A beneficial impact on regional emissions is predicted given the likelihood of the new bridge to reduce the distance travelled to cross the River Yare.	There are 10786 potentially sensitive receptors within 200m of the affected road network of which 10509 are predicted to experience a negligible impact upon NO_2 concentrations, 84 a slight improvement, 100 a slight worsening, 66 a moderate improvement and 27 a moderate worsening. The predicted Do Something, with scheme concentrations of NO_2, PM_{10} and $PM_{2.5}$ are well below the national air quality standards objective values. The maximum roadside PCM concentration within the study area in the scheme opening year 2023 is, 25.5µg/m^3. The maximum DS concentration of NO2 at a worst-case receptor adjacent to a PCM link is 25 µg/m3, well below the threshold of 40 µg/m^3 for the Annual Mean level which is unlikely to be exceeded by the proposed scheme.	neutral	not calculated	moderate adverse

	Greenhouse gases	The total regional traffic GHG emissions for the operational lifespan of the Scheme (2023-2082), as modelled as part of the air quality assessment, are 54,024 tCO2e lower (approximately -1.4%) than the baseline scenario. The decrease in GHG emissions is due to the predicted change in traffic speed and improvements in traffic flow. The reduction in operational GHG emissions, in comparison to the 'do nothing' scenario, is anticipated to have a slight beneficial impact. The operational phase of the Scheme is expected to have a neutral effect on climate change. IEMA guidance suggests that all GHG emissions are significant in the absence of any significance criteria or defined threshold. However, given the magnitude of GHG emissions (slight reduction) and the context of the Scheme, using professional judgement including previous experience of road infrastructure schemes, it is considered that the neutral effect of this Scheme will not be significant Note: information provided is for end-user GHG emissions (regional traffic flows), and does not include construction phase GHG emissions.	Baseline ('do nothing') total GHG emissions for traffic in the strategic and local road network (tCO_2e)	3900476	slight beneficial to neutral	£3.5m	not assessed
			Baseline ('do nothing') total GHG emissions for traffic in the strategic and local road network (tCO2e)	3846452			
	Landscape	Scoped out by environment team			neutral	not calculated	
	Townscape	The loss of some existing residential townscape although not of particularly strong or defined townscape value. Existing vistas along the river corridor may be interrupted or fore-shortened by the structure, although the bridge would not appear out of context in respect of existing townscape.	The density and mix of development will not substantially differ. The bascule bridge would be in scale with the river environment.		neutral	not calculated	

	Historic Environment	The setting of at least two Grade II Listed Buildings and two conservation areas may be indirectly impacted upon by this Option. Four non-designated heritage assets, including a railway line, a bomb crater and WWII defensive features may be directly impacted. there is potential to impact upon currently unknown below ground heritage assets.	Two Grade II Listed Buildings and two conservation areas may be indirectly impacted upon by this Option. Four non-designated heritage assets, including a railway line, a bomb crater and WWII defensive features may be directly impacted.	moderate adverse	not calculated	
	Biodiversity	No adverse effects to any international or national designated nature conservation sites. Potential to impact bat roosts, breeding birds, water voles, black redstarts and hedgehogs due to the loss of suitable habitat for these species associated with land take.	The Outer Thames Estuary Special Protection Area is within 2km of the proposed bridge crossing point. This site is designated because it supports 38% of the Great British population of red throated diver. There are no non-statutory designated sites within 2km.	slight adverse	not calculated	
	Water Environment	Water environment impacts include: Impact on tidal flood risk within Great Yarmouth - mixed impacts, some adverse and some beneficial. Generally, to the south of the proposed bridge, there is an increase in predicted flood level for a given event with the Scheme in place due to the constriction caused by the bridge. generally, to the north of the proposed bridge there is a reduction in predicted flood level for a given event. Localised changes to the flow regime and sediment transport at the Yare crossing which may cause a slight decrease in water quality due to mobilisation of contaminated sediments Increased discharge of road runoff into local waterbodies (surface and groundwater), which may cause a slight decrease in water quality. Local surface watercourse diversions and increased culverting which lead to a slight decrease in morphological quality. Potential loss of small surface water ponds close to the Scheme. Localised changes to groundwater levels and flow regime during dewatering operations and due to piles.	A maximum increase in water levels in the channel and on the floodplain of 0.1m with the Scheme in place compared to the Baseline scenario - this is for both the 0.5% Annual Exceedance Probability (AEP) event and the 0.5% AEP plus climate change event. Flood hazard is not increased to any receptors as a result of the Scheme. The potential impacts to the water environment are not sufficient affected the WFD status or objectives for the affected waterbodies.	moderate adverse	not calculated	

Social	Commuting and Other users	Scheme primarily impacts on short journey times of less than 5 minutes within study area but also benefits longer distance travel. Access to the peninsula to the south of the town centre is improved and this reduces the amount of congestion at key junctions to the north and critically allows traffic to use an alternative river crossing between the port and the business areas to the east and the A47 to the west.	**Value of journey time changes (£)**: £130.9m **Net journey time changes (£)** 0 to 2min: £42.5m 2 to 5min: £49.4m > 5min: £39.0m	large beneficial	£141.1m	large beneficial
	Reliability impact on Commuting and Other users	The proposed bridge would produce modest benefits in terms of reliability benefits as reduction in delays and congestion on several key junctions and Gapton roundabout while providing faster and shorter travel time and distance to the Peninsula.	Moderate flows reported in traffic modelling	beneficial	£9.8m	
	Physical activity	The proposed scheme assists walking/ cycling/ physical activity.	Pedestrians and cyclists counted as part of the assessment.	slight beneficial	£3.2m	
	Journey quality	The scheme promotes walking/ cycling, and improves journey quality for all users.	Reduction in traveller stress from fewer queues and shorter journeys.	slight beneficial	£7.0m	
	Accidents	The proposed scheme produces benefits in terms of accident savings. The total number of accidents saved over the appraisal period is 1 serious and 53 slight accidents.	54 accidents saved over 60 years - from COBALT	slight beneficial	£0.9m	slight adverse
	Security	No change is predicted.	No assessment required	neutral	not calculated	not assessed
	Access to services	Bus, pedestrian and cycle journeys improved in addition to major benefits for commercial traffic. Produces town centre relief and therefore improves travel throughout the town.	Existing bus services will benefit from improved journey times	large beneficial	not calculated	not assessed
	Affordability	Reduced travel times produces fuel savings and operating costs for all income groups.	The scheme leads to commute benefits in excess £40m	slight beneficial	not calculated	large beneficial
	Severance	Severance is reduced by the provision of a new crossing in a location that involves transfer distances of up to around 3km to be saved for the same journey.	Scheme produces network wide lower levels of veh kms travelled and significantly reduces some journey distances to/from the peninsula	moderate beneficial	not calculated	slight beneficial
	Option and non-use values	Not assessed	Not assessed	neutral	not calculated	

Public Accounts	Cost to Broad Transport Budget	The scheme has been costed at 2016 risk adjusted prices. Sunk costs have been removed and all costs converted to a 2010 price-base year and discounted to 2010, giving a present value of cost of just under £112m when 21% Optimism Bias is added.	Delivery period over 5 years to 2023 opening	Cost Note	£111.1m	
	Indirect Tax Revenues	Assessed in TUBA over 60 years. Indirect tax income reduces as the efficiency of the road network improves.	60 year assessment period	TUBA benefits	-£6.7m	

5.12.3 The environmental impacts have not currently been assessed to full WebTAG requirements, but the relevant sections of the AST have been updated to reflect the current work status.

5.12.4 The Environmental Appraisal of the Scheme will be updated for the FBC, and will include quantified, qualitative and monetised assessments where required by WebTAG. As such an updated AST will form part of the Economic Case of the FBC.

6 Summary

6.1.1 The purpose of this report has been to update the EAR that was submitted as part of the OBC. The report details how the benefits and costs of the Great Yarmouth Third River Crossing scheme have been derived for the economic appraisal and to present the results.

6.2 Economic Appraisal Process

6.2.1 The economic appraisal has been undertaken in accordance with the relevant guidance documents (WebTAG). Industry-standard computer programmes TUBA and COBA-LT have been used to undertake the user benefit and accident appraisals respectively. All other monetised benefits have been calculated in line with the latest WebTAG guidance at the time.

6.2.2 The study area used for the economic analysis has been based on the study area used for the strategic traffic model. All traffic data used in the economic appraisal is consistent with those presented in the Traffic Forecasting Report.

6.2.3 The economic appraisal has been undertaken over the standard 60 year appraisal period. All costs and benefits have been deflated and discounted to the Present Value Year of 2010.

6.2.4 The different types of benefits which are being assessed as part of the economic analysis, and the methodology used to calculate and monetise them, are as follows:

- Travel time savings which involves multiplying savings by monetary values and user benefits using TUBA;
- Vehicle Operating Costs (VOCs), which is a mixture of increases and decreases, due to changes in fuel consumption and changes in distances travelled was also assessed using TUBA;
- Carbon emissions (both in tonnes and in monetary terms) for the life of the Scheme was estimated using TUBA;
- Accident saving benefits assessed using COBA-LT;
- Reliability Benefits calculated manually following WebTAG;
- Wider Impacts Benefits calculated manually following WebTAG; and
- Active Model Appraisal Benefits calculated manually following WebTAG.

6.3 Results

6.3.1 The Scheme produces significant time savings, improves safety and reduces carbon emissions.

6.3.2 The total scheme Present Value of Benefits (PVB) is £297.3 million (2010 prices) for the core scenario. The total Present Value of Costs (PVC) of the Scheme is £111.1 million (2010 prices).

6.3.3 The Wider Impacts Benefits produced by the Scheme is £58.7 million (2010 prices).

6.3.4 The BCR for the core scenario is 2.0 with an adjusted BCR of 2.7 (including reliability and wider benefits), therefore the Scheme offers high value for money under all scenarios.

6.3.5 In accordance DfT's Value for Money Framework, schemes with a BCR over 2.0 represent a high value for money.

Appendix A – Local Model Validation Report Addendum

Norfolk County Council

GREAT YARMOUTH TRANSPORT MODEL

Local Model Validation Report Addendum

PUBLIC

70046035-TPL
MARCH 2019

PUBLIC

Norfolk County **Council**

GREAT YARMOUTH TRANSPORT MODEL

Local Model Validation Report Addendum

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70046035

OUR REF. NO. 70046035-TPL

DATE: MARCH 2019

Norfolk County **Council**

GREAT YARMOUTH TRANSPORT MODEL

Local Model Validation Report Addendum

WSP

8 First Street
Manchester
M15 4RP

WSP.com

CONTENTS

TABLES

PLATES

1. INTRODUCTION

1.1. BACKGROUND

1.1.1. Mouchel (now part of WSP) was appointed by Norfolk County Council (NCC) to produce traffic forecasts and economic appraisal outputs as part of a Value for Money (VfM) appraisal for the proposed Great Yarmouth Third River Crossing (GYTRC). The VfM case formed part of an Outline Business Case (OBC) which was submitted to the Department of Transport (DfT) in March 2017 and was subsequently approved.

1.1.2. To inform the OBC a SATURN highway and CUBE demand model of Great Yarmouth was developed in 2017 with a base year of 2016. At the request of NCC this model has been updated to 2018 base year to inform the Transport Assessment (TA) which in turn feeds into the Environmental Statement (ES) and Development Consent Order (DCO) submission.

1.2. PURPOSE OF THIS ADDENDUM

1.2.1. This document acts as Addendum to the original Local Model Validation Report (Ref - 1076653-MOU-GEN-XX-TN-TP-0003) and outlines the revisions applied to the 2016 model to update it to a 2018 base year. Given the short period of two years between the original 2016 base year model and the 2018 updated model, the revisions to the 2016 base model are relatively minor and mainly focused on network changes.

1.2.2. This Addendum demonstrates that the updated Great Yarmouth Traffic Model (GYTM) provides an accurate representation of highway travel patterns in the Great Yarmouth area and continues to comply with DfT Transport Appraisal Guidance (TAG) for supporting the DCO for the Scheme.

2. UPDATE TO 2018

2.1. INTRODUCTION

2.1.1. The objective of this model validation exercise is to demonstrate that the updated 2018 model is fit for appraising the proposed Scheme for the DCO and subsequent Full Business Case (FBC) submission. A comprehensive set of ATCs (Automatic Traffic Counts) were collected at various locations around Great Yarmouth during March 2018 to inform the model validation. The model network was updated to include any network changes (see Chapter 3).

2.1.2. Following the analysis of long term count data, it was not considered necessary to uplift the 2016 matrices as part of the update given the minimal changes in Great Yarmouth during the intervening two-year period, as explained in the following chapter.

2.2. DATA COLLECTION

2.2.1. In 2016 traffic data was compiled within the Great Yarmouth area for the model calibration and validation, including traffic counts (both ATC and MCC), RSI surveys and journey time surveys. To facilitate the 2018 model update a new set of ATC and MCC surveys were commissioned at locations around Great Yarmouth town centre. The ATC data was used to inform the 2018 SATURN model update while the MCC surveys were used to calculate the vehicle splits.

2.2.2. A comprehensive description of the data collection is included in the Great Yarmouth Traffic Survey Report (35915 - WSP - GY Traffic Survey - Report).

Automatic Traffic Counts

2.2.3. A total of 20 ATCs were commissioned at key locations around Great Yarmouth town centre and the peninsula. The data was recorded for a full two-week period between Monday 5th March and Sunday 18th March, 2018, and this data was compared to 2016 to check whether the flows had changed significantly from 2016 levels.

2.2.4. The site locations of the ATCs are listed in Table 1 shown in Figure 1.

Table 1 - ATC Locations in Great Yarmouth

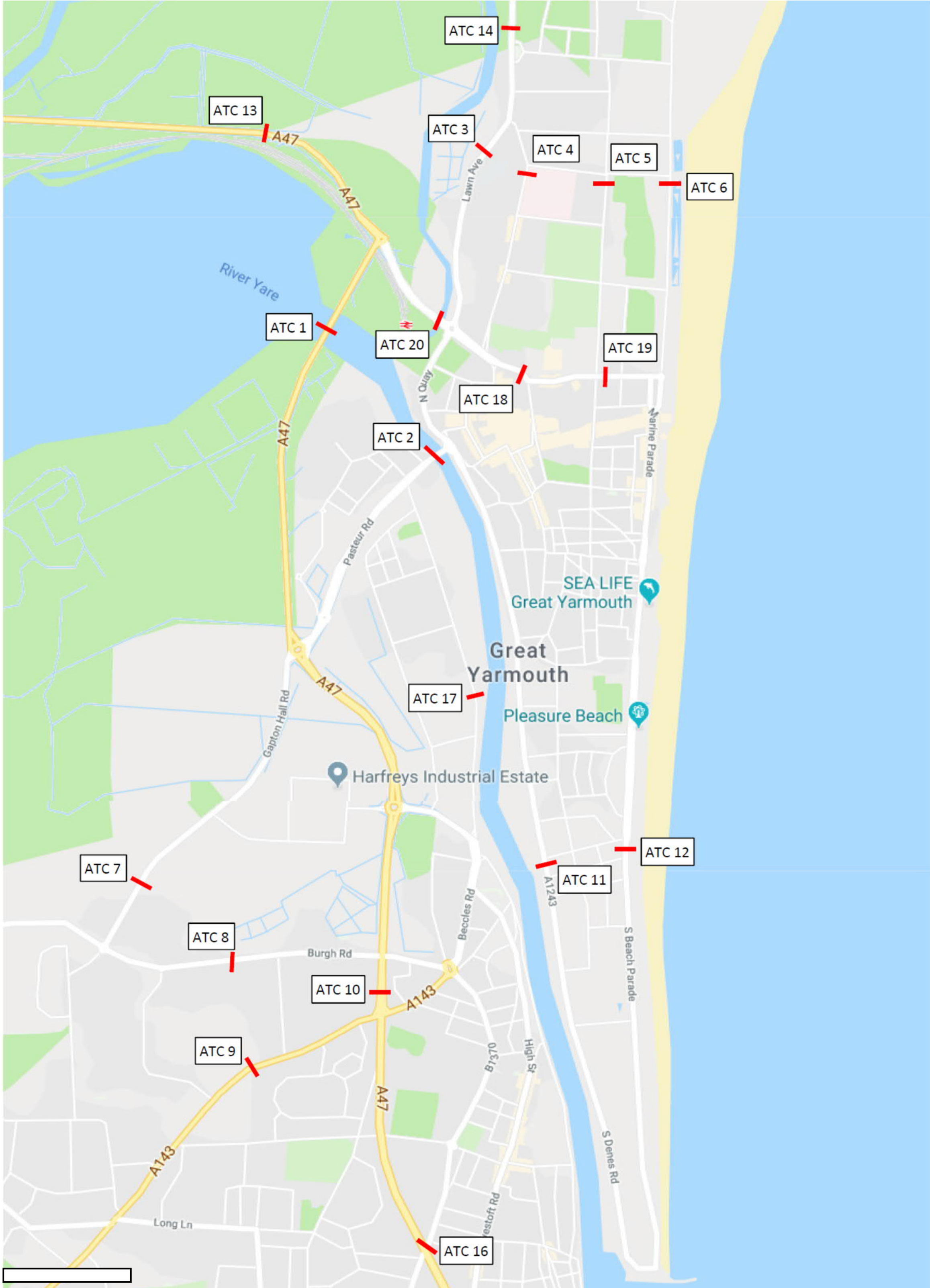
REF NO.	LOCATION
1	A47 - Breydon Bridge
2	Haven Bridge
3	Lawn Avenue
4	Northgate Street
5	N Denes Road
6	North Drive
7	Gapton Hall Rd
8	Burgh Rd

9	Beccles Rd
10	A47/Beccles Rd
11	S Denes Rd
12	S Beach Parade
13	A47 New Rd
14	Caister Rd
15	A149 Caister By-Pass
16	B1370 Middleton Rd
17	Southtown Rd
18	B1141 Priory Plain
19	Euston Rd
20	Acle New Rd

2.2.5. This section provides an overview of the processing and analysis of the 2018 traffic data. More detail on this processing can be found in the Traffic Data Report. The key processing elements carried out were:

- All ATC traffic count data has been standardised into Cars, LGVs and HGVs derived from the MCC data, and each link count has been assigned to an A node and B node in the network.
- ATC data has been processed in order to derive the average weekday flow for that site by removing outliers and taking the mean.
- Counts have been normalised to account for monthly and yearly variation using factors from long term Highways England counts.

Plate 1 - ATC Location Map



2.3. COUNT DATA ANALYSIS

Long term count data

2.3.1. Long term count data was used to check whether any growth in traffic has occurred in Great Yarmouth between 2016 and 2018. This data was obtained from the Highways England TRADS/TRIS database for a number of permanent count sites located along the A47 through Great Yarmouth shown in Figure 2. The graph in Figure 3 shows the AADT (annual average daily traffic) profile for each count over the period between 2010 and 2017, and AADT totals and growth are summarised in Table 2. The profiles show that over the period of observed data the traffic flow levels on the A47 have remained almost static with a slight increase from 2013 onwards. The change in AADT flow between 2016 and 2017 is negligible with an increase of just 0.05% based on the TRADS count flow totals. At the time of analysis, no data was available for 2018.

Plate 2 - TRADS/TRIS Sites

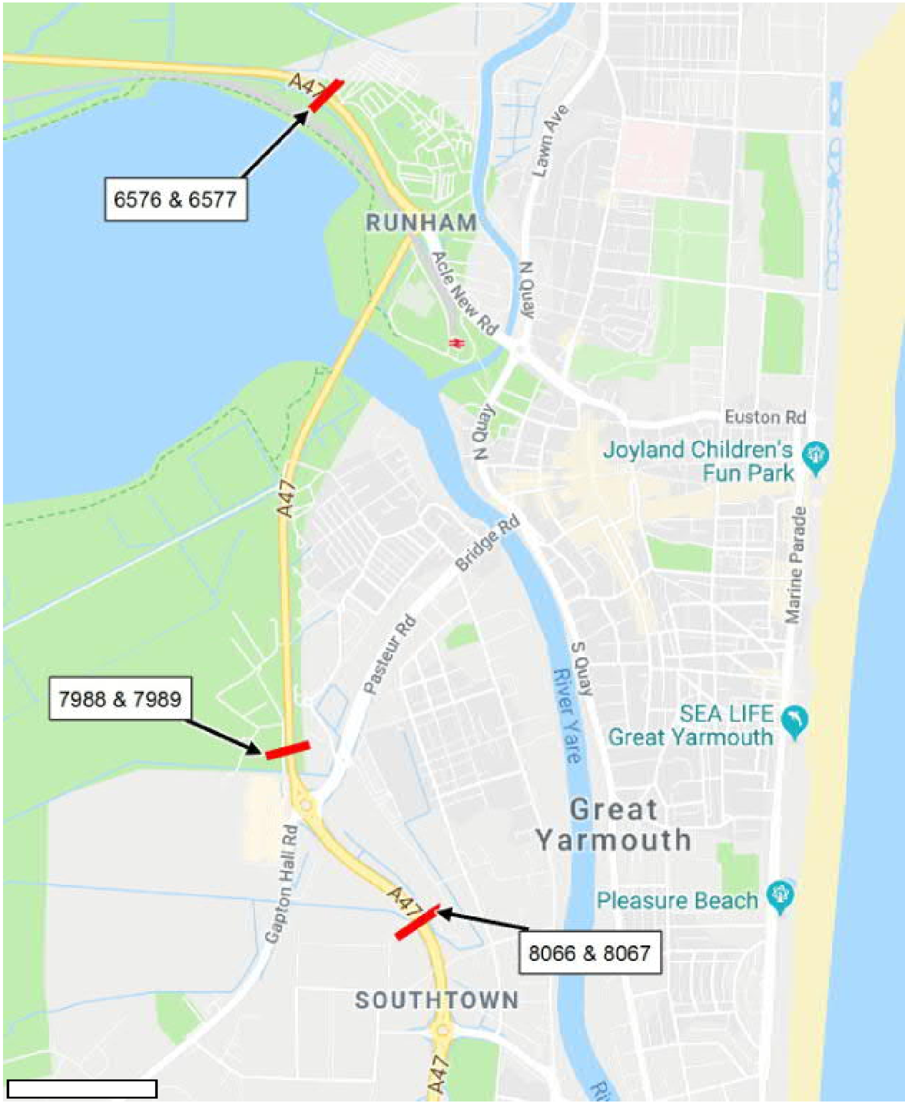


Plate 3 - AADT Flow at A47 Permanent Count Sites (2010 – 2017)

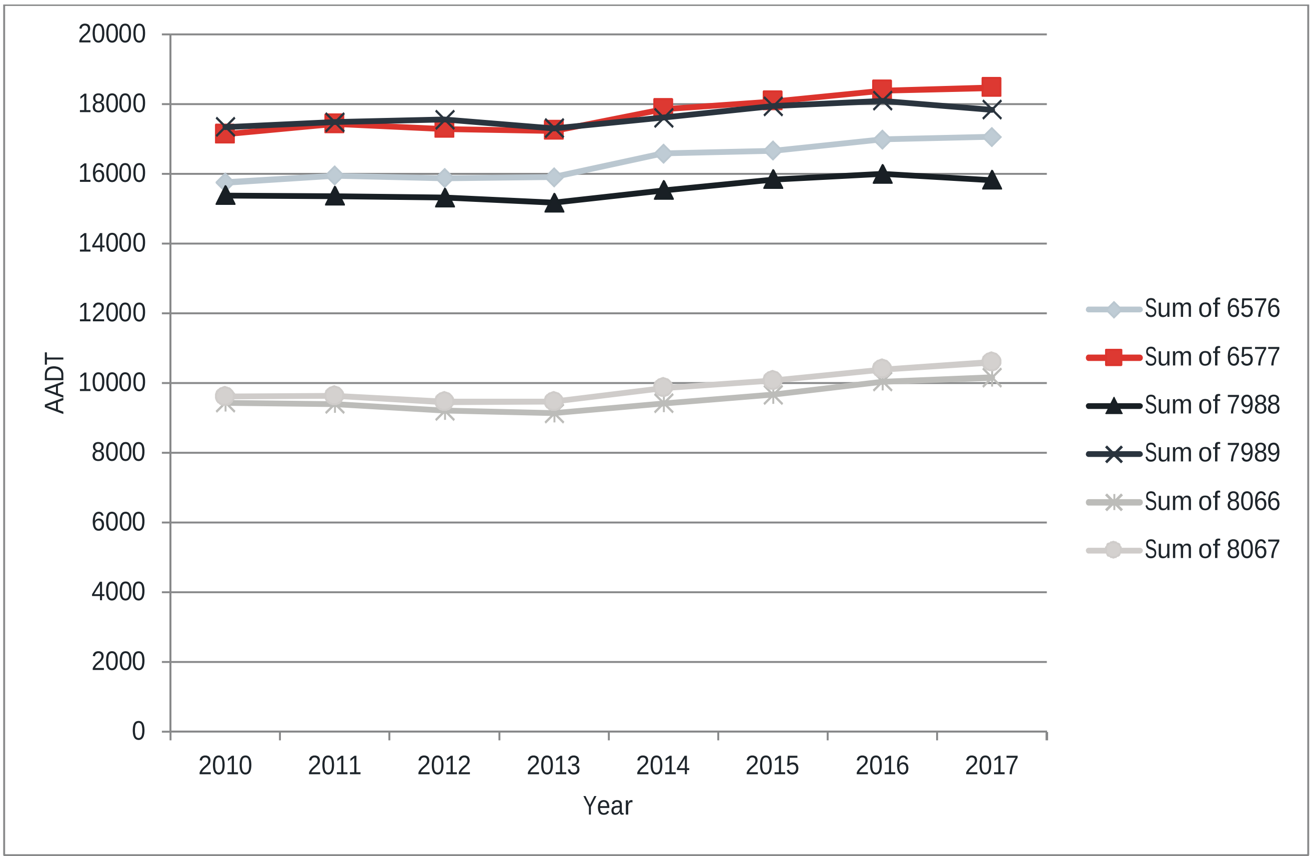


Table 2 - AADT Totals and Growth at A47 Permanent Count Sites (2010 – 2017)

Year	Total Traffic	Growth from 2010	Growth year on year
2010	84677	0%	-
2011	85269	1%	0.70%
2012	84721	0%	-0.64%
2013	84239	-1%	-0.57%
2014	86883	3%	3.14%
2015	88275	4%	1.60%
2016	89932	6%	1.88%
2017	89974	6%	0.05%

ATC data

2.3.2. The local ATC surveys also support the case that traffic growth has been minimal between 2016 and 2018. The similarity of the 2016 and 2018 counts at common sites (with percentage difference and the GEH statistic) is shown in Tables 3 to 5, along with the total traffic flow at the common ATC survey sites for the AM peak, IP and PM peak. Comparison of the two years shows a slight decline of about 5% in total traffic flow in Great Yarmouth for each of the three time periods. This is likely to be due to seasonal variation as the 2016 surveys were conducted in November while the more recent 2018 surveys were conducted in March.

2.3.3. The GEH comparison between the 2016 and 2018 observed counts indicates that at the majority of sites traffic flow has not changed significantly with most counts achieving a GEH less than 4. The exception being the N Denes Road (NB) count where the 2018 observed flow has increased significantly compared to the 2016 observed flow (from 265 to 515) in the PM Peak. It appears that some rerouting has occurred here, with traffic switching to N Denes Road (NB) from Northgate Street (NB).

Table 3 - ATC Flow Comparison (2016 v 2018) AM

Site	Dir	2016 Observed flow	2018 Observed flow	Difference	% Difference	GEH
A47 Breydon Bridge	*NEB*	1278	1211	-67	-5%	1.90
A47 Breydon Bridge	*SWB*	1444	1257	-187	-13%	5.09
Bridge Road - Haven Bridge	*SWB*	677	768	91	13%	3.37
Bridge Road - Haven Bridge	*NEB*	1101	1039	-62	-6%	1.89
Lawn Avenue	*NEB*	506	567	61	12%	2.64
Lawn Avenue	*SWB*	589	766	177	30%	6.79
Northgate Street	*NB*	211	210	-1	0%	0.04
Northgate Street	*SB*	690	543	-147	-21%	5.92
N Denes Road	*NB*	177	203	26	15%	1.87
N Denes Road	*SB*	345	282	-63	-18%	3.54
North Drive	*NB*	172	171	-1	-1%	0.07
North Drive	*SB*	540	454	-86	-16%	3.84
Gapton Hall Road	*NEB*	No count	912	-	-	-
Gapton Hall Road	*SWB*	No count	264	-	-	-
Burgh Road	*EB*	226	284	58	26%	3.64
Burgh Road	*WB*	277	198	-79	-28%	5.12
Beccles Road	*NEB*	603	590	-13	-2%	0.53
Beccles Road	*SWB*	335	369	34	10%	1.79
A47/ Beccles Road	*NB*	1992	1814	-178	-9%	4.07
A47/ Beccles Road	*SB*	1219	1165	-54	-4%	1.57
S Denes Road	*NB*	41	107	66	161%	7.69
S Denes Road	*SB*	107	181	74	69%	6.19
S Beach Parade	*NB*	41	21	-20	-49%	3.63
S Beach Parade	*SB*	133	91	-42	-31%	3.93
A47 New Road	*NWB*	681	708	27	4%	1.02
A47 New Road	*SEB*	879	730	-149	-17%	5.27
Caister Road	*NB*	No count	562	-	-	-
Caister Road	*SB*	No count	1057	-	-	-
A149 Caister By-Pass	*NWB*	No count	445	-	-	-
A149 Caister By-Pass	*SEB*	No count	985	-	-	-
B1370 Middleton Road	*NEB*	No count	392	-	-	-
B1370 Middleton Road	*SWB*	No count	422	-	-	-
Southtown Road	*NB*	549	460	-89	-16%	3.96
Southtown Road	*SB*	371	307	-64	-17%	3.50

Site	Dir	2016 Observed flow	2018 Observed flow	Difference	% Difference	GEH
B1141 Priory Plain	*NWB*	243	191	-52	-21%	3.54
B1141 Priory Plain	*SEB*	690	601	-89	-13%	3.49
Euston Road	*WB*	163	132	-31	-19%	2.56
Euston Road	*EB*	108	85	-23	-22%	2.37
Acle New Road	*NWB*	1106	1035	-71	-6%	2.17
Acle New Road	*SEB*	1026	939	-87	-8%	2.78
		18520	**17480**	**-1041**	**-6%**	

Table 4 - ATC Flow Comparison (2016 v 2018) IP

Site	Dir	2016 Observed flow	2018 Observed flow	Difference	% Difference	GEH
A47 Breydon Bridge	*NEB*	1027	1000	-27	-3%	0.84
A47 Breydon Bridge	*SWB*	1307	1040	-267	-20%	7.78
Bridge Road - Haven Bridge	*SWB*	672	747	75	11%	2.81
Bridge Road - Haven Bridge	*NEB*	942	907	-35	-4%	1.15
Lawn Avenue	*NEB*	747	681	-66	-9%	2.49
Lawn Avenue	*SWB*	642	587	-55	-9%	2.21
Northgate Street	*NB*	259	229	-30	-12%	1.93
Northgate Street	*SB*	325	309	-16	-5%	0.91
N Denes Road	*NB*	176	185	9	5%	0.70
N Denes Road	*SB*	163	132	-31	-19%	2.52
North Drive	*NB*	250	222	-28	-11%	1.81
North Drive	*SB*	268	213	-55	-20%	3.54
Gapton Hall Road	*NEB*	No count	421	-	-	-
Gapton Hall Road	*SWB*	No count	499	-	-	-
Burgh Road	*EB*	178	181	3	2%	0.22
Burgh Road	*WB*	186	154	-32	-17%	2.42
Beccles Road	*NEB*	353	349	-4	-1%	0.22
Beccles Road	*SWB*	356	361	5	1%	0.27
A47/ Beccles Road	*NB*	1173	1172	-1	0%	0.04
A47/ Beccles Road	*SB*	1119	1120	1	0%	0.02
S Denes Road	*NB*	99	169	70	71%	6.08
S Denes Road	*SB*	101	149	48	47%	4.25
S Beach Parade	*NB*	113	61	-52	-46%	5.58
S Beach Parade	*SB*	107	59	-48	-44%	5.22
A47 New Road	*NWB*	647	615	-32	-5%	1.26
A47 New Road	*SEB*	663	597	-66	-10%	2.65
Caister Road	*NB*	No count	724	-	-	-
Caister Road	*SB*	No count	724	-	-	-
A149 Caister By-Pass	*NWB*	No count	552	-	-	-
A149 Caister By-Pass	*SEB*	No count	617	-	-	-
B1370 Middleton Road	*NEB*	No count	318	-	-	-
B1370 Middleton Road	*SWB*	No count	322	-	-	-
Southtown Road	*NB*	399	367	-32	-8%	1.65
Southtown Road	*SB*	343	324	-19	-6%	1.03
B1141 Priory Plain	*NWB*	264	249	-15	-6%	0.97

Site	Dir	2016 Observed flow	2018 Observed flow	Difference	% Difference	GEH
B1141 Priory Plain	*SEB*	583	563	-20	-4%	0.86
Euston Road	*WB*	186	158	-28	-15%	2.16
Euston Road	*EB*	193	146	-47	-24%	3.63
Acle New Road	*NWB*	981	1026	45	5%	1.43
Acle New Road	*SEB*	824	906	82	10%	2.78
		15646	**14977**	**-669**	**-4%**	

Table 5 - ATC Flow Comparison (2016 v 2018) PM

Site	Dir	2016 Observed flow	2018 Observed flow	Difference	% Difference	GEH
A47 Breydon Bridge	*NEB*	1299	1310	11	1%	0.30
A47 Breydon Bridge	*SWB*	1427	1335	-92	-6%	2.47
Bridge Road - Haven Bridge	*SWB*	786	992	206	26%	6.90
Bridge Road - Haven Bridge	*NEB*	1000	976	-24	-2%	0.77
Lawn Avenue	*NEB*	956	910	-46	-5%	1.51
Lawn Avenue	*SWB*	513	534	21	4%	0.93
Northgate Street	*NB*	486	358	-128	-26%	6.25
Northgate Street	*SB*	283	282	-1	-1%	0.09
N Denes Road	*NB*	265	515	250	94%	12.66
N Denes Road	*SB*	161	153	-8	-5%	0.63
North Drive	*NB*	413	376	-37	-9%	1.89
North Drive	*SB*	219	199	-20	-9%	1.40
Gapton Hall Road	*NEB*	No count	288	-	-	-
Gapton Hall Road	*SWB*	No count	1042	-	-	-
Burgh Road	*EB*	275	270	-5	-2%	0.30
Burgh Road	*WB*	338	252	-86	-25%	4.99
Beccles Road	*NEB*	398	412	14	4%	0.72
Beccles Road	*SWB*	540	573	33	6%	1.39
A47/ Beccles Road	*NB*	1295	1346	51	4%	1.41
A47/ Beccles Road	*SB*	1905	1669	-236	-12%	5.59
S Denes Road	*NB*	146	263	117	80%	8.15
S Denes Road	*SB*	37	67	30	82%	**4.18**
S Beach Parade	*NB*	187	131	-56	-30%	4.47
S Beach Parade	*SB*	67	31	-36	-53%	5.09
A47 New Road	*NWB*	890	956	66	7%	2.18
A47 New Road	*SEB*	826	664	-162	-20%	5.92
Caister Road	*NB*	No count	1020	-	-	-
Caister Road	*SB*	No count	646	-	-	-
A149 Caister By-Pass	*NWB*	No count	796	-	-	-
A149 Caister By-Pass	*SEB*	No count	546	-	-	-
B1370 Middleton Road	*NEB*	No count	439	-	-	-
B1370 Middleton Road	*SWB*	No count	397	-	-	-
Southtown Road	*NB*	431	375	-56	-13%	2.79
Southtown Road	*SB*	502	426	-76	-15%	3.53
B1141 Priory Plain	*NWB*	320	256	-64	-20%	3.75
B1141 Priory Plain	*SEB*	636	465	-171	-27%	7.27

Site	Dir	2016 Observed flow	2018 Observed flow	Difference	% Difference	GEH
Euston Road	*WB*	174	147	-27	-16%	2.13
Euston Road	*EB*	186	137	-49	-26%	3.87
Acle New Road	*NWB*	1241	1007	-234	-19%	6.97
Acle New Road	*SEB*	1065	960	-105	-10%	3.29
		19267	**18347**	**-920**	**-5%**	

2.4. NETWORK CHANGES

2.4.1. The model network has been updated to include any changes to the Great Yarmouth highway network between 2016 and 2018. These include the improvement schemes at the Fullers Hill roundabout, and on North Quay and The Conge (as detailed in Section 3.5).

2.5. LAND USE CHANGES

2.5.1. There were no changes in land use between 2016 and 2018 in Great Yarmouth that would impact upon the OD movements within model matrices.

2.6. GENERALISED COSTS CHANGES

2.6.1. The TAG values of time and distance that feed into the generalised cost equation have been updated to December 2017 (as detailed in Section 3.11).

2.7. MODEL UPDATE

2.7.1. The model update has been restricted to network changes only with no adjustments to the 2016 matrix on the basis that:

- Long term (TRADS/TRIS) counts on the A47 suggest relatively static growth between 2010 and 2017 and no growth between 2016 and 2017 at all the A47 sites;
- Local counts comparing 2016 and 2018 show a slight decrease in total traffic flow though the change is relatively small;
- Changes to the network are minimal will have no impact on OD movements within the model; and
- There have been no major changes in land use.

2.7.2. Given the above it was not considered necessary to uplift or run matrix estimation on the 2016 matrices.

3. TRANSPORT MODEL DESCRIPTION AND SPECIFICATION

3.1. INTRODUCTION

3.1.1. During the period between the 2016 model build and the 2018 update there have been some changes to the network, the most significant being the recently completed scheme at Fullers roundabout. In addition, there have been some local improvements on North Quay and The Conge. These schemes have been incorporated into the 2018 model update.

3.1.2. The 2016 Great Yarmouth Traffic Model (GYTM) was developed using SATURN v11.3.12U and for consistency the 2018 model uses the same version.

3.2. PROPOSED SCHEME DETAILS

3.2.1. The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. It consists of a new dual carriageway road across the river, linking the A47 at Harfrey's Roundabout on the western side to the A1243 South Denes Road on the eastern side. It features an opening span Double Leaf Bascule Bridge across the river, which will involve the construction of two "knuckles" that extend the quay wall into the river. The new dual carriageway will also have a clear span over Southtown Road on the western side of the river, as it rises to the centre of the new crossing.

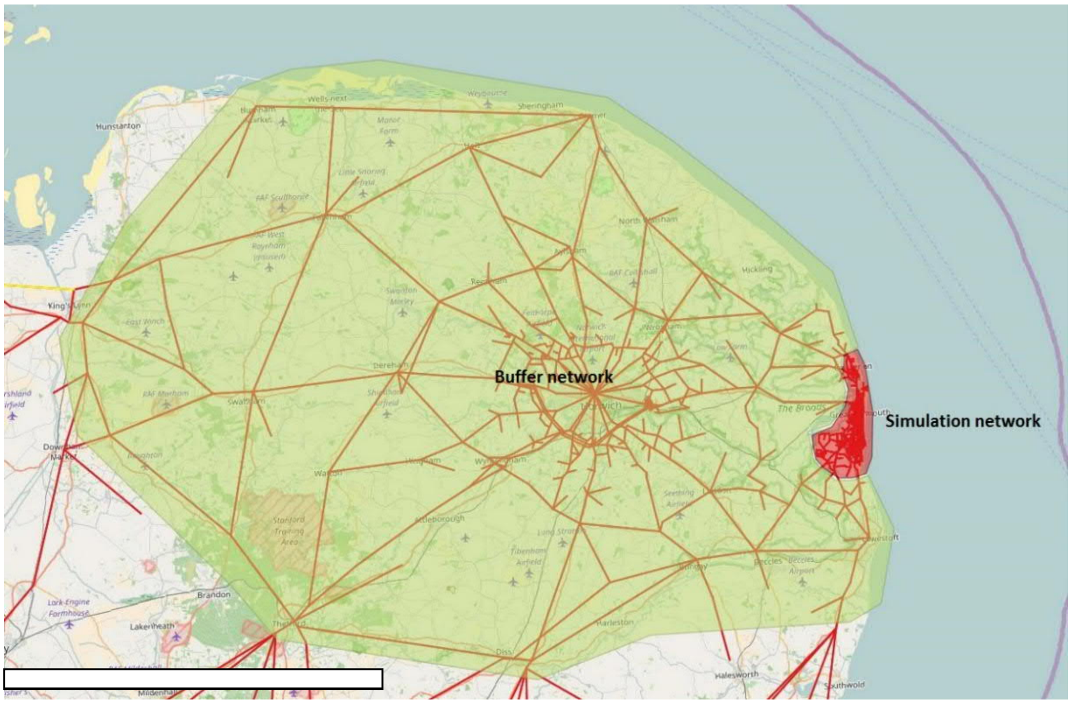
3.2.2. The Scheme will create a new, direct link between the western and eastern parts of the town. It will substantially improve connectivity between the A47 (part of the SRN) and significant destinations on the South Denes peninsula, including the South Denes Business Park, Great Yarmouth Energy Park, the Port and Outer Harbour, including part of the Great Yarmouth and Lowestoft (New Anglia) Enterprise Zone.

3.3. STUDY AREA

3.3.1. The 2018 GYTM simulation area covers the whole of the Great Yarmouth conurbation. The model covers all the urban areas in simulation detail between Caister-on-Sea to the north, Gorleston-on-Sea to the south and the village of Belton to the west, as shown in Figure 4.

3.3.2. This boundary of the simulation area of the model is considered wide enough to capture the biggest impacts expected due to the Scheme and also includes an area where impacts are quite likely but relatively weak in magnitude.

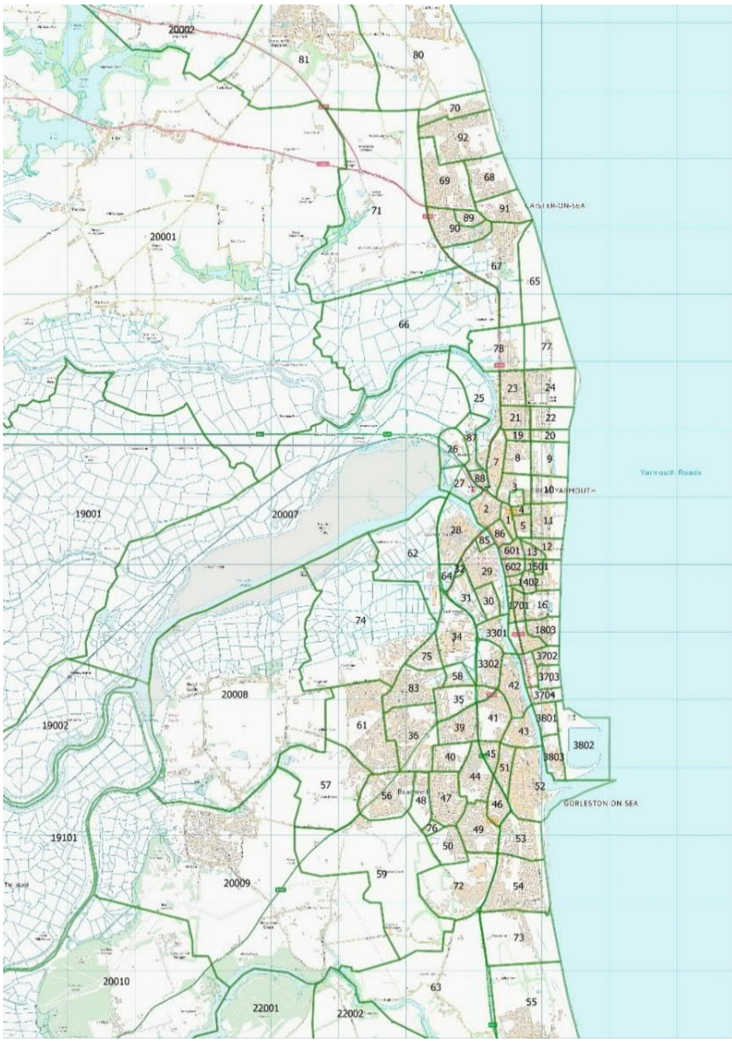
Plate 4 - Great Yarmouth Traffic Model Simulation and Study Area



3.4. ZONING SYSTEM

3.4.1. The zoning system of the 2018 GYTM is consistent with the 2016 model and contains 240 zones as shown in Figure 5.

Plate 5 - Great Yarmouth Traffic Model Zone Plan



3.5. MODELLED HIGHWAY NETWORK

3.5.1. The 2018 GYTM network has been updated to include the following recently completed schemes (shown in Figure 6):

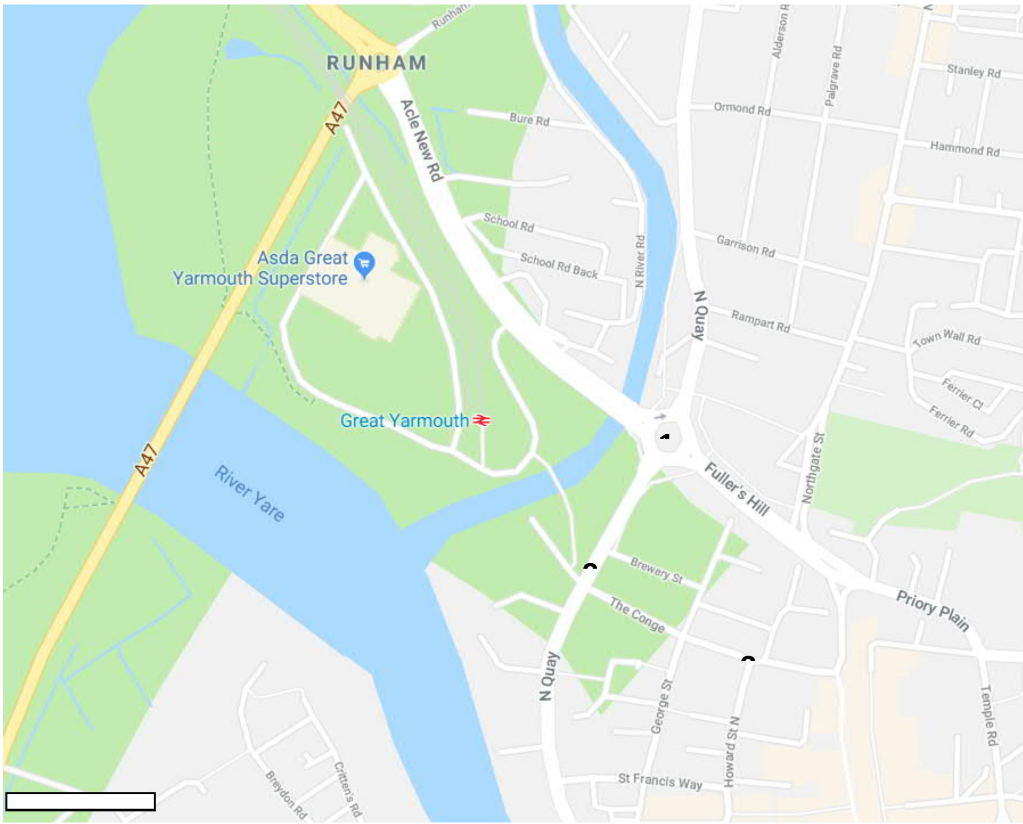
- (1) Fullers Hill 4-arm roundabout improvements – widening North Quay (northern arm) from 2 lanes to 3 lanes and widening of the circulation lanes to increase capacity.

- (2) Improvements to North Quay and The Conge – narrowing of North Quay (northbound) at its junction with The Conge from 2 lanes to 1 lane, and improved pedestrian facilities.

- (3) The Conge / Howard Street N junction – Change of priority at The Conge / Howard Street N junction making Howard Street N the minor arm.

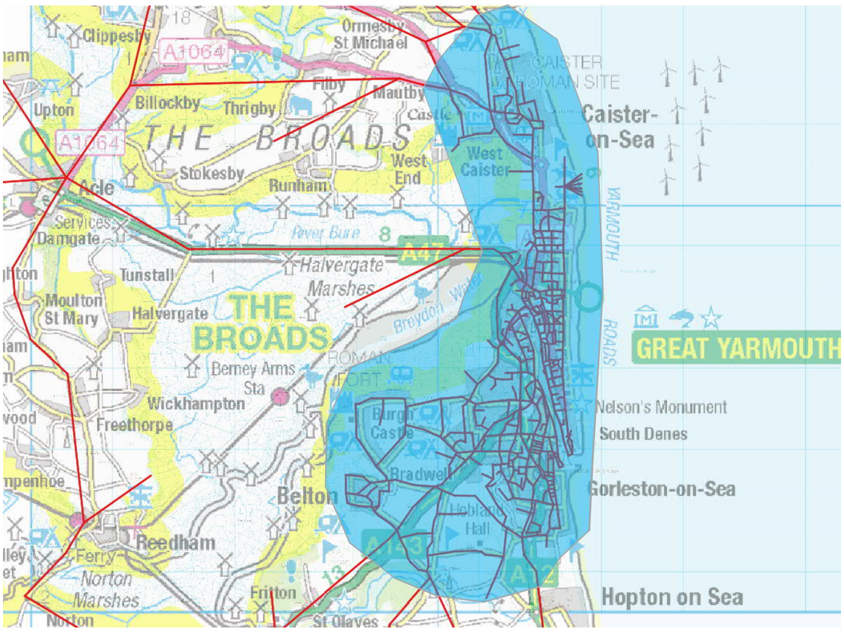
3.5.2. At the time of the model update the improvement scheme at the A149 Acle New Road / Station access junction was also introduced. However, this scheme has not been included in the updated Base given that it was incomplete when the count data was collected.

Plate 6 - Great Yarmouth Network Updates



3.5.3. The simulation network of the model (shaded in blue) is shown in Figure 7.

Plate 7 - Great Yarmouth Model Network Simulation Area



3.6. MATRIX DEVELOPMENT

3.6.1. Following a comparison of traffic counts and land use data from both 2016 and 2018 it was concluded that traffic flows and distribution would not have significantly changed from 2016. In addition, analysis of TEMPro indicates that growth in population and jobs has been marginal during this period, and it was therefore deemed that the existing matrices were suitable to represent 2018 flows.

3.7. MODELLED DATE AND TIME PERIODS

3.7.1. Three time periods have been modelled in order to represent the different travel patterns that exist during a typical weekday, based on the analysis of traffic flow data:

- AM Peak period (07:00 - 10:00)
- Inter-Peak (IP) period (10:00 - 15:30)
- PM Peak period (15:30 - 18:00)

The above peak periods are represented by modelled peak hours:

- AM Peak hour (08:00 - 09:00);
- Inter-Peak average hour (10:00 - 15:30)
- PM Peak hour (16:30 - 17:30)

3.8. VEHICLE CLASSES

3.8.1. Five user classes have been modelled;

- UC1: Cars - employer business;
- UC2: Cars - commute;
- UC3: Cars - other;
- UC4: Light Goods Vehicles (LGVs); and
- UC5: Other Goods Vehicles (OGVs).

3.9. PASSENGER CAR UNIT

3.9.1. The highway assignment models operate in passenger car units (PCU) as opposed to vehicle units. It was therefore required that traffic counts and demand matrices be converted to the PCU unit prior to the assignment.

The following PCUs per vehicle apply to each user class in the GYTM:

- Car - 1.00
- LGV - 1.00

- HGV - 2.30

The HGV PCU factor was calculated from the OGV1 PCU factor (1.90) and the OGV2 PCU factor (2.90). These were averaged based on observed proportions of the two OGV classes to calculate the HGV PCU factor.

3.10. ASSIGNMENT METHODOLOGY

3.10.1. The updated 2018 GYTM uses SATURN v11.3.12U which is consistent with the 2016 model. The standard Wardrop User Equilibrium, using the Frank-Wolfe algorithm, has been used as the assignment procedure.

3.11. GENERALISED COSTS

3.11.1. The components of the generalised cost function used in the traffic model were based on TAG A1.3 and have been updated from July 2016 to December 2017 (release v1.9.1) for the updated model. Values of pence per kilometre (PPK) and pence per minute (PPM) for three vehicle classes (Car, LGV, HGV) by purpose type (Work, Commute, Other) were calculated for all three time periods for input to SATURN. Monetary time (PPM) and distance (PPK) costs have also been converted into generalised costs and are shown in Table 6.

Table 6 - Generalised Cost Parameters

User Class	TIME PERIOD	time (PPM)	DISTance (PPK)
Car Work	AM Peak	30.72	12.26
	Inter-Peak	31.48	12.26
	PM Peak	31.17	12.26
Car Commute	AM Peak	20.60	5.75
	Inter-Peak	20.94	5.75
	PM Peak	20.68	5.75
Car Other	AM Peak	14.22	5.75
	Inter-Peak	15.14	5.75
	PM Peak	14.89	5.75
LGV	AM Peak	21.72	13.49
	Inter-Peak	21.72	13.49
	PM Peak	21.72	13.49
	AM Peak	50.71	46.86

HGV	Inter-Peak	50.71	46.86
	PM Peak	50.71	46.86

4. MODEL STANDARDS

4.1. INTRODUCTION

4.1.1. Throughout the model development process reported here, reference was made to the guidance provided in DfT TAG Unit M3.1, *Highway Assignment Modelling*. Specific reference was made to the criteria and standards appropriate for highway assignment validation and for model convergence.

4.1.2. The model has been developed to be consistent with WebTAG unit M3.1, Highway Assignment Modelling, and the general objective has been to exceed the minimum standards wherever possible.

4.2. CALIBRATION/ VALIDATION

4.2.1. The following criteria was used to assess the model's validation levels.

Trip Matrix Validation

4.2.2. The following criteria for matrix validation and acceptability guidelines for matrix validation were targeted in terms of screenline flow validation:

Table 7 - Screenline Validation Criteria

Measure	Acceptability Guideline
Differences between modelled flows and counts should be less than 5% of counts	all or nearly all screenlines

Link Flow and Turning Movement Validation

4.2.3. The criteria for followed for link flow validation are set out below.

Table 8 - Link Flow Validation Criteria

Criteria		Acceptability GuidelinE
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases

2	GEH <5 for individual flows	> 85% of cases

Journey Time Validation

4.2.4. Journey time comparisons were undertaken as part of the GYTM validation process, to match the objectives set out as follows.

Table 9 - Journey Time Validation Criteria

Criteria	Acceptability Guideline
Modelled times along routes should be within 15% of observed times (or 1 minute if higher than 15%)	> 85% of routes

4.2.5. In all cases, these criteria were applied to combined all-vehicle flows and journey times.

4.3. MODEL CONVERGENCE

4.3.1. TAG guidelines suggested the criteria listed in Table 10 to measure model convergence.

Table 10 - TAG Convergence Criteria

MEASure of CONvergence	Acceptability GuidelinE
Delta and % Gap	less than 0.1% or at least stable with convergence fully documented and all other criteria met
percentage of links with flow change (P) < 1%	four consecutive iterations greater than 98%
percentage of links with cost change (P2) < 1%	four consecutive iterations greater than 98%
Percentage change in total user costs (V)	Four consecutive iterations > 0.1%

5. HIGHWAY MODEL PERFORMANCE

5.1. LINK CALIBRATION AND VALIDATION

Link Flow Validation

5.1.1. The following section presents details of link flow validation for all vehicle types.

5.1.2. The link flow validation is presented in Table 11 for both the original 2016 and updated 2018 models. This shows the percentage of link flow counts meeting acceptability criteria (as set out in TAG Unit M3-1 Table 2). Calibration counts are defined as those that were used in matrix estimation for the original 2016 model, validation counts are independent count sites not used in matrix estimation.

5.1.3. No further matrix estimation was carried out as part of the 2018 model update.

5.1.4. In the AM Peak the there is a slight decrease in the percentage of counts that meet the flow and GEH criteria though 93% of all counts still meet the flow criteria and 84% meet the GEH criteria.

5.1.5. Similarly, in the inter-peak and PM Peak there is a decrease in the percentage of counts that meet the flow and GEH criteria. However, the decrease is marginal when considering all counts with 96% and 92% meeting the flow criteria (in the IP and PM respectively) and 91% meeting the GEH criteria (both in the IP and PM).

Table 11 - GYTM Link Validation Statistics (2016 v 2018)

Period	Count Type	Number of Counts	Criteria 1: Flow		Criteria 2: GEH	
			2016	**2018**	**2016**	**2018**
AM	Calibration	177	99%	94%	93%	86%
	Validation	57	93%	91%	79%	77%
	All counts	234	97%	93%	90%	84%
IP	Calibration	177	99%	97%	95%	93%
	Validation	57	95%	91%	82%	82%
	All counts	234	98%	96%	92%	91%
PM	Calibration	177	98%	95%	97%	94%
	Validation	57	82%	79%	81%	75%
	All counts	234	94%	92%	93%	91%

5.1.6. Tables 12 to 14 shows link flow validation for individual link counts against the TAG acceptability criteria for the 2018 counts. Generally, the tables show that the updated 2018 GYTM achieves a good validation in all three modelled time periods, particularly on the key routes such as A47 and on the Breydon and Haven Bridge. In the AM Peak and IP period most of the model flows validate well again the 2018 observed data with 83% and 88% passing the GEH criteria (AM Peak and IP respectively). In the PM 78% of the model flows pass the GEH criteria while most of the remaining flows are acceptable except NB on N Denes Road and SWB on Gapton Hall Road.

5.1.7. On N Denes Road the 2018 observed flow has increased significantly compared to the 2016 observed flow (from 265 to 515). This increase is not reflected in the 2018 model flow and it appears that some rerouting has occurred, with traffic switching to N Denes Road (NB) from Northgate Street (NB) in the PM Peak. Given that the overall northbound flow across Screenline 3 GY North (see Table 16) validates well in the PM Peak, this appears to be a local issue with no impact on the Scheme.

5.1.8. On Gapton Hall Road the model flow is low against the 2018 observed count at the ATC location which is south of Morton Peto Road. The 2016 ATC survey site was north of Morton Peto Road, and as the model was calibrated using this count, the validation further south is less reliable but is further from the Scheme.

5.1.9. The GEH comparison between the 2016 and 2018 observed counts indicates that at the vast majority of sites traffic flow has not changed significantly. The exception being the N Denes Road (NB) count considered above.

Table 12 - Model Flow Validation Statistics – AM Peak hour

Site Location	Dir	2018 Observed	2018 Modelled	GEH	GEH Pass?	Flow Pass?
A47 Breydon Bridge	*NEB*	1211	1293	2.31	✓	✓
A47 Breydon Bridge	*SWB*	1257	1405	4.07	✓	✓
Bridge Road - Haven Bridge	*SWB*	768	660	4.01	✓	✓
Bridge Road - Haven Bridge	*NEB*	1039	1055	0.49	✓	✓
Lawn Avenue	*NEB*	567	499	2.96	✓	✓
Lawn Avenue	*SWB*	766	637	4.88	✓	×
Northgate Street	*NB*	210	211	0.02	✓	✓
Northgate Street	*SB*	543	625	3.37	✓	✓
N Denes Road	*NB*	203	120	6.49	×	✓
N Denes Road	*SB*	282	318	2.05	✓	✓
North Drive	*NB*	171	161	0.75	✓	✓
North Drive	*SB*	454	408	2.22	✓	✓
Gapton Hall Road	*NEB*	912	774	4.74	✓	×
Gapton Hall Road	*SWB*	264	287	1.42	✓	✓
Burgh Road	*EB*	284	216	4.32	✓	✓

Burgh Road	*WB*	198	107	7.41	✗	✓
Beccles Road	*NEB*	590	417	7.71	✗	✗
Beccles Road	*SWB*	369	398	1.52	✓	✓
A47/ Beccles Road	*NB*	1814	1973	3.64	✓	✓
A47/ Beccles Road	*SB*	1165	1322	4.46	✓	✓
S Denes Road	*NB*	107	69	4.06	✓	✓
S Denes Road	*SB*	181	117	5.30	✗	✓
S Beach Parade	*NB*	21	45	4.26	✓	✓
S Beach Parade	*SB*	91	91	0.04	✓	✓
A47 New Road	*NWB*	708	654	2.07	✓	✓
A47 New Road	*SEB*	730	875	5.15	✗	✗
Caister Road	*NB*	562	555	0.33	✓	✓
Caister Road	*SB*	1057	1120	1.89	✓	✓
A149 Caister By-Pass	*NWB*	445	462	0.79	✓	✓
A149 Caister By-Pass	*SEB*	985	1080	2.98	✓	✓
B1370 Middleton Road	*NEB*	392	446	2.63	✓	✓
B1370 Middleton Road	*SWB*	422	271	8.08	✗	✗
Southtown Road	*NB*	460	517	2.59	✓	✓
Southtown Road	*SB*	307	279	1.62	✓	✓
B1141 Priory Plain	*NWB*	191	163	2.12	✓	✓
B1141 Priory Plain	*SEB*	601	667	2.63	✓	✓
Euston Road	*WB*	132	147	1.24	✓	✓
Euston Road	*EB*	85	28	7.57	✗	✓
Acle New Road	*NWB*	1035	1077	1.30	✓	✓
Acle New Road	*SEB*	939	1026	2.77	✓	✓
					33/40 (83%)	35/40 (88%)

Table 13 - Model Flow Validation Statistics – Inter-peak

Site Location	Dir	2018 Observed	2018 Modelled	GEH	GEH Pass?	Flow Pass?
A47 Breydon Bridge	*NEB*	1000	1074	2.30	✓	✓

A47 Breydon Bridge	*SWB*	1040	1247	6.12	✗	✗
Bridge Road - Haven Bridge	*SWB*	747	697	1.85	✓	✓
Bridge Road - Haven Bridge	*NEB*	907	927	0.68	✓	✓
Lawn Avenue	*NEB*	681	708	1.04	✓	✓
Lawn Avenue	*SWB*	587	628	1.67	✓	✓
Northgate Street	*NB*	229	263	2.20	✓	✓
Northgate Street	*SB*	309	334	1.42	✓	✓
N Denes Road	*NB*	185	207	1.51	✓	✓
N Denes Road	*SB*	132	185	4.16	✓	✓
North Drive	*NB*	222	246	1.56	✓	✓
North Drive	*SB*	213	214	0.06	✓	✓
Gapton Hall Road	*NEB*	421	354	3.39	✓	✓
Gapton Hall Road	*SWB*	499	443	2.56	✓	✓
Burgh Road	*EB*	181	92	7.59	✗	✓
Burgh Road	*WB*	154	70	7.97	✗	✓
Beccles Road	*NEB*	349	364	0.82	✓	✓
Beccles Road	*SWB*	361	396	1.77	✓	✓
A47/ Beccles Road	*NB*	1172	1306	3.83	✓	✓
A47/ Beccles Road	*SB*	1120	1165	1.35	✓	✓
S Denes Road	*NB*	169	99	6.09	✗	✓
S Denes Road	*SB*	149	97	4.61	✓	✓
S Beach Parade	*NB*	61	107	5.04	✗	✓
S Beach Parade	*SB*	59	89	3.44	✓	✓
A47 New Road	*NWB*	615	690	2.91	✓	✓
A47 New Road	*SEB*	597	644	1.90	✓	✓
Caister Road	*NB*	724	783	2.15	✓	✓
Caister Road	*SB*	724	806	2.95	✓	✓
A149 Caister By-Pass	*NWB*	552	662	4.45	✓	✗
A149 Caister By-Pass	*SEB*	617	667	1.99	✓	✓
B1370 Middleton Road	*NEB*	318	327	0.52	✓	✓

B1370 Middleton Road	*SWB*	322	266	3.26	✓	✓
Southtown Road	*NB*	367	363	0.17	✓	✓
Southtown Road	*SB*	324	278	2.64	✓	✓
B1141 Priory Plain	*NWB*	249	196	3.51	✓	✓
B1141 Priory Plain	*SEB*	563	587	1.02	✓	✓
Euston Road	*WB*	158	139	1.55	✓	✓
Euston Road	*EB*	146	141	0.40	✓	✓
Acle New Road	*NWB*	1026	947	2.52	✓	✓
Acle New Road	*SEB*	906	835	2.40	✓	✓
					35/40 (88%)	38/40 (95%)

Table 14 - Model Flow Validation Statistics – PM peak hour

Site Location	Dir	2018 Observed	2018 Modelled	GEH	GEH Pass?	Flow Pass?
A47 Breydon Bridge	*NEB*	1310	1315	0.14	✓	✓
A47 Breydon Bridge	*SWB*	1335	1398	1.69	✓	✓
Bridge Road - Haven Bridge	*SWB*	992	787	6.88	×	×
Bridge Road - Haven Bridge	*NEB*	976	984	0.26	✓	✓
Lawn Avenue	*NEB*	910	954	1.43	✓	✓
Lawn Avenue	*SWB*	534	507	1.18	✓	✓
Northgate Street	*NB*	358	511	7.36	×	×
Northgate Street	*SB*	282	285	0.20	✓	✓
N Denes Road	*NB*	515	209	16.07	×	×
N Denes Road	*SB*	153	132	1.80	✓	✓
North Drive	*NB*	376	403	1.40	✓	✓
North Drive	*SB*	199	195	0.27	✓	✓
Gapton Hall Road	*NEB*	288	443	8.09	×	×
Gapton Hall Road	*SWB*	1042	639	13.90	×	×
Burgh Road	*EB*	270	198	4.72	✓	✓
Burgh Road	*WB*	252	181	4.80	✓	✓

Beccles Road	*NEB*	412	440	1.32	✓	✓
Beccles Road	*SWB*	573	559	0.59	✓	✓
A47/ Beccles Road	*NB*	1346	1485	3.69	✓	✓
A47/ Beccles Road	*SB*	1669	1867	4.71	✓	✓
S Denes Road	*NB*	263	182	5.42	✕	✓
S Denes Road	*SB*	67	66	0.16	✓	✓
S Beach Parade	*NB*	131	161	2.55	✓	✓
S Beach Parade	*SB*	31	60	4.23	✓	✓
A47 New Road	*NWB*	956	813	4.81	✓	✓
A47 New Road	*SEB*	664	854	6.90	✕	✕
Caister Road	*NB*	1020	1152	4.00	✓	✓
Caister Road	*SB*	646	620	1.03	✓	✓
A149 Caister By-Pass	*NWB*	796	1010	7.11	✕	✕
A149 Caister By-Pass	*SEB*	546	576	1.27	✓	✓
B1370 Middleton Road	*NEB*	439	498	2.71	✓	✓
B1370 Middleton Road	*SWB*	397	370	1.41	✓	✓
Southtown Road	*NB*	375	355	1.04	✓	✓
Southtown Road	*SB*	426	435	0.43	✓	✓
B1141 Priory Plain	*NWB*	256	223	2.17	✓	✓
B1141 Priory Plain	*SEB*	465	442	1.12	✓	✓
Euston Road	*WB*	147	171	1.94	✓	✓
Euston Road	*EB*	137	171	2.76	✓	✓
Acle New Road	*NWB*	1007	1242	7.00	✕	✕
Acle New Road	*SEB*	960	1092	4.11	✓	✓
					31/40 (78%)	32/40 (80%)

Screen-line Validation

5.1.10. Tables 15 to 17 present a summary of the model validation against the 2016 screenlines (shown in Figure 8) for AM peak, inter-peak and PM peak periods.

5.1.11. The tables show that the model flows validate well across all the 2016 screenlines for all three time periods.

Table 15 - AM Peak Screenline Validation

Screenline / Direction	Observed flow	Modelled flow	Difference	% Difference	GEH
Peninsula Northbound	587	592	5	1%	0.2
Peninsula Southbound	924	928	3	0%	0.1
River Yare Eastbound	2,379	2,375	-4	0%	0.1
River Yare Westbound	2,121	2,093	-28	-1%	0.6
Fuller's Hill/ St Nicholas Road Northbound	1,296	1,307	11	1%	0.3
Fuller's Hill/ St Nicholas Road Southbound	2,290	2,237	-52	-2%	1.1
Newtown Northbound	1,067	1,023	-43	-4%	1.3
Newtown Southbound	2,164	2,058	-106	-5%	2.3
North of Town Inbound	2,384	2,373	-12	-1%	0.2
North of Town Outbound	1,375	1,353	-22	-2%	0.6
Outer Cordon Inbound	4,524	4,457	-67	-1%	1.0
Outer Cordon Outbound	3,071	3,037	-34	-1%	0.6
East of A12 Eastbound	2,579	2,713	134	5%	2.6
East of A12 Westbound	2,066	2,104	38	2%	0.8
North of Beccles Road (east Of A12) Eastbound	1,220	1,257	37	3%	1.0
North of Beccles Road (east Of A12) Westbound	1,281	1,402	121	9%	3.3
				15/16 (94%)	16/16 (100%)

Table 16 - Inter-Peak Screenline Validation

Screenline / Direction	Observed flow	Modelled flow	Difference	% Difference	GEH
Peninsula Northbound	700	709	9	1%	0.3
Peninsula Southbound	640	651	11	2%	0.4
River Yare Eastbound	1,969	2,027	58	3%	1.3
River Yare Westbound	1,979	1,969	-9	0%	0.2
Fuller's Hill/ St Nicholas Road Northbound	1,423	1,334	-89	-6%	2.4
Fuller's Hill/ St Nicholas Road Southbound	1,386	1,382	-5	0%	0.1
Newtown Northbound	1,433	1,441	8	1%	0.2
Newtown Southbound	1,399	1,398	-1	0%	0.0
North of Town Inbound	1,508	1,507	-1	0%	0.0
North of Town Outbound	1,549	1,590	41	3%	1.0
Outer Cordon Inbound	2,970	2,974	3	0%	0.1
Outer Cordon Outbound	3,043	3,064	21	1%	0.4
East of A12 Eastbound	2,142	2,164	22	1%	0.5
East of A12 Westbound	2,003	2,068	65	3%	1.5
North of Beccles Road (east Of A12) Eastbound	1,108	1,178	70	6%	2.1
North of Beccles Road (east Of A12) Westbound	1,011	991	-20	-2%	0.6
				14/16	16/16

Screenline / Direction	Observed flow	Modelled flow	Difference	% Difference	GEH
				(88%)	(100%)

Table 17 - PM Peak Screenline Validation

Screenline / Direction	Observed flow	Modelled flow	Difference	% Difference	GEH
Peninsula Northbound	1,016	1,003	-13	-1%	0.4
Peninsula Southbound	565	575	10	2%	0.4
River Yare Eastbound	2,299	2,320	21	1%	0.4
River Yare Westbound	2,213	2,205	-7	0%	0.2
Fuller's Hill/ St Nicholas Road Northbound	2,427	2,376	-51	-2%	1.0
Fuller's Hill/ St Nicholas Road Southbound	1,459	1,513	54	4%	1.4
Newtown Northbound	2,120	2,093	-27	-1%	0.6
Newtown Southbound	1,177	1,145	-32	-3%	0.9
North of Town Inbound	1,595	1,574	-21	-1%	0.5
North of Town Outbound	2,147	2,146	-1	0%	0.0
Outer Cordon Inbound	3,477	3,424	-52	-2%	0.9
Outer Cordon Outbound	4,459	4,373	-85	-2%	1.3
East of A12 Eastbound	2,376	2,229	-147	-6%	3.1
East of A12 Westbound	2,451	2,668	217	9%	4.3
North of Beccles Road (east Of A12) Eastbound	1,468	1,459	-10	-1%	0.2
North of Beccles Road (east Of A12) Westbound	1,203	1,228	26	2%	0.7
				14/16	15/16
				(88%)	(94%)

Plate 8 - Great Yarmouth Screenline Locations

5.2. ASSIGNMENT JOURNEY TIME VALIDATION

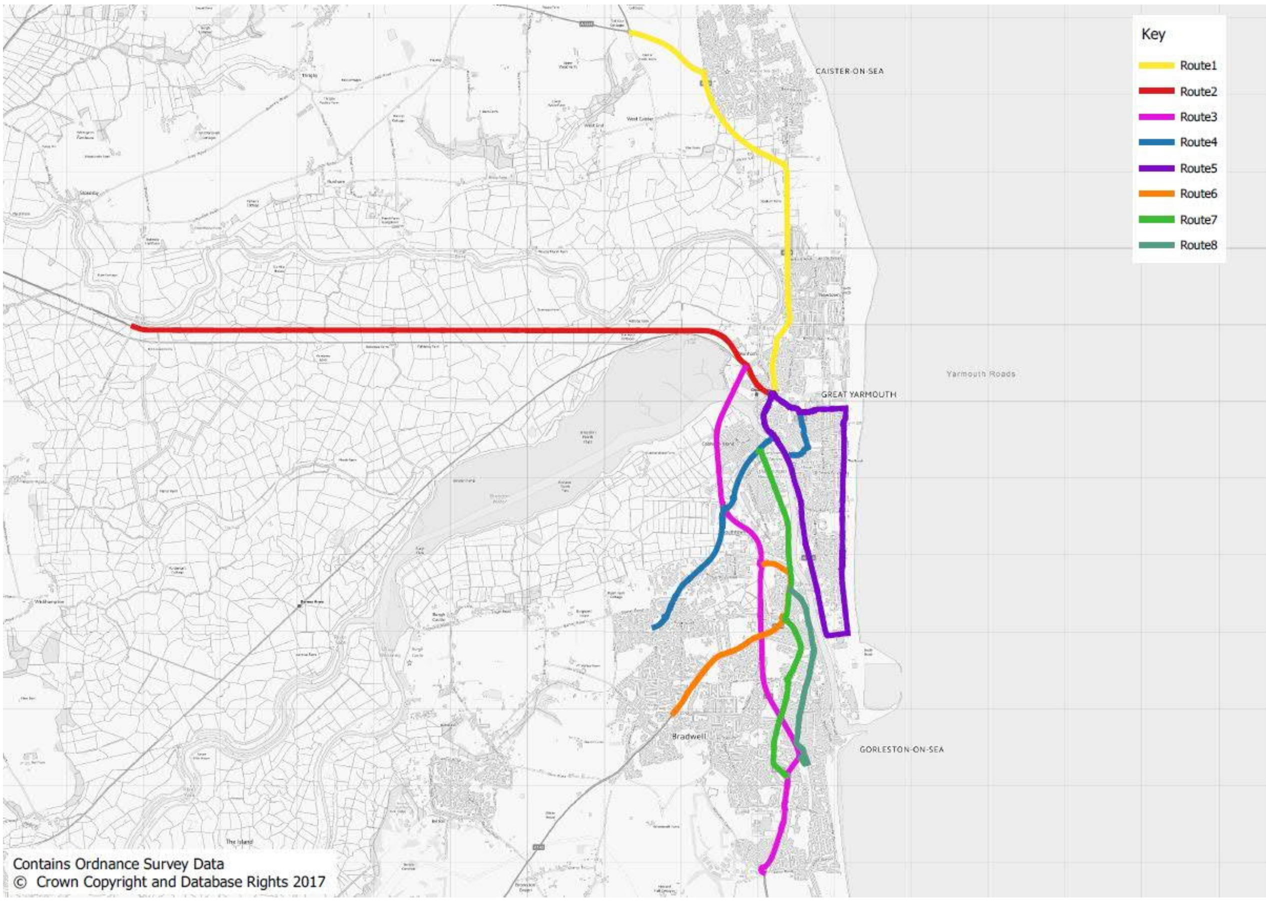
5.2.1. For the 2016 GYTM journey time data was collected for eight routes across the study area reflecting the range of journeys which take place and covering all of the significant roads within the area of impact. For these eight routes, Trafficmaster origin/destination (TMOD) data was obtained from the BaseMap 'Highways Analyst' tool. Given the limited changes to the network, land use and traffic growth between 2016 and 2018, the existing journey time data was considered valid for checking the 2018 GYTM journey time validation.

A route description is provided in Table 18, and the journey time routes are shown in Figure 9.

Table 18 - Journey Time Route Descriptions

Route	Description
1 NB	A149 from Fuller's Hill Roundabout to Main Road Roundabout
1 SB	A149 from Main Road Roundabout to Fuller's Hill Roundabout
2 EB	A47 from Branch Road junction to Fuller's Hill Roundabout
2 WB	A47 from Fuller's Hill Roundabout to Branch Road junction
3 NB	A47 from Beaufort Way Roundabout to Vauxhall Roundabout
3 SB	A47 from Vauxhall Roundabout to Beaufort Way Roundabout
4 NB	Blackbird close/Gapton Hall Road/Pasteur Road from Mill Lane to A47 Roundabout
4 SB	Blackbird close/Gapton Hall Road/Pasteur Road from A47 Roundabout to Mill Lane
5 CW	Peninsular Clockwise from A47 roundabout via South Beach Parade/A1243/B1141
5 ACW	Peninsular Anticlockwise from A47 roundabout via South Beach Parade/A1243/B1141
6 NB	A143 Beccles Road from Long Lane to Southtown A47 Roundabout
6 SB	A143 Beccles Road from Southtown A47 Roundabout to Long Lane
7 NB	Middleton Road/Southdown Road from A47 Roundabout to Pasteur Road
7 SB	Middleton Road/Southdown Road from Pasteur Road to A47 Roundabout
8 NB	Gorleston Lowestoft Road/ High Street from A47 Roundabout to Pasteur Road
8 SB	Gorleston Lowestoft Road/ High Street from Pasteur Road to Roundabout

Plate 9 - Journey Time Routes



5.2.2. Tables 19 to 21 present results for the journey time validation for the routes set out above. For each journey time route the table show whether it meets TAG Acceptability criteria, and comparison purposes the both the 2016 and 2018 have been included.

Table 19 - Journey Time Results - AM Peak

Route	Observed Time (minutes)	Modelled Time (minutes)	Percentage Difference	TAG Acceptability	
				2018	**2016**
1 NB	00:06:58	00:07:14	3.9%	✓	✓
1 SB	00:08:03	00:08:05	0.4%	✓	✓
2 EB	00:13:37	00:08:33	-37.2%	×	×
2 WB	00:10:39	00:07:40	-27.9%	×	×
3 NB	00:09:06	00:10:13	12.3%	✓	✓
3 SB	00:07:58	00:08:32	7.1%	✓	✓
4 NB	00:09:23	00:10:30	12.0%	✓	✓

4 SB	00:08:55	00:08:01	-10.1%	✓	✓
5 CW	00:14:38	00:12:32	-14.4%	✓	✓
5 ACW	00:14:49	00:12:45	-14.0%	✓	✓
6 NB	00:05:53	00:06:15	6.4%	✓	✓
6 SB	00:06:06	00:07:01	15.1%	✓	✓
7 NB	00:07:54	00:10:09	28.4%	×	×
7 SB	00:08:56	00:08:55	-0.3%	✓	✓
8 NB	00:04:12	00:05:15	24.8%	×	✓
8 SB	00:05:24	00:04:50	-10.4%	✓	✓
				12/16 (75%)	13/16 (81%)

Table 20 - Journey Time Results - Inter Peak

Route	Observed Time (minutes)	Modelled Time (minutes)	Percentage Difference	TAG Acceptability	
				2018	**2016**
1 NB	00:06:27	00:07:33	16.9%	×	×
1 SB	00:06:35	00:07:28	13.4%	✓	×
2 EB	00:07:47	00:07:45	-0.4%	✓	✓
2 WB	00:07:42	00:07:44	0.5%	✓	✓
3 NB	00:07:56	00:08:02	1.4%	✓	✓
3 SB	00:07:34	00:08:06	7.1%	✓	✓
4 NB	00:08:20	00:09:32	14.5%	✓	✓
4 SB	00:08:01	00:08:14	2.7%	✓	✓
5 CW	00:14:17	00:13:01	-8.9%	✓	✓
5 ACW	00:13:05	00:13:21	2.0%	✓	✓
6 NB	00:05:24	00:05:37	4.1%	✓	✓
6 SB	00:05:04	00:06:25	26.7%	×	✓
7 NB	00:07:37	00:09:18	22.1%	×	✓
7 SB	00:08:01	00:08:40	8.0%	✓	✓

8 NB	00:04:46	00:05:29	15.0%	✓	✓
8 SB	00:05:47	00:04:56	-14.7%	✓	✓
				13/16 (81%)	14/16 (88%)

Table 21 - Journey Time Results - PM Peak

Route	Observed Time (minutes)	Modelled Time (minutes)	Percentage Difference	TAG Acceptability	
				2018	2016
1 NB	00:06:46	00:09:02	33.6%	×	×
1 SB	00:06:39	00:07:18	9.6%	✓	✓
2 EB	00:08:53	00:08:26	-5.0%	✓	✓
2 WB	00:09:25	00:08:05	-14.2%	✓	✓
3 NB	00:12:20	00:11:08	-9.8%	✓	✓
3 SB	00:08:43	00:09:29	8.9%	✓	✓
4 NB	00:09:55	00:09:38	-2.8%	✓	✓
4 SB	00:12:55	00:08:30	-34.1%	×	×
5 CW	00:15:23	00:13:15	-13.9%	✓	✓
5 ACW	00:13:16	00:13:09	-0.9%	✓	✓
6 NB	00:06:18	00:07:48	23.7%	×	✓
6 SB	00:05:05	00:06:35	29.5%	×	✓
7 NB	00:08:05	00:10:30	30.1%	×	✓
7 SB	00:11:07	00:09:07	-18.0%	×	×
8 NB	00:04:34	00:05:27	19.4%	✓	✓
8 SB	00:05:42	00:05:05	-10.8%	✓	✓
				10/16 (63%)	13/16 (88%)

5.2.3. Generally, the journey time validation for the 2018 GYTM are comparable with the 2016 model. In the **AM Peak** 12 out of the 16 routes (75%) meet TAG acceptability with only one additional route failing the criteria on Route 8 (NB). However, the increase between 2016 and 2018 in the modelled journey time for this route is marginal at only 5 seconds.

5.2.4. In the **Inter-Peak** 81% of the journey time routes meet TAG acceptability while two routes that previously passed in the 2016 model now narrowly fail (Route 6 SB and 7 NB) and one route now passes (Route 1 SB) that previously failed. The increases the in the modelled journey for the two routes that now fail (Route 6 SB and Route 7 NB) are slightly more significant, however, the overall journey time validation for the Inter-Peak remains acceptable.

5.2.5. In the **PM Peak** 10 of the 16 routes (62%) pass TAG acceptability, a reduction of 3 routes compared to 2016; Route 6 (NB and SB) and Route 7 (NB). On Route 6 (NB) the model journey time on Beccles Road are similar to the 2016 model journey times on all sections of the journey time route except on the approach to Harfrey's roundabout. Here the model delays have increased slightly due to an increase in the opposing southbound traffic flow on A47. Similarly, on Route 6 (SB) the model journey times are almost identical to the 2016 model journey times except on the final section of the Beccles Road route.

5.2.6. In addition to the above, the model zone granularity is relatively coarse to the south of the A143 and an additional centroid connector was added to the zone that loads onto Beccles Road near the ATC site (Zone 36). This increased the model traffic flow on Beccles Road and improved the flow validation, as previously in the 2016 PM Peak model, the model traffic flow Beccles Road was slightly low compared to the observed flow. However, the improved flow validation on Beccles Road has adversely impacted on the journey time validation as the model journey times are now slightly too slow between the A47 and Long Lane, though this section is further from the Scheme.

5.2.7. On Route 7 (NB) the model journey time on the B1370 Church Road section between the Church Lane and Beccles Road roundabouts has slightly increased compared to the 2016 model, though again, this section is further from the Scheme.

5.2.8. A further factor that has had a more general impact on the model assignments is the change to the generalised cost parameters. The ratio between the value of time and distance has changed, particularly for car 'work' trips, potentially resulting in some traffic taking more direct routes and causing model journey times to increase slightly.

5.2.9. The PM Peak is below the recommended TAG level. However, the routes that fail to meet the criteria are less critical to the Scheme and the journey times on key routes along the A47 (Routes 2 and 3) and on the peninsula (Route 5) in both directions pass TAG criteria.

5.3. MODEL CONVERGENCE

5.3.1. Table 22 presents convergence statistics from the three base year time periods including the iteration loop at which these criteria were all met over four consecutive iterations.

Table 22 - Great Yarmouth Traffic Model Convergence Statistics

AM Peak			Inter-Peak			PM Peak		
Loop	**%Flow**	**%GAP**	**Loop**	**%Flow**	**%GAP**	**Loop**	**%Flow**	**%GAP**
16	99.6	0.0033	11	99.6	0.00091	16	99.6	0.00022
17	99.7	0.0030	12	99.5	0.00074	17	99.7	0.00019
18	99.7	0.0026	13	99.7	0.00057	18	99.6	0.00025
19	99.7	0.0026	14	99.7	0.00039	19	99.7	0.00021

5.3.2. All three time periods converge to a high level within a relatively small number of iterations. This indicates model stability resultant from clear route choice alternatives and will prove beneficial in travel demand forecasting.

6. SUMMARY AND CONCLUSION

6.1. ADDENDUM SUMMARY

6.1.1. This document acts as Addendum to the original Local Model Validation Report and outlines the revisions applied to the 2016 model to update it to a 2018 base year. Given the short period of two years between the original 2016 base year model and the 2018 updated model, the revisions to the 2016 base model are relatively minor and mainly focused on network changes.

6.1.2. This Addendum considers the following:

- The update to 2018 with analysis of both long term and ATC data;
- Network description and updates;
- Model standards;
- ATC data collection for the 2018 update and 2016 journey time routes;
- Link calibration and validation considering 2018 model performance against both 2016 counts and 2018 counts; and
- Journey time validation.

6.2. SUMMARY OF MODEL PERFORMANCE

6.2.1. Analysis of the long term and ATC data shows that there is no need to uplift the 2016 matrices to 2018 given the minimal change in overall traffic flow between the two years. The long-term TRADS/TRIS data on the A47 shows almost static growth for an 8-year period between 2010 and 2017 while the ATC data also shows minimal change between 2016 and 2018.

6.2.2. The link flow validation shows the overall the 2018 model continues to validate well against both the previous 2016 counts and the new 2018 ATC data.

6.2.3. The journey time analysis shows that, while 2018 model has declined slightly on some routes, the model continues to validate well on the key routes in the network.

6.3. CONCLUSION

6.3.1. This Addendum demonstrates that the updated 2018 GYTM provides an accurate representation of highway travel patterns in the Great Yarmouth area and continues to comply with DfT TAG for supporting the DCO for the Scheme.

6.3.2. The latest 2018 GYTM is deemed appropriate for use in terms of its ability to replicate existing strategic traffic movements within the Area of Detailed Modelling (ADM). The base year model forms a suitable platform from which forecast year models can be developed, creating reference case, do minimum and do something scheme testing.

6.3.3. The model provides the required level of rigour and assurance, including model validation, to underpin robust investment decisions.

8 First Street
Manchester
M15 4RP

wsp.com

Appendix B – Traffic Forecasting Report

Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING

Forecasting Report

70046035-TPL
MARCH 2019

PUBLIC

Norfolk County **Council**

GREAT YARMOUTH THIRD RIVER CROSSING

Forecasting Report

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70046035

OUR REF. NO. 70046035-TPL

DATE: MARCH 2019

Norfolk County **Council**

GREAT YARMOUTH THIRD RIVER CROSSING

Forecasting Report

WSP

St. Johns House
Queen Street
Manchester
M2 5JB

Phone: +44 161 602 8400

WSP.com

CONTENTS

TABLES

PLATES

ANNEXES

APPENDIX C

DAILY DEMAND MATRICES

APPENDIX D

CONVERGENCE STATISTICS

APPENDIX E

FIXED TRAFFIC FLOW CHANGES

APPENDIX F

REFERENCE MATRIX COMPRESSION

APPENDIX G

VDM TRAFFIC FLOW CHANGES

APPENDIX H

VDM MATRIX SECTOR COMPRESSION

1. INTRODUCTION

1.1. SUMMARY

1.1.1. Mouchel (now part of WSP) was appointed by Norfolk County Council (NCC) to produce traffic forecasts and economic appraisal outputs as part of a Value for Money (VfM) appraisal for the proposed Great Yarmouth Third River Crossing (GYTRC). The VfM case formed part of an Outline Business Case (OBC) which was submitted to the Department of Transport (DfT) in March 2017 and was subsequently approved.

1.1.2. To inform the OBC a SATURN highway and CUBE demand model of Great Yarmouth was developed in 2017 with a base year of 2016. This model has been updated to 2018 base year to inform the Transport Assessment (TA) which in turn feeds into the Environmental Statement (ES) and Development Consent Order (DCO) submission.

1.2. BACKGROUND

1.2.1. The Scheme involves the construction, operation and maintenance of a new crossing of the River Yare in Great Yarmouth. It consists of a new dual carriageway road across the river, linking the A47 at Harfrey's Roundabout on the western side to the A1243 South Denes Road on the eastern side. It features an opening span Double Leaf Bascule Bridge across the river, which will involve the construction of two "knuckles" that extend the quay wall into the river. The new dual carriageway will also have a clear span over Southtown Road on the western side of the river, as it rises to the centre of the new crossing.

1.2.2. The Scheme will create a new, direct link between the western and eastern parts of the town. It will substantially improve connectivity between the A47 (part of the SRN) and significant destinations on the South Denes peninsula, including the South Denes Business Park, Great Yarmouth Energy Park, the Port and Outer Harbour, including part of the Great Yarmouth and Lowestoft (New Anglia) Enterprise Zone.

1.3. REPORT STRUCTURE

1.3.1. This report supersedes the original forecasting report (GY Forecast Report - Final_v1) that was a supporting document of the OBC submission. This report describes the methods employed to develop the traffic forecasts required to support the DCO from the updated 2018 base year model. The following sections of the report are included to provide a full understanding of the processing undertaken:

- Chapter 2. Forecast and Appraisal Requirements;

- Chapter 3. Overview of Forecasting Requirements;
- Chapter 4. Future Year Scenarios;
- Chapter 5. Future Year Network Configurations;
- Chapter 6. Future Year Travel Demands;
- Chapter 7. Core Scenario Outputs;
- Chapter 8. Variable Demand Model Outputs;
- Chapter 9. Sensitivity Test Outputs; and
- Chapter 10. Summary and Conclusions

2. FORECASTING AND APPRAISAL REQUIREMENTS

2.1. INTRODUCTION

2.1.1. Forecasting the usage and performance of transport networks is a critical component in any transport appraisal. The principal purpose in the development of the future year traffic forecasts is to support the Norfolk County Council funding bid for the Great Yarmouth Third River Crossing scheme. This chapter describes the various requirements of the forecasting and appraisal process for the TRC scheme. These include the prediction of the future year travel demands and the assumptions relating to changes in the future year highway network.

2.1.2. The forecasting model has been developed in accordance with guidance provided by the DfT in the WebTAG series of documents, specifically those areas focussed on Forecasting and Uncertainty[1].

2.2. FUTURE YEAR TRAVEL DEMAND SCENARIOS

2.2.1. The principal requirement of the traffic model was the provision of traffic forecasts for use in economic, environmental and social impacts appraisal of the TRC scheme for the Opening Year (2023), Design Year (2038) and Horizon Year (2051). Future travel demand forecasts for these years take into account the existing base year traffic demand together with the effects of future traffic growth and the additional traffic due to new development activity.

2.2.2. Traffic is forecast to grow mostly because people are expected to become wealthier and to live longer, because economic activity increases, and because households are forecast to become more numerous. Traffic growth is facilitated by car ownership, which is linked to wealth. Wealth enhances economic activity and also underpins new household formation. These progenitors of traffic growth are reconciled at a national level and are translated through to local changes. Local congestion levels seek to limit the impact of growth via a negative feedback process. Network improvements mitigate the levels of congestion. The remainder of the report explains how this process has been applied in respect of the Great Yarmouth Third River Crossing.

2.2.3. More specifically the assumptions adopted in the derivation of the future travel demands for the wider Great Yarmouth area are documented in Chapter 4.

[1] TAG_Unit_M4_Forecasting_and_Uncertainty_May2018.pdf

2.3. FUTURE YEAR HIGHWAY NETWORK CONFIGURATIONS

2.3.1. 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 Norfolk CC. The actual highway and traffic management schemes that have been adopted in the future year traffic models are discussed in detail in Chapter 5.

3. OVERVIEW OF FORECASTING REQUIREMENTS

3.1. INTRODUCTION

3.1.1. This chapter highlights the main features of the model structure and presents an overview of the forecasting methodology that was adopted in the preparation of the Opening, Design and Horizon Year forecasts.

3.2. BASE YEAR MODEL OVERVIEW

3.2.1. *Model base year* – The 2016 base year model was revised to a 2018 base year using updated survey data.

3.2.2. *Software* – The base year models were developed using the SATURN (v11.3.12U) suite of programs.

3.2.3. *Study Area* – The study area covers the urban area of Great Yarmouth and surrounding areas of Caister, Bradwell and Gorleston. The study area is shown in Plate 1 below.

Plate 1 - Great Yarmouth Modelled Area

3.2.4. *Zoning System* – A zoning system aggregates geographical areas into individual blocks and so reduces the amount of detail in the model. The zoning system designed for the Great Yarmouth model comprised 240 zones, of which approximately 90 are internal zones, within the study area, and 150 are external zones.

3.2.5. In order to represent traffic patterns to an adequate level of detail, the zoning system in Great Yarmouth contained a number of smaller sized zones. Outside the study area the zoning system is much less detailed with larger zones covering wider areas, reflecting the lower level of detail required for these areas.

A detailed list of the zoning system, including the relationship between the TEMPro sectors and the zoning system used in the traffic model is presented in Appendix A.

3.2.6. *Modelled Time Periods* – Three time periods identified from the survey data were modelled in order to replicate different trip patterns during a typical weekday. The three time periods are shown below:

- AM Peak hour (08:00 – 09:00);
- PM Peak hour (16:30 – 17:30); and
- Average Inter-Peak hour (10:00 – 15:30).

3.2.7. *Private Vehicle Classes* - Five user classes were modelled:

- Cars – employer business ;
- Cars – commute;
- Cars – other
- Light Goods Vehicles; and
- Heavy Goods Vehicles (OGV1, OGV2 and Coaches).

3.2.8. *Modelled Highway Network* – Within the study area, the modelled network included all ‘A’ and ‘B’ class roads and most minor roads. Within Great Yarmouth, residential roads that act as distributor routes or ‘rat-runs’ were also included in the model. The network was coded in detail to reproduce the effects of traffic queues and delays on vehicle routing patterns.

3.2.9. Outside the study area, a coarse network of buffer links was defined to include major ‘A’ roads; including the A12, A143 and A47. This ensured that long distance traffic was properly routed into and around Great Yarmouth.

3.2.10. *Highway Matrix Development* – The demand matrices for the base model were created by combining RSI/Traffic Master Origin Destination (TMOD) matrices and the original MM model uplifted matrices. First, the RSI data was expanded to form OD matrices and these were blended with TMOD data to fill any missing data. These matrices were then combined with the uplifted matrices from the original MM model using weighting factors favouring RSI matrices if the data was sufficient.

3.2.11. *Highway Model Calibration* – The calibration of the Base Year traffic models was undertaken using a standard approach where the network was adjusted to ensure that the model realistically replicated routeing and vehicle speeds through the study area. Matrix estimation was incorporated in the model calibration process in order to obtain matrices based on the routeing patterns to which the network was calibrated.

3.2.12. *Highway Model Validation* – Network validation was undertaken to establish that the network structure was accurate and that characteristics of the network are suitably represented in the model. A number of range and logic checks were undertaken, including routeing checks. Assignment validation was then undertaken for traffic flows (links and turns) and journey times.

3.2.13. The development of the base year traffic model and its validation against observed traffic flows and journey times was fully documented in the Great Yarmouth Traffic Model, Local Model Validation Report (Mouchel 2017).

3.3. FORECAST MODEL OVERVIEW

3.3.1. 'Network Configurations' refer to combinations of different transport interventions, which in broad terms encompass changes in capacity, e.g. new infrastructure, operating conditions, and prices. Network Configurations typically include a Reference Network Configuration, referred to as the Do Minimum (DM), against which to test a scheme focused Network Configuration, referred to as the Do Something (DS).

3.3.2. 'Scenarios' refer to the level, distribution and structure of population, households, employment, and car ownership, which affect car availability, as well as general economic variables such as the level of GDP and fuel prices. Scenarios combine growth information from Development Logs and TEMPro and typically include:

- Core Scenario;
- Low Demand Scenario; and
- High Demand Scenario.

3.3.3. The future year modelling falls into two parts, the second dependent upon the first:

- **Unconstrained Forecast** - or 'reference growth', including pure changes in demand (assuming constant transport costs) brought about by external changes, e.g. effects due to land use, income, car ownership etc; and
- **Constrained Forecast** - changes to the above brought about by the transport system, including the result of supply side constraints.

3.3.4. The Forecasting Model produced production and attraction growth factors for each purpose for the scenario being tested, and applied them to the Calibrated Segmented Base matrices, yielding a set of 'Future Base' matrices which represented the change in demand for transport on the assumption of transport costs remaining fixed. The Forecast Model has been used to predict the change to these Future Base matrices, as a result of changes in generalised cost arising both from transport network configurations and from the level of demand predicted in the travel scenario.

3.3.5. Individuals' demand for travel varies by person-type. Changes in the distribution of such person-types between the base and forecast year has repercussions on total travel demand. There was therefore a need for an interface at the 'trip generation' stage with external 'planning' data to reflect the scenario assumptions. This was the role of the Forecast Model which combined the UK forecasts available through the TEMPro software and local development planning data.

3.3.6. Given a basic demand forecast for any chosen scenario, the function of the Forecast Model is to predict the effects of a Network Configuration. This model is postulated on the basis that any changes in the transport system can be represented by changes in the components of generalised cost (journey time, distance etc) between specific zones at specific times. Changes to capacity are impacted in the model via an appropriate modification of the supply side relationship in the assignment models (Supply Model).

3.3.7. After each change in generalised costs, the Demand Model was rerun and the output 'loaded' into the Supply Model where changes in generalised cost were recalculated, until convergence is reached. The final estimates could then be passed to the appraisal process.

3.3.8. For convenience in preparing the Forecast Model, and providing early indications of scheme performance, the highway assignment element of the Forecast Model was initially used without running the Demand Model, referred to as the Fixed Demand forecasts. These forecasts provided an opportunity to evaluate changes in advance of a set of actual TAG compliant forecasts including the Demand and Supply model looping, referred to as the Variable Demand forecasts. Fixed and Variable Demand forecasts were prepared for Do Minimum and Do Something Network Configurations and are both reported in this Forecasting Report.

3.4. FORECAST MODEL STAGES

3.4.1. The forecasting process comprised the following main stages:

- define future year travel Scenarios;
- define future year intervention Network Configurations;
- undertake Fixed Matrix DM and DS forecasting;
- undertake Variable Matrix DM and DS forecasting; and
- Report of Model Outputs.

3.4.2. Each of these stages is described in subsequent chapters.

4. FUTURE YEAR SCENARIOS

4.1. INTRODUCTION

4.1.1. This chapter presents the assumptions adopted in the derivation of the future year forecasts for the scheme's Opening and Design Years. The Uncertainty Log has been updated to reflect the latest assumptions relating to future developments and highway network improvements.

4.1.2. Assumptions relating to future developments are outlined in the Development Uncertainty Log used in developing the alternative scenarios in accordance with the Department's guidance included in the WebTAG Unit M4 (May 2018). Other assumptions relating to highway network improvements and to travel cost parameters are also discussed in this chapter.

4.2. UNCERTAINTY LOG

4.2.1. A robust set of assumptions relating to land use and future developments within Great Yarmouth were generated as part of the forecasting process. The land use forecasting assumptions were based on two broad key land use types, these were:

- Employment – Measured by gross floor area (m^2); and
- Housing – Measured by number of dwellings.

4.2.2. A detailed development log was generated to collate all developments built, proposed or planned for Great Yarmouth covering the period from 2016 through to the opening year (2023) and the design year (2038). The development log remains largely the same following the 2018 update with only minor adjustments for completions applied (the size of the residential site on 'Land South of Bradwell' has been adjusted).

4.2.3. It was assumed that the development traffic in the 2051 forecasts would be the same as those in 2038 as the ability to predict individual developments over this longer horizon was diminished. The key developments included within the development log are detailed within Table 2 and Table 3.

4.2.4. As part of the input to the development log all housing data was given in number of dwellings and the employment data was given by gross floor area in meters squared.

4.2.5. The specific details relating to each development were collated from the respective planning application, Area Action Plan or Development Order.

4.2.6. Each development detailed within the development log was assessed against the following scale:

Table 1 - Classification of Development Inputs

PROBABILITY OF INPUT	STATUS	CORE SCENARIO ASSUMPTIONS
Near certain: The outcome will happen or there is a high probability that it will happen.	Intent announced by proponent to regulatory agencies. Approved development proposals. Projects under construction	This should form part of the core scenario

PROBABILITY OF INPUT	STATUS	CORE SCENARIO ASSUMPTIONS
More than likely: The outcome is likely to happen but there is some uncertainty.	Submission of planning or consent application imminent. Development application within the consent process.	This could form part of the core scenario
Reasonably foreseeable: The outcome may happen, but there is significant uncertainty	Identified within a development plan. Not directly associated with the transport strategy/scheme, but may occur if the strategy/scheme is implemented. Development conditional upon the transport strategy/scheme proceeding. Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty	These should be excluded from the core scenario but may form part of the alternative scenarios
Hypothetical: There is considerable uncertainty whether the outcome will ever happen.	Conjecture based upon currently available information. Discussed on a conceptual basis. One of a number of possible inputs in an initial consultation process. Or, a policy aspiration	These should be excluded from the core scenario but may form part of the alternative scenarios

4.2.7. Tables 2 and 3 detail the uncertainty assessment for each development within the log.

4.3. SCENARIO DEFINITION

4.3.1. Advice provided in the Department's series of TAG documents highlights the fact that studies should test a 'core' scenario and in addition alternative scenarios should also be developed to account for future uncertainty. In response to those requirements, three scenario options were developed for forecasting, as listed below:

- Low Demand Growth;
- Core (or 'Most Likely' scenario); and
- High Demand Growth.

4.3.2. The methodology for the calculation of the Low and High traffic growth rates is given in Section 4-7.

4.3.3. Each scenario option was applied to the different Network Configurations to reflect the future possibilities.

4.4. DEVELOPMENT ASSUMPTIONS

4.4.1. For the forecast models, future developments must be included to reflect the changes in demand in future year scenarios. The developments that have been included in the Great Yarmouth model forecasts are discussed in this section.

4.4.2. The developments included in the assumptions was decided based on a threshold of 25 (vehicle) arrival and departure trips for an average inter-peak hour based on TRICS data. The developments that exceed this threshold gave a broad representation of developments within the modelled area. The remainder were absorbed by background growth.

4.4.3. Several key additional locations for development are summarised below.

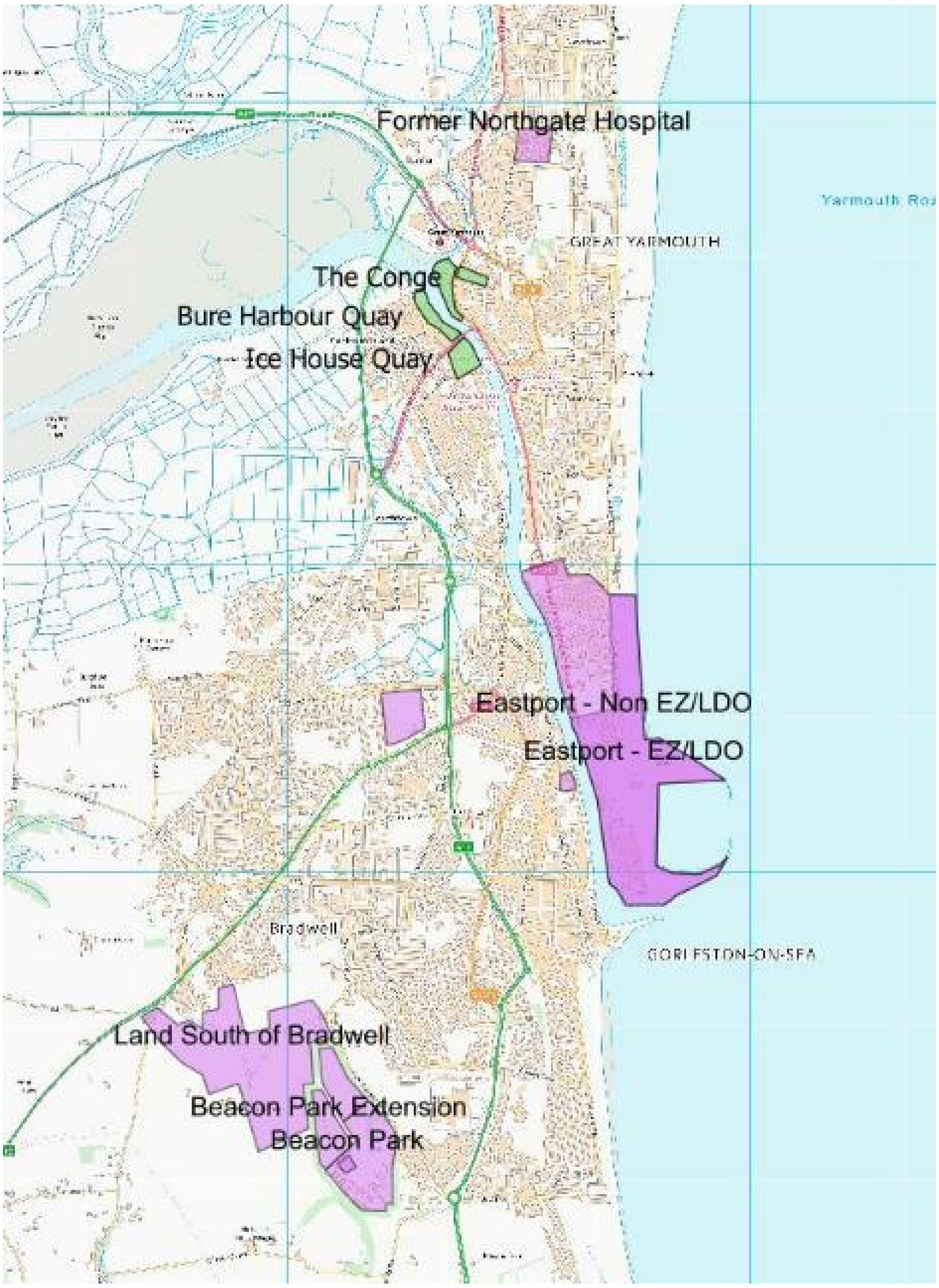
- The Eastport and South Denes Road Local Development Order covers the southern area of the Great Yarmouth peninsula and consists of only industrial and storage units. The development was included in the Core Scenario as it is assigned ‘more than likely’ status and is in close proximity to the new bridge scheme.
- Beacon Park is a mixed-use development located on the southern outskirts of Great Yarmouth. The development is based around the new A12/ A143 link road and is a combination of offices and industrial units. The development has been gauged as ‘more than likely’ and so developments within the given threshold are included in the Core Scenario.
- The Waterfront Area Action Plan is a regeneration plan encompassing several areas along the River Bure near Great Yarmouth town centre including North Quay, The Conge, Ice House Quay and Bure Harbour Quay as part of Great Yarmouth’s Local Development Framework. The development contains a variety of uses including residential buildings, offices, shops, restaurants and a hotel. This scheme has been quantified as ‘more than likely’ so developments within the given threshold are included in the Core Scenario.

4.4.4. Several other (mainly residential) developments are also included in the development assumptions.

4.4.5. The scale of these developments was provided to WSP in yearly summaries which have been grouped into those from 2018 to 2023 and from 2024 to 2038 to calculate trip totals for the respective future year scenarios.

4.4.6. The developments are identified in Plate 2.

Plate 2 - Great Yarmouth Development Locations



4.5. DEVELOPMENT TRIP GENERATION

4.5.1. For the developments above, trip rates were calculated using the TRICS (Version 7.3.3) software package. The TRICS software package is a database of observed arrivals and departures for a variety of sites and land use types across the UK, and is used to estimate trip generation for proposed developments. All developments contained within the development log were classified into the TRICS land uses and their respective trip rates generated using the TRICS software. All housing was classified as privately owned households. The different land uses within the employment were treated separately and then combined to generate a total number of trips arriving/leaving at each site.

4.5.2. The TRICS trip rates were agreed with NCC as part of the OBC assessment and it was not deemed necessary to update the trip rates for the DCO assessment.

4.5.3. The individual developments that have been included in the forecasting assumptions and their trip rates for 2023 and 2038 are shown in Table 2 and Table 3, the grouping of these developments into zones for matrix calculations are shown in Table 4 and Table 5.

Table 2 - Individual Developments for 2023

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2023					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Eastport (EZ/LDO)	B1 – Offices/ Industrial	More Than Likely	8238 m²	129	15	29	33	15	88
Eastport (EZ/LDO)	B2 – Industrial	More Than Likely	6850 m²	33	15	19	20	12	29
Eastport (EZ/LDO)	B8 – Storage	More Than Likely	63625 m²	92	51	85	90	64	98
South Denes (Non EZ/LDO)	B2 – Industrial	More Than Likely	2950 m²	14	7	8	9	5	12
South Denes (Non EZ/LDO)	B8 – Storage	More Than Likely	7160 m²	10	6	10	10	7	11
Beacon Park EZ/LDO	B2 –Industrial	More Than Likely	31760 m²	70	19	33	39	10	64
Beacon Park (15ha extension)	B1 – Offices	More Than Likely	6000 m²	82	10	15	18	10	48
Beacon Park (15ha extension)	B2 – Industrial	More Than Likely	11250 m²	25	7	12	14	4	23
Beacon Park Neighbourhood Centre	A1 – Food Superstore	Near Certain	4366 m²	152	112	255	251	233	235
Halls, Riverside Road	Residential	More Than Likely	104 dwellings	15	39	18	17	28	18

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2023					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Halls, Riverside Road	B1 – Offices	More Than Likely	2600 m²	56	8	15	15	9	44
Land South of Bradwell, Site A (Phase 1)	Residential	More Than Likely	64 dwellings	9	24	11	10	28	11
Land South of Bradwell, Site A (Phase 2-6)	Residential	More Than Likely	240 dwellings	28	89	39	38	67	43
Land South of Bradwell, Site B	Residential	More Than Likely	130 dwellings	19	49	23	21	35	23
Former Claydon School Site	Residential	More Than Likely	110 dwellings	16	41	19	18	29	19
Site 25, Beacon Park	Residential	More Than Likely	287 dwellings	33	106	47	45	80	52
Former Northgate Hospital Site	Residential	More Than Likely	79 dwellings	11	29	14	13	22	14
Land off Yarmouth Road, Ormesby St Margaret	Residential	More Than Likely	189 dwellings	22	70	31	30	53	34
Land west of Caister	Residential	More Than Likely	220 dwellings	26	82	36	34	62	40
Land west of Yarmouth Road, Hemsby	Residential	More Than Likely	93 dwellings	14	35	16	15	25	16
Land sout-east of Hopton, Hopton-on-Sea	Residential	More Than Likely	200 dwellings	23	74	33	31	56	36

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2023					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Former Mushroom Farm, Martham	Residential	More Than Likely	100 dwellings	15	37	17	16	27	17
Land north of Hemsby Road, Martham	Residential	More Than Likely	103 dwellings	15	39	18	17	28	18
Land south of Repps Road, Martham	Residential	More Than Likely	144 dwellings	21	54	25	23	38	25

Table 3 - Individual Developments for 2038

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Eastport (EZ/LDO)	B1 – Offices/ Industrial	More Than Likely	11988 m²	187	22	43	48	21	128
Eastport (EZ/LDO)	B2 – Industrial	More Than Likely	10600 m²	51	24	30	32	19	45
Eastport (EZ/LDO)	B8 – Storage	More Than Likely	93625 m²	135	75	125	132	94	144

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
South Denes (Non EZ/LDO)	B2 – Industrial	More Than Likely	2950 m²	14	7	8	9	5	12
South Denes (Non EZ/LDO)	B8 – Storage	More Than Likely	7160 m²	10	6	10	10	7	11
Beacon Park EZ/LDO	B2 –Industrial	More Than Likely	46760 m²	102	22	49	57	15	94
Beacon Park (15ha extension)	B1 – Offices	More Than Likely	21000 m²	309	28	24	25	18	129
Beacon Park (15ha extension)	B2 – Industrial	More Than Likely	26250 m²	57	16	27	32	8	53
Beacon Park Neighbourhood Centre	A1 – Food Superstore	Near Certain	4366 m²	152	112	255	251	233	235
North Quay (Area Action Plan)	Residential	More Than Likely	370 dwellings	39	153	67	63	122	73
North Quay (Area Action Plan)	B1 – Offices	More Than Likely	6200 m²	85	11	16	19	11	50
North Quay (Area Action Plan)	A1/ A3 – Shops/ Restaurants	More Than Likely	4100 m²	85	71	169	170	142	140
North Quay (Area Action Plan)	C1 – Hotel	More Than Likely	150 beds	23	37	15	18	21	19
The Conge (Area Action Plan)	Residential	More Than Likely	90 dwellings	13	34	16	15	24	16

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
The Conge (Area Action Plan)	A1/ A3 – Shops/ Restaurants	More Than Likely	3600 m²	75	62	149	149	125	123
Ice House Quay (Area Action Plan)	Residential	More Than Likely	450 dwellings	30	159	69	70	129	80
Ice House Quay (Area Action Plan)	B1 – Offices	More Than Likely	7000 m²	96	12	18	21	12	56
Ice House Quay (Area Action Plan)	A1/ A3 – Shops/ Restaurants	More Than Likely	6500 m²	135	112	268	269	226	222
Bure Harbour Quay (Area Action Plan)	Residential	More Than Likely	100 dwellings	15	37	17	16	27	17
Halls, Riverside Road	Residential	More Than Likely	104 dwellings	15	39	18	17	28	18
Halls, Riverside Road	B1 – Offices	More Than Likely	2600 m²	56	8	15	15	9	44
Land South of Bradwell, Site A (Phase 1)	Residential	More Than Likely	64 dwellings	9	24	11	10	28	11
Land South of Bradwell, Site A (Phase 2-6)	Residential	More Than Likely	700 dwellings	47	248	107	109	201	125
Land South of Bradwell, Site B	Residential	More Than Likely	130 dwellings	19	49	23	21	35	23
Former Claydon School Site	Residential	More Than Likely	110 dwellings	16	41	19	18	29	19

DEVELOPMENT	DEVELOPMENT TYPE	CERTAINTY	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
				AM		IP		PM	
				Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Site 25, Beacon Park	Residential	More Than Likely	287 dwellings	33	106	47	45	80	52
Former Northgate Hospital Site	Residential	More Than Likely	79 dwellings	11	29	14	13	22	14
Land off Yarmouth Road, Ormesby St Margaret	Residential	More Than Likely	189 dwellings	22	70	31	30	53	34
Land west of Caister	Residential	More Than Likely	850 dwellings	99	315	139	133	238	154
Land west of Yarmouth Road, Hemsby	Residential	More Than Likely	93 dwellings	14	35	16	15	25	16
Land south-east of Hopton, Hopton-on-Sea	Residential	More Than Likely	200 dwellings	23	74	33	31	56	36
Former Mushroom Farm, Martham	Residential	More Than Likely	100 dwellings	15	37	17	16	27	17
Land north of Hemsby Road, Martham	Residential	More Than Likely	103 dwellings	15	39	18	17	28	18
Land south of Repps Road, Martham	Residential	More Than Likely	144 dwellings	21	54	25	23	38	25

Table 4 - Grouped Developments for 2023 Forecast Matrices

DEVELOPMENT GROUPING	ZONE NUMBER	SIZE OF DEVELOPMENT	TRIP GENERATION 2023					
			AM		IP		PM	
			Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Eastport and South Denes Road LDO	714	8238 m² B1 (offices/ light industrial), 9800 m² B2 industrial and 70785 B8 storage	278	94	151	162	103	238
Beacon Park	707	43010 m² B2 industrial, 6000 m² B1 offices and 4366 m² A1 food superstore	328	148	315	322	257	369
Halls, Riverside Road	709	104 residential dwellings and 2600 m² B1 offices	72	47	33	32	37	62
Land South of Bradwell	705	459 residential dwellings	56	161	73	69	120	77
Former Claydon School Site	708	110 dwellings	16	41	19	18	29	19
Site 25, Beacon Park	706	287 dwellings	33	106	47	45	80	52
Former Northgate Hospital Site	710	79 dwellings	11	29	14	13	22	14
Land off Yarmouth Road, Ormesby St Margaret	712	189 dwellings	22	70	31	30	53	34
Land west of Caister	713	220 dwellings	26	82	36	34	62	40

DEVELOPMENT GROUPING	ZONE NUMBER	SIZE OF DEVELOPMENT	TRIP GENERATION 2023					
			AM		IP		PM	
			Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Land west of Yarmouth Road, Hemsby	20006	93 dwellings	14	35	16	15	25	16
Land south-east of Hopton, Hopton-on-Sea	55	200 dwellings	23	74	33	31	56	36
Former Mushroom Farm, Martham	20004	100 dwellings	15	37	17	16	27	17
Land north of Hemsby Road, Martham	20004	103 dwellings	15	39	18	17	28	18
Land south of Repps Road, Martham	20004	144 dwellings	21	54	25	23	38	25

Table 5 - Grouped Developments for 2038 Forecast Matrices

DEVELOPMENT GROUPING	ZONE NUMBER	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
			AM		IP		PM	
			Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Eastport and South Denes Road LDO	714	8238 m² B1 (offices/ light industrial), 9800 m² B2 industrial and 70785 B8 storage	278	94	151	162	103	238

DEVELOPMENT GROUPING	ZONE NUMBER	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
			AM		IP		PM	
			Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Beacon Park	707	43010 m² B2 industrial, 6000 m² B1 offices and 4366 m² A1 food superstore	328	148	315	322	257	369
Halls, Riverside Road	709	104 residential dwellings and 2600 m² B1 offices	72	47	33	32	37	62
Land South of Bradwell	705	459 residential dwellings	75	320	141	140	253	158
Former Claydon School Site	708	110 dwellings	16	41	19	18	29	19
Site 25, Beacon Park	706	287 dwellings	33	106	47	45	80	52
Former Northgate Hospital Site	710	79 dwellings	11	29	14	13	22	14
Land off Yarmouth Road, Ormesby St Margaret	712	189 dwellings	22	70	31	30	53	34
Land west of Caister	713	220 dwellings	26	82	36	34	62	40
Land west of Yarmouth Road, Hemsby	20006	93 dwellings	14	35	16	15	25	16
Land south-east of Hopton, Hopton-on-Sea	55	200 dwellings	23	74	33	31	56	36

DEVELOPMENT GROUPING	ZONE NUMBER	SIZE OF DEVELOPMENT	TRIP GENERATION 2038					
			AM		IP		PM	
			Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Former Mushroom Farm, Martham	20004	100 dwellings	15	37	17	16	27	17
Land north of Hemsby Road, Martham	20004	103 dwellings	15	39	18	17	28	18
Land south of Repps Road, Martham	20004	144 dwellings	21	54	25	23	38	25

4.6. HIGHWAY IMPROVEMENTS

4.6.1. The Uncertainty Log should also contain information on supply side changes which are anticipated within the study area. Since the 2017 forecast modelling a number of changes have been made to the status of several committed and proposed highway improvements. Key changes comprise the inclusion of the HE improvement schemes at the Vauxhall, Gapton and Station Access junctions in the forecast networks, and the Fullers Hill scheme which is now open.

4.6.2. An updated set of potential schemes and their status are listed in Table 6. Dependent upon scheme timing and level of certainty inclusion has been referenced by modelled year in columns 7 through 10 of the table. The table also shows whether each scheme will have an impact in the strategic model or not. Most of the schemes will have an impact except the relatively minor improvements to the rail station forecourt and Trafalgar Road.

Table 6 - Highway Improvements for Forecast Networks

SCHEME	LOCATION	OWNER	DESCRIPTION	CERTAINTY	IMPACT IN MODEL	2018	2023	2038	2051
Vauxhall Junction	*A47/ Runham Rd/ A149 Acle Rd/ A12*	*HE*	*Option 2, HE551491-ACM-HGN-VR-DR-HE-00011*	*More than likely*	*Yes*	*No*	*Yes*	*Yes*	*Yes*
Great Yarmouth Station Access	*A149 Acle New Rd /Station Access*	*HE*	*Option 9, HE551491-ACM-HGN-VR-DR-HE-00014-P01.3*	*Near Certain*	*Yes*	*No*	*Yes*	*Yes*	*Yes*
Gapton Junction	*A12/ Pasteur Road*	*HE*	*Option 1, HE551491-ACM-HGN-GR-DR-HE-00011*	*More than likely*	*Yes*	*No*	*Yes*	*Yes*	*Yes*
Harfreys Junction	*A12 / William Adamsway*	*HE*	*Option 1, HE551491-ACM-HGN-HR-DR-HE-00011*	*Hypothetical*	*Yes*	*No*	*No*	*No*	*No*
James Paget Hospital	*A12 Lowstoft Rd/ JP Hospital Access*	*HE*	*Option 1, HE551491-ACM-HGN-JP-DR-HE-00011*	*Hypothetical*	*Yes*	*No*	*No*	*No*	*No*
Fullers Hill	A149 Acle New Rd /Fullers Hill / N Quay	NCC	Fuller's Hill - SK01 211116, Programmed for 2018	Open	Yes	Yes	Yes	Yes	Yes
Bridge Rd	*A12 Lowstoft Rd/ Bridge Rd*	*HE*	*Option 1, HE551491-*	*Hypothetical*	*Yes*	*No*	*No*	*No*	*No*

			ACM-HGN-BR-DR-HE-00011						
Improvements to Rail Station Forecourt and Surrounding Highways	Station Forecourt	NCC	PK6060-HP1-037 Consultation Plan One	Near Certain	*No*	*No*	*Yes*	*Yes*	*Yes*
Improvements to the North Quay and The Conge	North Quay and The Conge	NCC	PK6060-HP1-038 Consultation Plan Two	Near Certain	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Great Yarmouth Trafalgar Rd Improvements	Trafalgar Rd/ Marine Parade/ Nelson Rd	NCC	PE1022-HP1-013 Phase 1 - Shared Use Facility Only	Near Certain	*No*	*No*	*Yes*	*Yes*	*Yes*
Possible congestion improvement	South Quay/Yarmouth Way	NCC		Reasonably Foreseeable	*Yes*	*No*	*No*	*No*	*No*
Possible congestion improvement	Southtown Road/Pasteur Road/Bridge Road	NCC		Reasonably Foreseeable	*Yes*	*No*	*No*	*No*	*No*
Possible congestion improvement	Town centre locations TBD	NCC		Reasonably Foreseeable	*Yes*	*No*	*No*	*No*	*No*

4.7. SENSITIVITY TESTS ON GROWTH ASSUMPTIONS

4.7.1. In accordance with advice provided in TAG Unit M4 sensitivity tests were developed to test the uncertainty regarding future growth.

4.7.2. This relies on the proportion of base year demand added to the demand from the core scenario.

4.7.3. Unit M4 Section 4.2 provides the guidelines on how to derive the test demands as described below:

- *for 1 year after the base year, proportion p of base year demand added to the core scenario;*
- *for 36 or more years after the base year, proportion 6*p of base year demand added to the core scenario;*
- *between 1 and 36 years after the base year, the proportion of base year demand should rise from p to 6*p in proportion with the square root of the years. (So, for example, 16 years after the base year the proportion is 4*p).*

For highway demand at the national level, the value of p is 2.5%, reflecting uncertainty around annual forecasts from the National Transport Model (NTM), based on the macro-economic variables that influence the main drivers of travel demand.

4.7.4. Hence the high and low alternatives are presented below as:

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

4.7.5. The resulting growth factors that were applied to the Core scenario matrices are presented in Table 7.

Table 7 - Sensitivity Tests - Growth Factors

FUTURE YEAR	PERCENTAGE ADJUSTMENT FACTOR	LOW ADJUSTMENT (% OF BASE DEMAND)	HIGH ADJUSTMENT (% OF BASE DEMAND)
2023	5.6	0.944	1.056
2038	11.2	0.888	1.112
2051	14.4	0.856	1.144

4.7.6. The adjustment factors were applied across the matrices to encompass both background growth and specific development trips.

4.8. FUTURE COST PARAMETERS

4.8.1. The values of time and operating costs, provided in the TAG databook, that feed into the generalised cost equation have been updated from July 2016 to December 2017 (release v1.9.1). Tables 8 presents the cost parameters adopted for this study for the Base year, the opening and the design year respectively.

Generalised Cost = Time + (PPK / PPM) x Distance

Where:

PPK = Distance related cost in pence per Kilometre

PPM = Time related cost in pence per minute

Table 8 - Generalised Cost Parameters

USER CLASS	TIME PERIOD	2018		2023		2038		2051	
		ppm	ppk	ppm	ppk	ppm	Ppk	ppm	ppk
Car Work	AM Peak	30.72	12.26	32.29	12.14	42.28	11.54	55.54	11.76
	Inter Peak	31.48	12.26	33.09	12.14	43.33	11.54	55.89	11.76
	PM Peak	31.17	12.26	32.76	12.14	42.89	11.54	55.33	11.76
Car Commute	AM Peak	20.60	5.75	21.65	5.67	28.36	5.43	36.58	5.70
	Inter Peak	20.94	5.75	22.01	5.67	28.82	5.43	37.17	5.70
	PM Peak	20.68	5.75	21.73	5.67	28.45	5.43	36.70	5.70

Car Other	AM Peak	14.22	5.75	14.94	5.67	19.56	5.43	25.24	5.70
	Inter Peak	15.14	5.75	15.91	5.67	20.84	5.43	26.88	5.70
	PM Peak	14.89	5.75	15.65	5.67	20.49	5.43	26.43	5.70
LGV	AM Peak	21.72	13.49	22.82	13.73	29.89	13.40	38.55	13.73
	Inter Peak	21.72	13.49	22.82	13.73	29.89	13.40	38.55	13.73
	PM Peak	21.72	13.49	22.82	13.73	29.89	13.40	38.55	13.73
HGV	AM Peak	50.71	46.86	53.29	49.83	69.78	54.62	90.02	56.51
	Inter Peak	50.71	46.86	53.29	49.83	69.78	54.62	90.02	56.51
	PM Peak	50.71	46.86	53.29	49.83	69.78	54.62	90.02	56.51

5. FUTURE YEAR NETWORK CONFIGURATIONS

5.1. INTRODUCTION

5.1.1. This chapter of the report describes the development of the future year highway network models. These include the initial Do Minimum (or Without-Intervention case) networks and subsequent Do Something (or With-Intervention case) networks for Opening (2023), Design (2038) and Horizon Year (2051).

5.1.2. These future year networks were developed from the base year networks by coding in committed and proposed highway improvement schemes, based on the information obtained from NCC. Reference was made to the updated uncertainty log when selecting the schemes for inclusion.

5.1.3. In summary, the three networks considered in this report are:

1. Do Minimum (DM) – The validated 2018 base Great Yarmouth road network, plus DM schemes coded.

2. Do Something (DS) – The DM networks plus the Great Yarmouth Third River Crossing Option 32 scheme.

5.1.4. The following section explains this network development process.

5.2. DO MINIMUM NETWORKS

5.2.1. The validated base networks now contain the following completed schemes:

- Improvements to the Fuller's Hill roundabout; and
- Improvements to North Quay and The Conge.

5.2.2. The following changes have been made to the validated base networks to create the DM networks:

- Improvements to Vauxhall roundabout;
- Improvements to Great Yarmouth Station Access; and
- Improvements to Gapton roundabout.

5.2.3. The wide area forecast DM network is shown in Plate 3 and the location of the improvement schemes are shown in Plate 4. All developments included will be complete by 2023 (see Table 6).

Plate 3 - Do Minimum Network

Plate 4 - Base and Do Minimum Improvement Locations

5.3. DO SOMETHING NETWORK

5.3.1. The Do Something network combines the Do Minimum network and the Third River Crossing improvement scheme. The wide area Do Something coding is included in Plate 5. The detail of Option 32 scheme, shown in Plate 6, is summarised below:

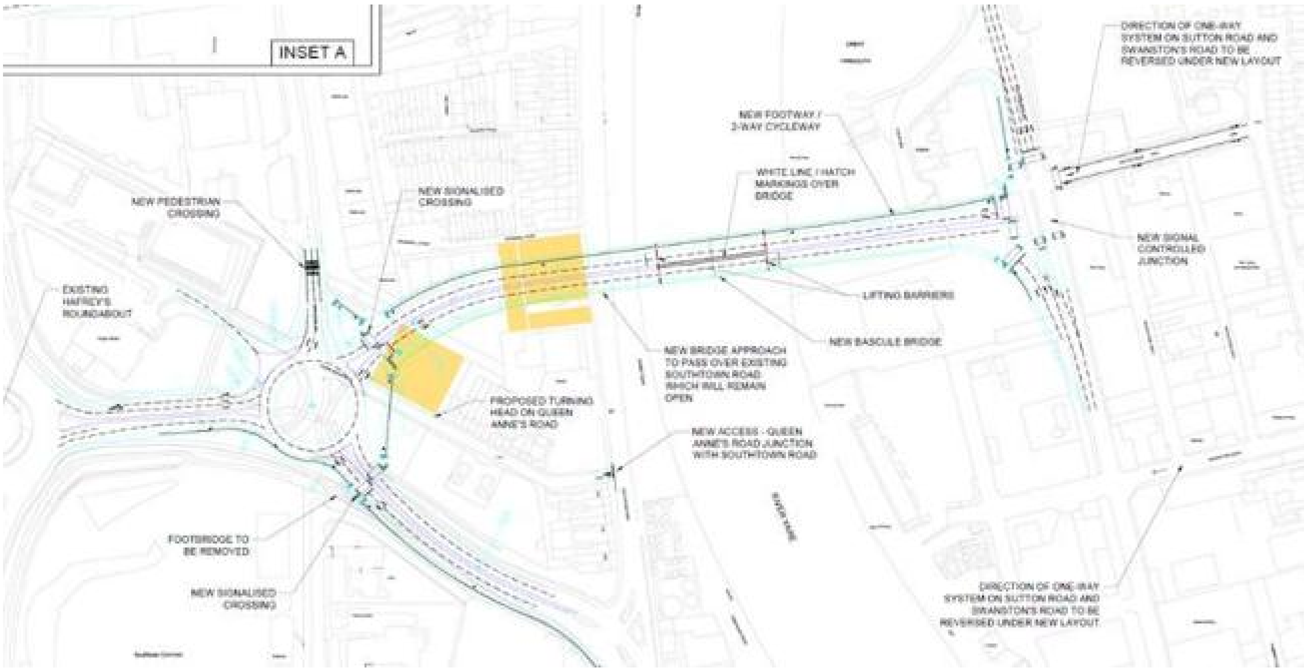
5.3.2. Option 32 comprises a four lane bridge which ties back into the local road network on the western side at a proposed new roundabout with William Adams Way/Suffolk Road. The western approach to the bridge from the new roundabout will pass over Southtown Road, which will remain open to traffic. William Adams Way will be realigned to accommodate the new roundabout and bridge approach and tie into the strategic road network at Harfrey's roundabout.

5.3.3. At the eastern side, the bridge will tie back into South Denes Road at a new signalised junction close to Sutton Road.

5.3.4. A change of direction is proposed on the one-way Sutton Rd to make it an exit from the new signal junction. A corresponding change of direction is also proposed for Swanston's Rd to the south. These proposed changes will reduce the number of conflict movements at the proposed signal junction whilst maintaining the flow of traffic in the local area for the east-west movements between South Denes Road and Admiralty Road.

Plate 5 - Do Something Network

Plate 6 – Do Something (Option 32) Scheme Detail



5.4. NETWORK CHECKS

5.4.1. Networks were coded in line with the protocols developed as part of the base model construction. Checks were conducted on the coded networks. These included:

- Checks on the distance;
- Checks on capacity of link and turns;
- Checks on free flow speed and speed limit; and
- Select link analyses on DM and DS network (with TEMPro growth matrices) to check for logical trip routing.

5.4.2. These checks were carried out to ensure the forecast networks were appropriate for application in the future year models.

6. FUTURE YEAR TRAVEL DEMANDS

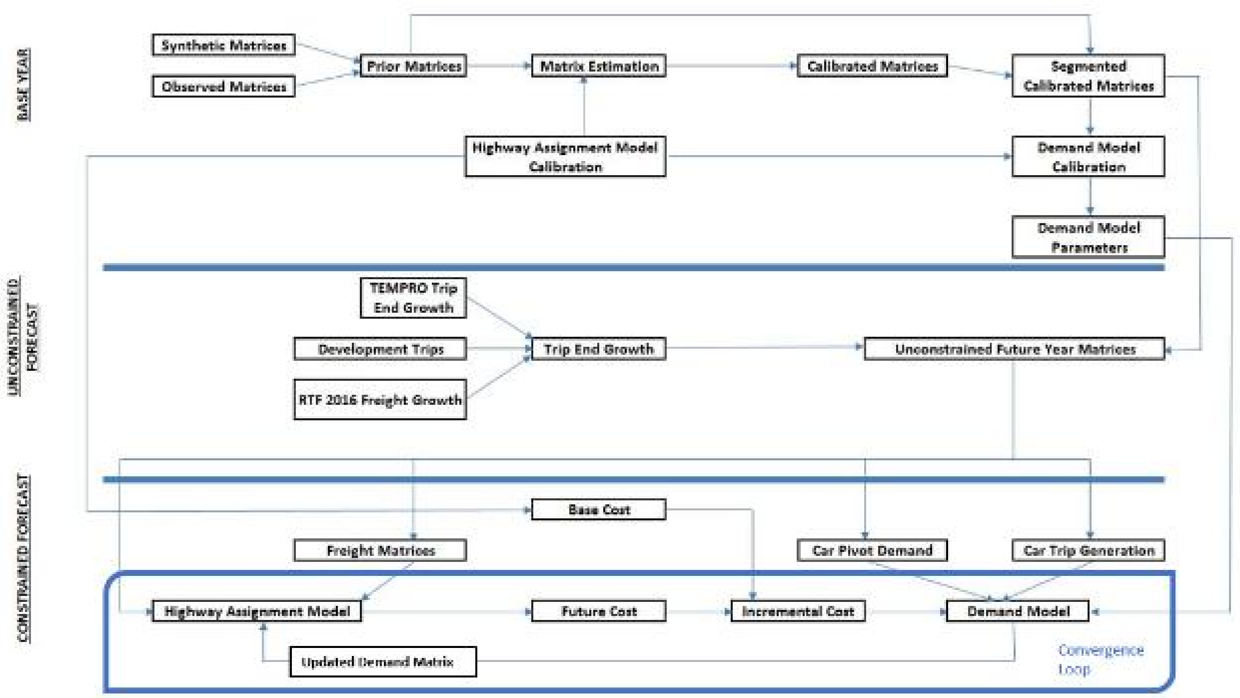
6.1. INTRODUCTION

6.1.1. Detailed guidance on the forecasting process using transport models and the derivation of future year travel demands using growth factors is given in TAG unit M4.

6.1.2. Plate 7 below provides a summary of the Forecasting Process and shows the Base Model Calibration (GYTM) and Forecasting Model GYVDM). The processes involved in creating the Forecast model output matrices are discussed in this section. This follows distinct stages of:

- Apply growth from TEMPro 7.2 (updated from TEMPro 7);
- Build development Matrices;
- Merge development and background growth matrices;
- Control to TEMPro 7.2; and
- Output the Future Calibrated Segmented Matrices.

Plate 7 - Forecast Development Process



6.2. MATRIX SEGMENTATION

6.2.1. Matrix processing was undertaken at a level of traveller segmentation that allows correlation to land use to be maintained and different characteristics of travellers to be forecast. The segmentation was derived from the Prior Matrices, which are built from observed and synthetic data and include the following traveller segmentation.

Table 9 - Modelled Journey Purposes

TRIP PURPOSE	SEGMENT		MODELLED APPROACH
	Short name	Long name	
1	HBW	Home Based Work	PA
2	HBO	Home Based Other	PA
3	HBEB	Home Based Employers Business	PA
4	NHBEB	Non Home Based Employers Business	OD
5	NHBO	Non Home Based Other	OD
6	LGV	Light Goods Vehicle	OD
7	OGV	Other Goods Vehicles	OD

Table 10 - Modelled Hours

PERIOD	DESCRIPTION	TIMING	MODELLED APPROACH
1	AM Peak	0800-0859	Peak hour assignment & demand model
2	Inter Peak	1000-1529	Average hour assignment & demand model
3	PM Peak	1630-1729	Peak hour assignment & demand model

6.2.2. The purposes and direction are aggregated to the following Flow Groups, or User Classes, for use in the GYTM.

Table 11 - Assignment User Classes

CLASS	DESCRIPTION	COMPOSITION
1	Commute	HBW
2	Other	HBE, HBO, NHBO
3	Employers Business	EB, NHBEB
4	LGV	LGV
5	OGV	OGV

6.3. BASE YEAR MATRIX DEVELOPMENT

6.3.1. Base matrix calibration used the Flow Group aggregated matrices as the starting Prior Matrices for each of the three one hour assignment periods, indicated above. This process is documented in the Local Model Validation Report (LMVR) and includes the use of Matrix Estimation (ME). The ME process applied changes to specific cells within the Prior Matrices to produce the Calibrated

Matrices. The ME output Calibrated Matrices represented the start of the preparation of future year travel matrices.

6.3.2. Following the completion of the ME process the ME change factors were applied back to the fully segmented Prior Matrices to produce the 2016 Base Calibrated Segmented Matrices. The 2018 model update was restricted to network changes only with no changes to the 2016 base matrix.

6.4. DEVELOPMENT MATRICES

6.4.1. The next stage in preparing the future matrices was to convert the Uncertainty Log information into the Development Matrices. The Uncertainty Log provides development information for the three peak assignment periods by Vehicle. As discussed previously there are three future years of 2023, 2038 and 2051, and three main travel Scenarios including:

- Core Scenario;
- Low Demand Growth Scenario; and
- High Demand Growth Scenario.

6.4.2. Tables 4 and 5 provide a summary of the trips for each Scenario and Year.

6.4.3. The next stage was to add the zone number associated with each development and identify the different types of land use within the development. Two principle types of land were included in the Uncertainty Log of:

- E – Employment; and
- R – Residential.

6.4.4. The development in / out trips needed converting to full traveller segmentation so the Development Matrices could be merged with the Base Calibrated Segmented Matrices.

6.5. TEMPRO GROWTH FACTORS

6.5.1. The second source of traffic growth was extracted from the Trip End Model Presentation Program (TEMPro) software. TEMPro provides projections of growth over time for use in local and regional transport models. Based on the outputs provided by the Department's National Trip End Model (NTEM), it presents projections of growth in planning data, car ownership, and resulting growth in trip-making by different modes under a constant cost assumption.

6.5.2. TEMPro includes travel by vehicles owned by households but does not include freight vehicles. Forecasts of freight traffic (available by region, road type and vehicle class) were provided by the National Transport Model (NTM).

6.5.3. The TEMPro 7.2 dataset was used to forecast growth at local zone level. The growth in each local traffic zone was adjusted to allow for new developments and was ultimately controlled to the TEMPro target growth total at district level.

6.5.4. Growth factors for cars have been applied for the periods 2018-2023, 2018-2038, and 2018-2051 for the assignment hours:

6.5.5. Growth factors were obtained for the four different levels of Geographic Area available in TEMPro (Region, County, Local Authority, and TEMPro Zone), forming 32 sectors which include all the traffic model zones. A breakdown of these sectors by TEMPro Geographic Area (from high to low level) is provided below:

- Regional Level: 6 sectors including the rest of the East Of England, South East, London, North East, North West, York & Humber, East Midlands, South West, West Midlands;
- Local Authority level: 13 sectors including Broadland, Norwich, South Norfolk, North Norfolk, Waveney, South Holland, Breckland, Mid Suffolk, Suffok Coastal, Ipswich, King's Lynn, Cambridge and St Edmundsbury;
- MSOA level: 13 sectors within Great Yarmouth.

6.5.6. Table 12 shows the description of the TEMPro zones and the corresponding districts. Table 13 shows the description of the districts. Growth factors extracted from TEMPro are presented in Appendix B.

6.6. APPLICATION OF TEMPRO GROWTH

6.6.1. Applying TEMPro growth used a two stage process which involved firstly constraining development growth at TEMPro zone level and by purpose and time period, and then constraining to the TEMPro by District growth and by time period.

6.6.2. The Base Calibrated Segmented Matrices were allocated to the TEMPro zone level and the TEMPro growth applied to provide an estimate of future year trip ends. The Development Matrices were also allocated to TEMPro zones for comparison with the matrices produced by applying TEMPro growth to the base year demand.

6.6.3. If the Base + Development trip ends were greater than the Base + TEMPro growth trip ends then the Base + Development trip ends were used. If the Base + Development trip ends were lower than the Base + TEMPro growth trip ends then the Base + TEMPro growth trip ends were used. The Base * TEMPro growth trip ends was mostly used as the development growth could be largely accommodated within the TEMPro growth.

6.6.4. These growths were then applied to the Base Calibrated Segmented Matrices and a Furness procedure was used to growth the matrix. This process controlled the overall matrix total to the Production trip end total for HB trips and an average of the Origin and Destination trip end totals for NHB purposes.

6.6.5. The second stage in this process was to aggregate the 2018 demand matrices to the District sector level and, now using an OD format, apply the Origin and Destination TEMPro district trip end growth by time period. This process controlled the overall matrix total to an average of the Origin and Destination trip end estimates and provided the ultimate future year growth targets. These trip ends were then applied back to the matrices created during the first stage to ensure District sector growth was controlled to TEMPro.

6.6.6. The headline magnitude of the matrices created within the demand build are included in Table 14 and Appendix C.

6.7. LGV AND HGV GROWTH FACTORS

6.7.1. Growth factors for Light and Heavy goods vehicles were obtained from the DfT's 'Road Traffic Forecasts (RTF) 2015' document. The forecasts are produced by the ITEA division of the DfT using the National Transport Model (NTM). The NTM provides detailed growth factors at regional level. It is consistent with TEMPro 7.2.

6.7.2. The NTM is a multi-modal model of land-based transport in Great Britain. This provides a systematic means of comparing the national consequences of alternative national transport policies or widely-applied local transport policies, against a range of background scenarios which take into account the major factors affecting future patterns of travel. Although the NTM is essentially a passenger transport model, freight road traffic is modelled for the purpose of assessing the impact of freight vehicles on congestion.

6.7.3. Heavy goods vehicle traffic growth is modelled using the Great Britain Freight Model (GBFM) which takes base year data from 2004 on international and domestic freight movements for 15 different commodities. The model then grows the traffic over time by modelling the effect of changes in macroeconomic variables and also changes in generalised cost. Light goods vehicle traffic is projected by a separate time series model relating LGV kilometres in a given year to the levels of GDP and fuel price.

6.7.4. The growth figures are central forecasts and represent percentage changes on base year values.

6.7.5. Goods vehicle growth was applied at a regional level as outlined in TAG. These growth factors are presented in detail in Table 15 below.

Table 12 - TEMPro Zones and Districts

DESCRIPTION	TEMPRO SECTOR	DISTRICT	REGION
Great Yarmouth 006 (E02005543)	1	3	East of England
Great Yarmouth 005 (E02005542) 002 (E02005539)	2	3	East of England
Great Yarmouth 004 (E02005541)	3	3	East of England
Great Yarmouth 003 (E02005540)	4	3	East of England
Great Yarmouth 007 (E02005544) 006 (E02005543)	5	3	East of England
Great Yarmouth 008 (E02005545)	6	3	East of England
Great Yarmouth 009 (E02005546)	7	3	East of England
Great Yarmouth 010 (E02005547)	8	3	East of England
Great Yarmouth 011 (E02005548) 013 (E02005550)	9	3	East of England
Great Yarmouth 013 (E02005550) 012 (E02005549)	10	3	East of England
Waveney 001 (E02006302)	11	5	East of England
Great Yarmouth 001 (E02005538)	12	3	East of England
Great Yarmouth 002 (E02005539)	13	3	East of England
Broadland	14	1	East of England
Norwich	15	8	East of England
South Norfolk	16	2	East of England

DESCRIPTION	TEMPRO SECTOR	DISTRICT	REGION
North Norfolk	17	4	East of England
Waveney	18	5	East of England
South Holland	19	11	UK
Breckland	20	6	East of England
Mid Suffolk	21	9	UK
Suffolk Coastal	22	9	UK
Ipswich	23	9	UK
King's Lynn and West Norfolk	24	7	East of England
Cambridge	25	9	UK
St Edmundsbury	26	9	UK
LON	27	10	London
Parts of SE	28	9	UK
Parts of SE	29	9	UK
SW and Parts of SE	30	9	UK
Midlands	31	11	UK
North	32	12	UK

Table 13 - District Sectors

DISTRICT	DESCRIPTION
1	Broadland
2	South Norfolk
3	Great Yarmouth
4	North Norfolk
5	Waveney
6	Breckland
7	King's Lynn and West Norfolk
8	Norwich
9	EAST_Other, SE, SW
10	LON
11	Midlands
12	North

Table 14 - 24 Hour Person Trips by Purpose

TOTAL	FORMAT	2018	2023	2038	2051
HBW	PA	22,987	23,968	25,565	27,100

TOTAL	FORMAT	2018	2023	2038	2051
HBE	PA	11,082	12,437	14,575	15,972
HBO	PA	81,416	87,613	97,698	107,447
HBB	PA	3,194	3,398	3,703	3,981
NHBO	OD	50,663	54,217	60,511	66,313
NHBEB	OD	8,190	8,545	9,151	9,822
SUM		**177,532**	**190,178**	**211,203**	**230,635**

Table 15 - NTM 2015 LGV and HGV Growth

	GROWTH INDEX					
REGION	2018 – 2023		2018 - 2038		2018 - 2051	
	LGV	HGV	LGV	HGV	LGV	HGV
NE	1.128615	1.030855	1.475244	1.133764	1.758437	1.230165
YH	1.128701	1.035429	1.474826	1.151933	1.756754	1.261418
EM	1.128366	1.034933	1.476954	1.148363	1.762637	1.257995
EAST	1.128143	1.049912	1.475597	1.209344	1.760851	1.360992
SE	1.128159	1.050285	1.475758	1.209331	1.759355	1.360709
LON	1.123088	1.029679	1.453429	1.127271	1.721556	1.218593
SW	1.128817	1.030338	1.477718	1.132975	1.763660	1.230124
WM	1.128491	1.035491	1.476064	1.151552	1.760241	1.261527
NW	1.128305	1.033585	1.474171	1.146734	1.755423	1.252466
WALES	1.129844	1.033836	1.480459	1.145356	1.767812	1.252368

6.8. FORECAST MATRIX TOTALS

6.8.1. Overall assignment matrix totals are presented in Table 16.

Table 16 - Assignment Matrices plus Development Matrices by Time Period – Core (PCU)

	CATEGORY	2018	2023	2038	2051	% DIFFERENCE 2018 to 2023	2018 to 2038	2018 to 2051
				AM Peak				
1	Emp Bus.	868	905	993	1,076	4%	14%	24%

	CATEGORY	2018	2023	2038	2051	% DIFFERENCE 2018 to 2023	2018 to 2038	2018 to 2051
2	Commute	5,114	5,318	5,806	6,264	4%	14%	22%
3	Other	7,895	8,461	9,911	11,016	7%	26%	40%
4	LGV	2,453	2,767	3,619	4,318	13%	48%	76%
5	HGV	1,318	1,382	1,588	1,783	5%	20%	35%
	Total	**17,648**	**18,832**	**21,916**	**24,457**	**7%**	**24%**	**39%**
	Development Trips	-	1,629	4,205	4,205			
	Background Trips	-	17,648	18,049	20,523			
				Inter Peak				
1	Emp Bus.	950	989	1,081	1,166	4%	14%	23%
2	Commute	1,507	1,560	1,689	1,801	3%	12%	19%
3	Other	9,967	10,717	12,651	14,047	8%	26%	41%
4	LGV	1,875	2,115	2,767	3,301	13%	48%	76%
5	HGV	1,249	1,310	1,504	1,688	5%	20%	35%
	Total	**15,549**	**16,692**	**19,691**	**22,004**	**7%**	**24%**	**42%**
	Development Trips	-	1,587	3,827	3,827			
	Background Trips	-	15,549	16,212	18,425			
				PM Peak				
1	Emp Bus.	895	934	1,023	1,107	4%	14%	24%
2	Commute	4,605	4,776	5,196	5,565	4%	13%	21%
3	Other	10,082	10,735	12,459	13,764	6%	24%	37%
4	LGV	2,093	2,361	3,088	3,685	13%	48%	76%
5	HGV	745	782	900	1,012	5%	20%	36%
	Total	**18,420**	**19,589**	**22,666**	**25,133**	**6%**	**23%**	**36%**
	Development Trips	-	1,634	4,403	4,403			
	Background Trips	-	18,420	18,621	20,982			

6.9. SENSITIVITY TEST INPUTS

6.9.1. As described previously, variants around the core scenario have been developed as follows:

- Low Demand Growth; and
- High Demand Growth

6.9.2. As well as including national growth variation the same tests also included pessimistic development growth for the low test and optimistic development growth for the high growth test. This was calculated using the TAG methodology outlined in Section 4.7. Tables 17 and 18 present the low and high growth respectively.

Table 17 - Low Growth & Pessimistic Development Trips (PCU)

CATEGORY		2018	2023	2038	2051	% DIFFERENCE 2018 to 2023	2018 to 2038	2018 to 2051
AM Peak								
1	Emp Bus.	868	857	895	952	-1%	3%	10%
2	Commute	5,114	5,032	5,235	5,530	-2%	2%	8%
3	Other	7,895	8,019	9,028	9,882	2%	14%	25%
4	LGV	2,453	2,630	3,345	3,966	7%	36%	62%
5	HGV	1,318	1,308	1,440	1,594	-1%	9%	21%
Total		**17,648**	**17,846**	**19,943**	**21,923**	**1%**	**13%**	**24%**
Development Trips		-	1,521	3,711	3,581			
Background Trips		-	16,589	16,473	18,537			
Inter Peak								
1	Emp Bus.	950	936	974	1,030	-2%	3%	8%
2	Commute	1,507	1,476	1,521	1,585	-2%	1%	5%
3	Other	9,967	10,160	11,536	12,616	2%	16%	27%
4	LGV	1,875	2,010	2,557	3,032	7%	36%	62%
5	HGV	1,249	1,240	1,364	1,509	-1%	9%	21%
Total		**15,549**	**15,822**	**17,952**	**19,771**	**2%**	**15%**	**27%**
Development Trips		-	1,482	3,378	3,259			
Background Trips		-	14,625	14,838	16,693			
PM Peak								
1	Emp Bus.	895	884	923	979	-1%	3%	9%
2	Commute	4,605	4,519	4,681	4,904	-2%	2%	6%
3	Other	10,082	10,171	11,332	12,316	1%	12%	22%
4	LGV	2,093	2,244	2,854	3,385	7%	36%	62%
5	HGV	745	741	816	905	-1%	10%	21%
Total		**18,420**	**18,559**	**20,606**	**22,488**	**1%**	**12%**	**22%**
Development Trips		-	1,524	3,886	3,761			
Background Trips		-	17,310	16,977	18,911			

Table 18 - High Growth & Optimistic Development Trips (PCU)

CATEGORY	2018	2023	2038	2051	% DIFFERENCE 2018 to 2023	2018 to 2038	2018 to 2051
AM Peak							

	CATEGORY	2018	2023	2038	2051	% DIFFERENCE 2018 to 2023	2018 to 2038	2018 to 2051
1	Emp Bus.	868	954	1,090	1,201	10%	25%	38%
2	Commute	5,114	5,604	6,378	6,998	10%	25%	37%
3	Other	7,895	8,902	10,794	12,150	13%	37%	54%
4	LGV	2,453	2,904	3,893	4,670	18%	59%	90%
5	HGV	1,318	1,456	1,735	1,972	10%	32%	50%
	Total	**17,648**	**19,819**	**23,889**	**26,992**	**12%**	**35%**	**53%**
	Development Trips	-	1,737	4,699	4,819			
	Background Trips	-	18,708	19,624	22,509			
	Inter Peak							
1	Emp Bus.	950	1,042	1,187	1,303	10%	25%	37%
2	Commute	1,507	1,644	1,858	2,018	9%	23%	34%
3	Other	9,967	11,275	13,765	15,479	13%	38%	55%
4	LGV	1,875	2,220	2,976	3,571	18%	59%	90%
5	HGV	1,249	1,380	1,643	1,868	10%	32%	50%
	Total	**15,549**	**17,561**	**21,429**	**24,237**	**12%**	**38%**	**56%**
	Development Trips	-	1,692	4,276	4,395			
	Background Trips	-	16,472	17,586	20,157			
	PM Peak							
1	Emp Bus.	895	984	1,123	1,236	10%	26%	38%
2	Commute	4,605	5,034	5,710	6,226	9%	24%	35%
3	Other	10,082	11,299	13,586	15,212	12%	35%	51%
4	LGV	2,093	2,478	3,322	3,986	18%	59%	90%
5	HGV	745	824	983	1,119	11%	32%	50%
	Total	**18,420**	**20,619**	**24,725**	**27,778**	**12%**	**34%**	**51%**
	Development Trips	-	1,740	4,918	5,055			
	Background Trips	-	19,530	20,265	23,054			

7. CORE SCENARIO OUTPUTS

7.1. INTRODUCTION

7.1.1. This section provides a summary of the model outputs used to assess the DM and DS Network Configuration performance when combined with the various travel Scenarios. It also contains details of key model statistics that are later used in the appraisal process.

7.2. MODEL CONVERGENCE

7.2.1. Convergence is the measure used to determine model stability during the assignment process. A suitably converged model can be expected to produce consistent outputs with minimal model noise.

7.2.2. The convergence criteria recommended in TAG Unit M3.1 (January 2014) are given in Table 19 below.

Table 19 - TAG Convergence Criteria

MEASURE OF CONVERGENCE	BASE MODEL ACCEPTABLE VALUES
Delta and % Gap	less than 0.1% or at least stable with convergence fully documented and all other criteria met
percentage of links with flow change (P) < 1%	four consecutive iterations greater than 98%
percentage of links with cost change (P2) < 1%	four consecutive iterations greater than 98%
Percentage change in total user costs (V)	Four consecutive iterations > 0.1%

7.2.3. Details of the model performance are included in Appendix D.

7.2.4. The statistics show that all three models for each time period reached convergence within between 19 and 81 assignment iterations. These ensure that both fixed demand and variable demand forecasting outputs are consistent and sufficiently stable.

7.2.5. Demand / Supply convergence has been described in the Variable Demand Model Report submitted as part of the OBC (document reference: 1076653-MOU-GEN-XX-TN-TP-0004). The model was deemed converged when a %GAP of less 0.1 is achieved.

7.3. TABULAR AND GRAPHICAL HIGHWAY NETWORK SUMMARY STATISTICS

7.3.1. The following summary highway network tabular and graphical information is provided:

1. total number of assigned trips;
2. total network travelled distance as vehicle kilometres;
3. total network travelled time as vehicle hours; and
4. average network speeds.

7.3.2. Modelled flows and link travel times in the vicinity of the TRC scheme, comparing the DM and the DS, are also plotted against a simple network background. Plots of the AADT flow difference between the DM and DS are also provided to further indicate the impact of the scheme. Tables and plots of forecast flows for key parts of the highway network within the study area are also appended.

7.4. SCENARIOS REPORTED

7.4.1. The following scenarios are reported:

- Core scenario (TEMPro V7.2)

7.5. CORE SCENARIO

7.5.1. The TRC flow volumes and traffic relief across the River Screenline (see Plate 8) is demonstrated in Table 20 below.

Plate 8 – River Screenline

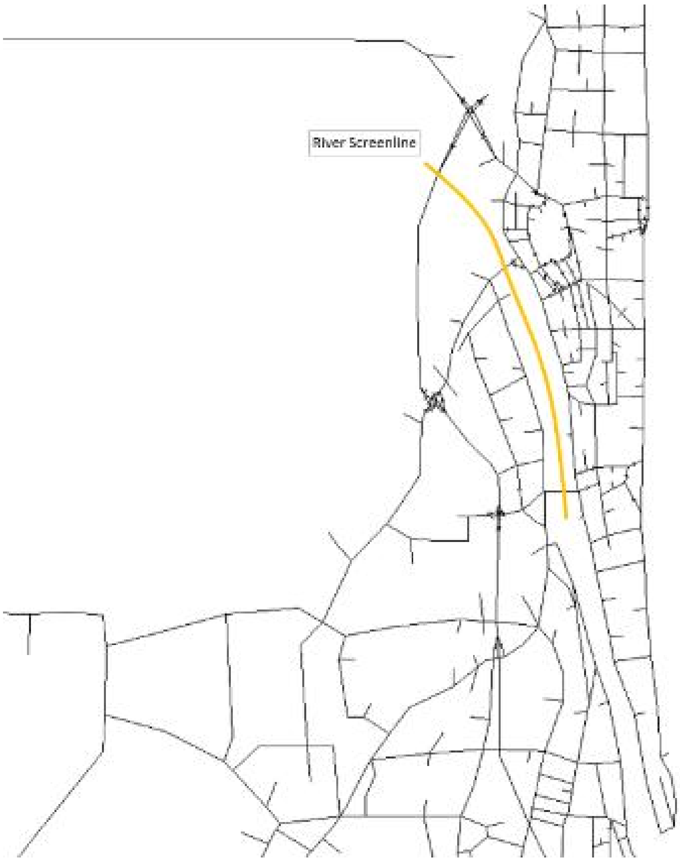


Table 20 - River Screenline Traffic Relief - Fixed Demand

ROAD	2018	2023 DM	2038 DM	2051 DM	2023 DS	2038 DS	2051 DS
AADT Flows							
A47	31,415	35,254	39,664	39,678	31,211	35,180	36,782
Bridge Road	21,457	25,513	32,749	36,378	12,050	19,094	22,101
TRC	0	0	0	0	18,812	21,147	24,830
Sum	52,871	60,768	72,414	76,056	62,073	75,422	83,713
Flow Change							
		Increase from Base	Increase from DM 2023	Increase from DM 2038	Increase from DM 2023	Increase from DM 2038	Increase from DM 2051
A47		12%	13%	0%	-11%	-11%	-7%
Bridge Road		19%	28%	11%	-53%	-42%	-39%
TRC							
Sum		15%	19%	5%	2%	4%	10%

7.5.2. Traffic volumes increase on Bridge Road with each successive forecast year in the DM. The traffic volume on the A47 (at Breydon Bridge) shows limited growth beyond 2023 indicating that the route will have reached capacity by 2038.

7.5.3. The TRC opening has the greatest impact on traffic volumes on Bridge Road. Traffic on this route shows growth year-on-year indicating sufficient route capacity for continued growth.

7.5.4. All DS scenarios show an increase in flow volume across the Bridge Screenline as traffic held within queues is released, resultant from the additional network capacity.

7.6. NETWORK PERFORMANCE

7.6.1. Travel distance and time are reported in Plate 9 and Plate 10. Speeds are shown in Plate 11. Traffic patterns show declining speed across the modelled area into the future. Inter-Peak networks operate at a higher speed and the PM peak operates at the lowest speed. All figures are included in Table 21. The introduction of the TRC (DS) positively impacts the network in each case.

Plate 9 - Travel Distance by Scenario Fixed Demand

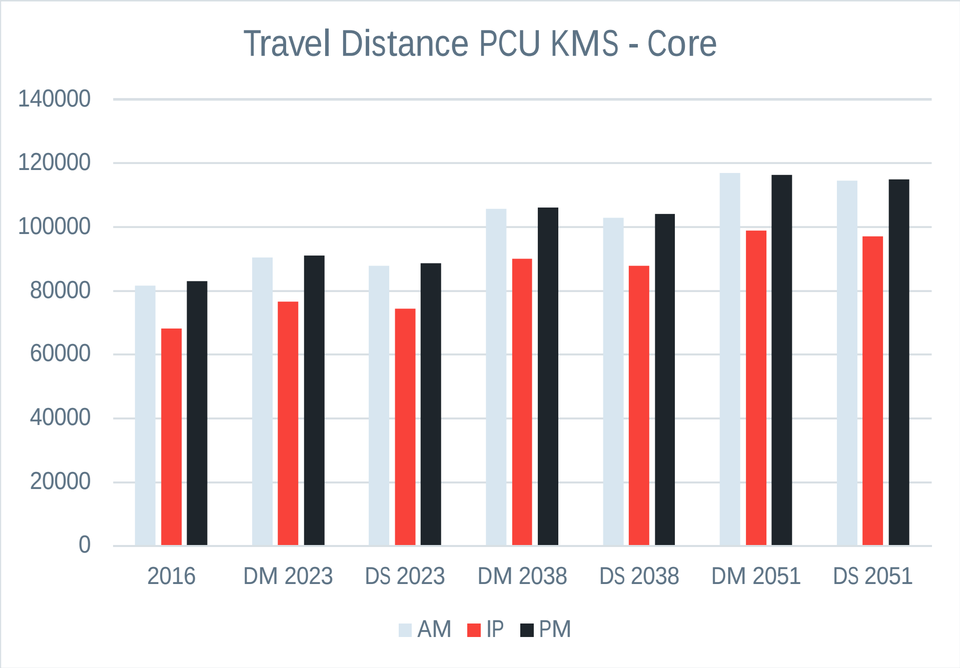


Plate 10 - Travel Time by Scenario – Fixed Demand

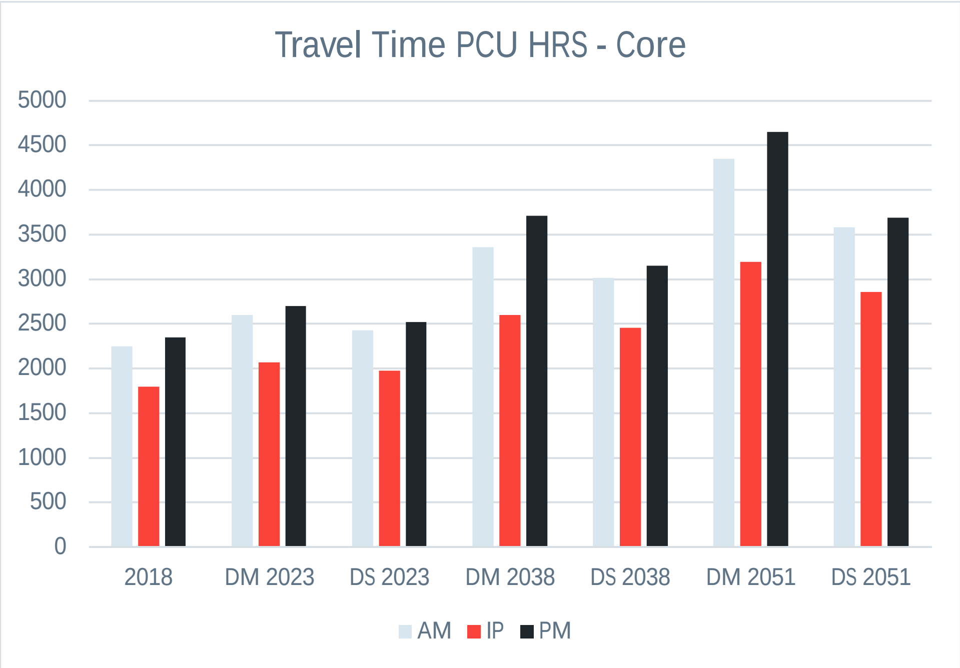


Plate 11 - Travel Speed by Scenario- Fixed Demand

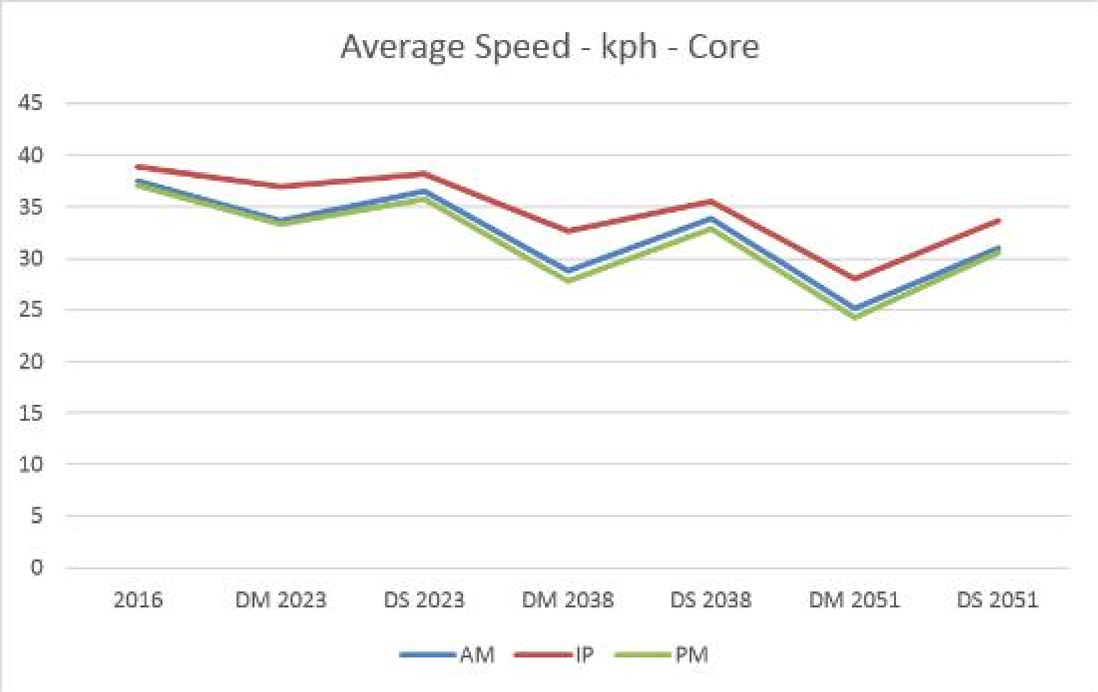


Table 21 - Core Area Assignment – Fixed Demand

ATTRIBUTE	2016	DM 2023	DS 2023	DM 2038	DS 2038	DM 2051	DS 2051
PCU KMS							
AM	81,592	90,263	87,845	105,521	102,830	116,933	114,376
IP	68,180	76,416	74,305	90,016	87,739	98,771	97,040
PM	82,933	91,043	88,484	105,992	103,922	116,215	114,737
PCU HRS							
AM	2,247	2,597	2,421	3,354	3,014	4,342	3,576
IP	1,790	2,068	1,970	2,592	2,456	3,190	2,856
PM	2,344	2,696	2,520	3,710	3,149	4,644	3,684
Speed kph							
AM	36	35	36	32	34	27	32
IP	38	37	38	35	36	31	34
PM	35	34	35	29	33	25	31

7.7. TRAFFIC PATTERNS

7.7.1. The increase in traffic flow due to fixed demand growth assignment for 2023, 2038 and 2051 are included in Appendix E. Heaviest growth occurs on the A47 corridor from the south of the town with the A1243 Bridge Road also showing heavy growth through the forecast years.

7.7.2. Traffic relief resulting from the TRC occurs in the areas expected, namely the northern sections of the A47, the A1243 and the A149 from the A47 into the Town Centre.

7.8. MATRIX VALUES

7.8.1. The reference matrix is compressed into 10 sectors, included in Appendix F.

8. VARIABLE DEMAND MODEL OUTPUTS

8.1. INTRODUCTION

8.1.1. This section provides the results of the Variable Demand forecasting process whereby the previously unconstrained demand forecasts are modified in response to future changes in travel costs to create the constrained demand forecasts. Iterations of the demand/ supply loop continue until these converge to a stable solution. This chapter reports on the Core Scenario.

8.1.2. Given the large number of the forecast runs and statistics only the Core scenario results are described in detail. However overall impacts for Low and High growth alternatives and sensitivity tests are also included later in the report.

8.2. FLOW IMPACTS

8.2.1. Traffic flow on the TRC and traffic relief on the other River Crossings is indicated below in Table 22. Some trip growth on the TRC can be seen in comparison to the fixed demand assignment. In comparison, the other bridges show a general reduction in trips, particularly on the Bridge Road crossing in both the DM and DS. Overall there is a reduction in trips on the river screenline in the DM while the level of trips in the DS remains roughly the same with a slight increase in 2023, and slight decreases in 2038 and 2051 compared to the fixed demand assignments. The trip reduction is largely due to the impact of the updated values of time (particularly for car business) used in the revised VDM which have resulted in a suppression of trips in the VDM DM and DS assignments compared to the fixed demand assignments.

Table 22 - River Screenline Traffic Relief VDM

ROAD	2018	2023 DM	2038 DM	2051 DM	2023 DS	2038 DS	2051 DS
AADT Flows							
A47	31,415	33,885	39,193	39,489	30,600	34,959	36,732
Bridge Road	21,457	24,143	30,296	34,454	12,121	18,623	21,768
TRC	0	0	0	0	19,420	21,702	24,912
Sum	52,871	58,028	69,489	73,943	62,140	75,283	83,412
Flow Change							
		Increase from Base	Increase from DM 2023	Increase from DM 2038	Increase from DM 2023	Increase from DM 2038	Increase from DM 2051
A47		8%	16%	1%	-10%	-11%	-7%

ROAD	2018	2023 DM	2038 DM	2051 DM	2023 DS	2038 DS	2051 DS
Bridge Road		12%	25%	14%	-50%	-39%	-37%
TRC							
Sum		10%	20%	6%	7%	8%	13%

8.2.2. Appendix G includes VDM flow difference plots demonstrating the catchment area of the TRC and the flow relief afforded by the scheme.

8.3. MATRIX CHANGES

8.3.1. The Variable Matrix runs involve Demand Model matrix changes in response to changes in travel cost as predicted by the highway Supply Model. As such, before any network information is considered, it is first important to understand the changes to the travel matrices output from the converged demand / supply model looping.

8.3.2. Appendix H provides vehicle highway matrix totals for all permutations of Scenario, Network Configuration, year and period, and for the three model User Classes of:

- Car Commute;
- Car Other; and
- Car EB.

8.3.3. It should be noted that LGV and HGV are not subject to the demand model and are therefore not reported.

8.3.4. The Vehicle totals are reported for the Unconstrained (input) and Constrained (output) matrices for both DM and DS. Sectorised outputs by time period and daily are included. The locations of the sectors are given in Plate 12 and Table 23 below.

8.3.5. Flow changes by sector are also reported in a subsequent set of tables.

Plate 12 - VDM Sectors

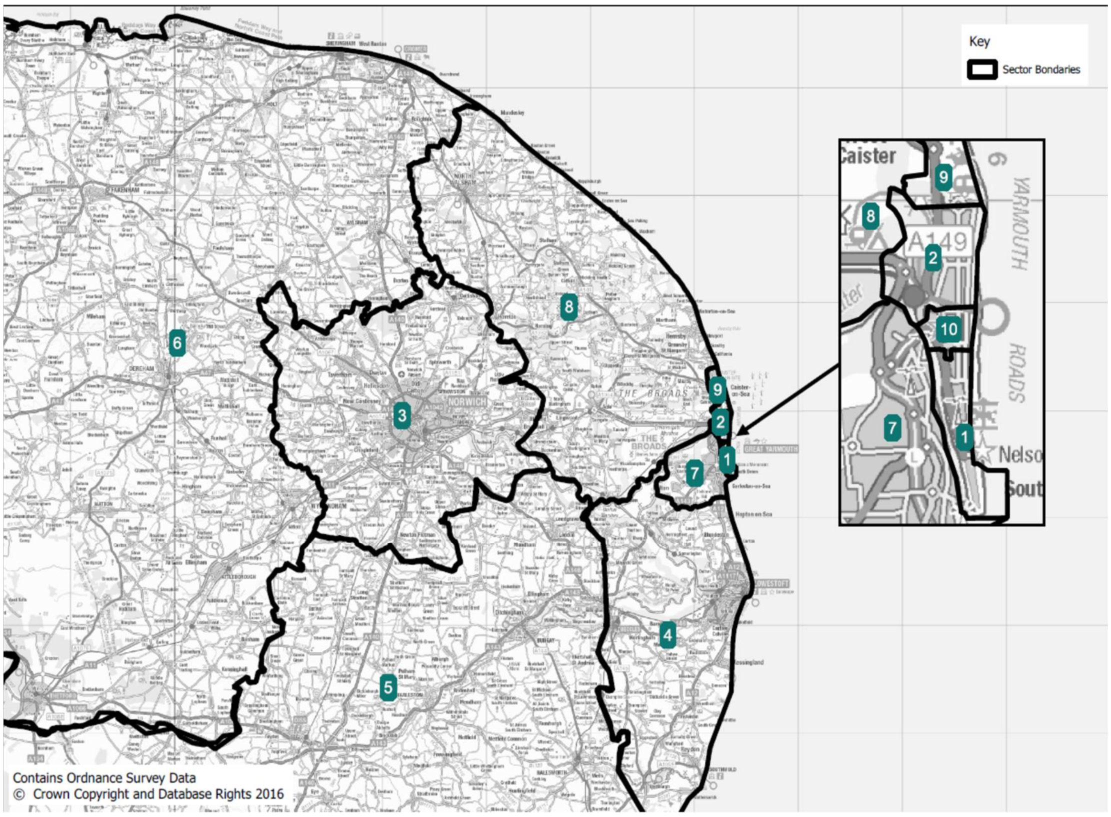


Table 23 - VDM Sectors

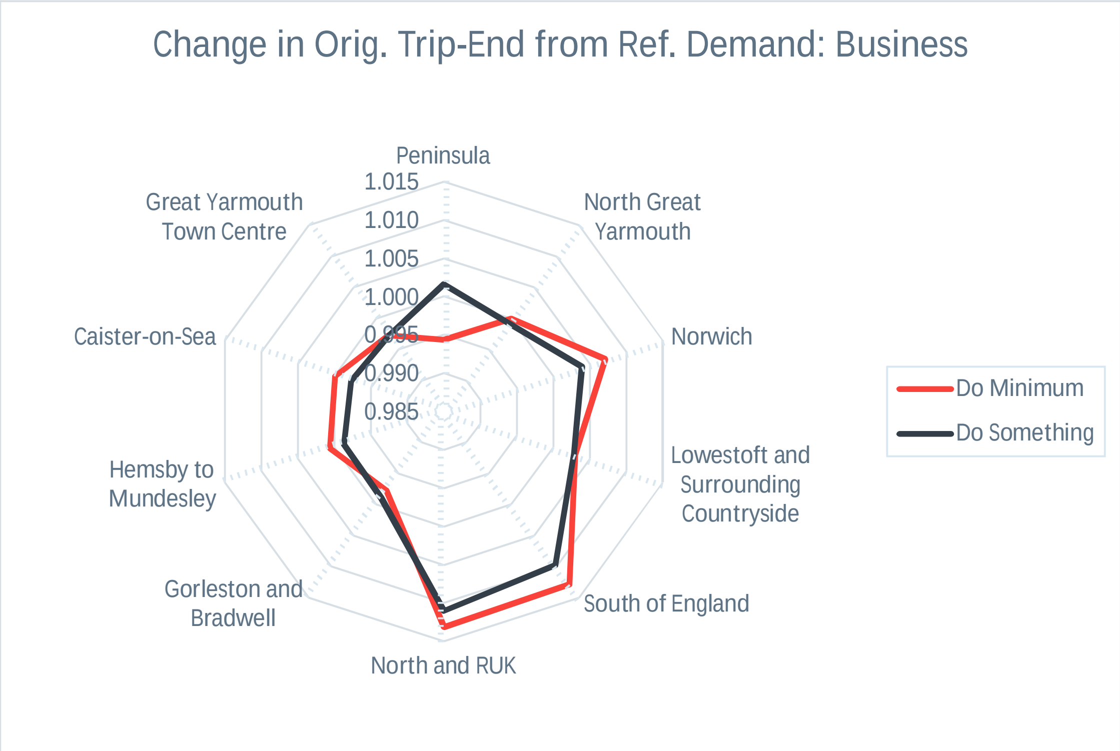
DISTRICT	DESCRIPTION
1	Peninsula
2	North Great Yarmouth
3	Norwich
4	Lowestoft and Surrounding Countryside
5	South of England
6	North and RUK
7	Gorleston and Bradwell
8	Hemsby to Mundesley
9	Caister-on-Sea
10	Great Yarmouth Town Centre

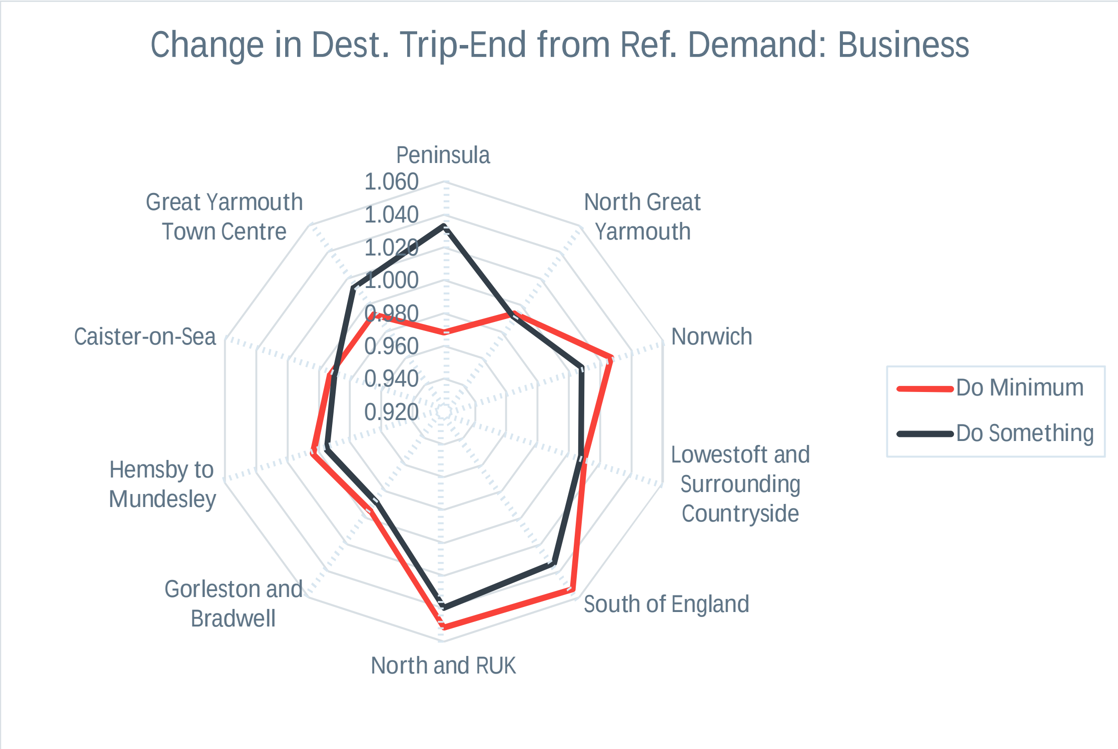
8.3.6. Plate 13, Plate 14 and Plate 15 below show constrained matrix change at a sector level. The diagrams demonstrate daily origins and destinations by sector in terms of trip induction or suppression from reference, for both DM and DS. Figures less than 1.00 indicate suppression for a sector and in excess of 1.00 indicates induction.

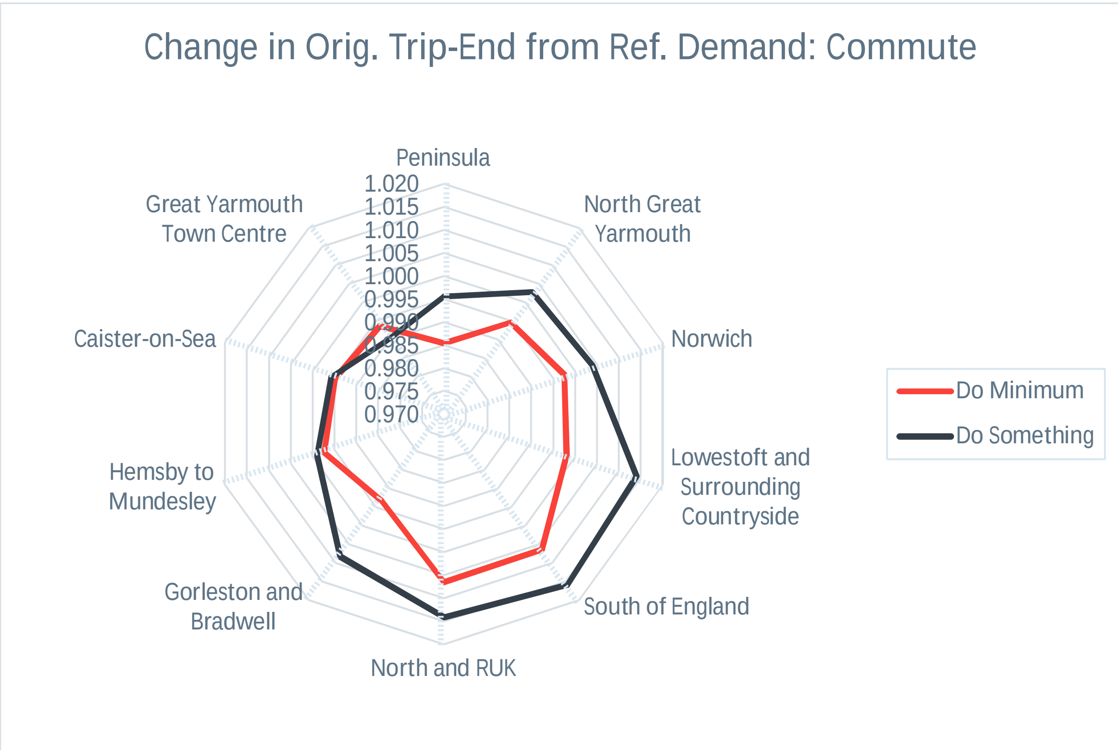
8.3.7. Plate 13 considers the 2023 models. For all car user classes, there is trip induction in the DM compared to the base in Sectors representing the wider South and North of England. In general, the longer distance movements experience a slight cost reduction within the demand model pivot, leading to a modest gain in trips. This is facilitated by DM network changes relative to the change in trips. In addition, in the DS compared to the DM, there is trip induction in the Sector representing the Peninsula. "Other" trip purposes are impacted the most, correctly reflecting the relative sensitivity of this user class. Business trips are impacted the least.

8.3.8. Plate 14 and Plate 15 consider the 2038 and 2051 models respectively. Patterns of trip change between reference and VDM scenario are similar to 2023, with the level of trip induction in the DS being generally greater, reflective of the increased network provision. The raised induction levels for longer distance movement stem from the changing mix of time and distance components within generalised cost over the forecast horizon.

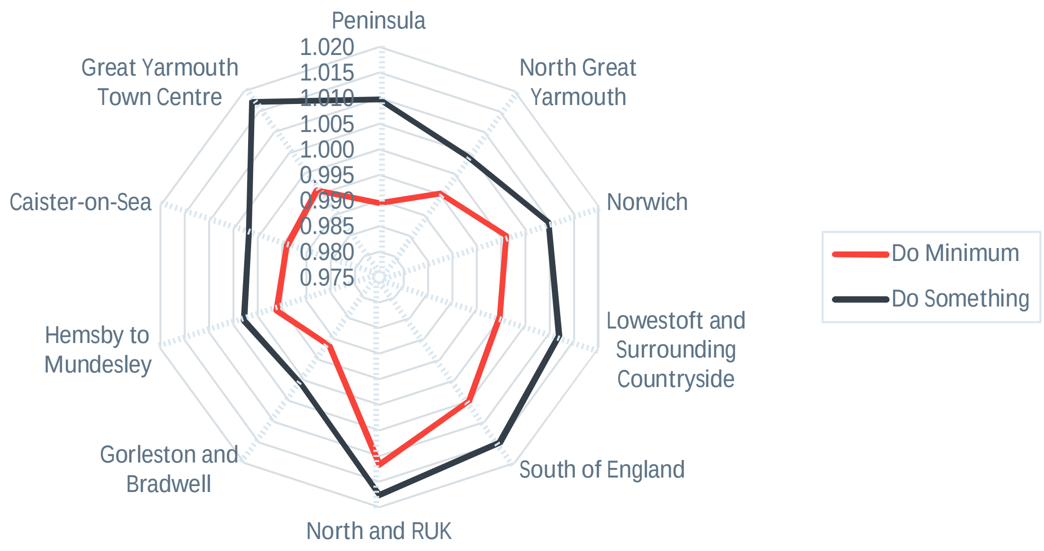
Plate 13 - Constrained Matrix Changes at Sector Trip End Level – 2023



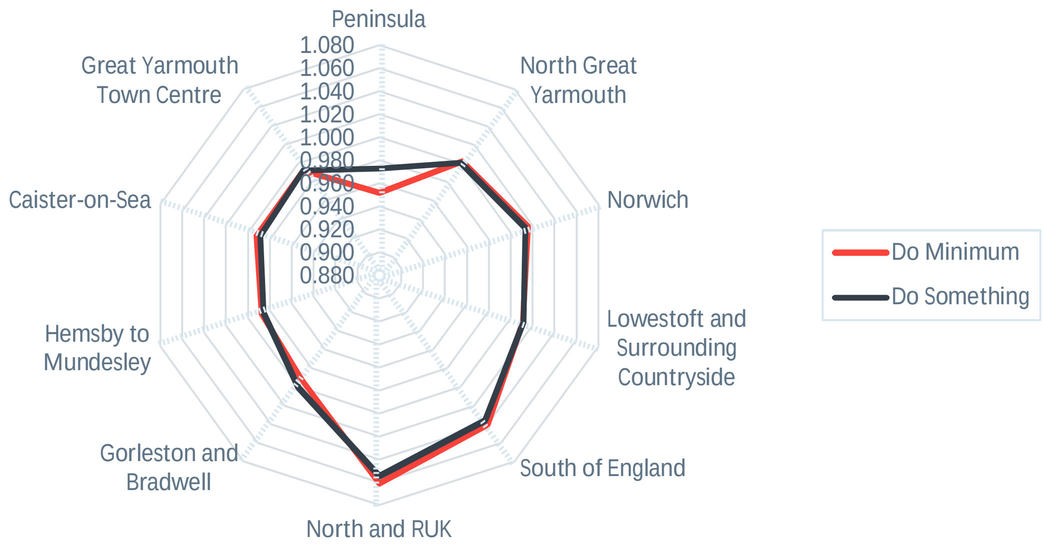

Change in Dest. Trip-End from Ref. Demand: Business
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
Do Minimum
Do Something


Change in Orig. Trip-End from Ref. Demand: Commute
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.020
1.015
1.010
1.005
1.000
0.995
0.985
0.980
0.975
0.970
Do Minimum
Do Something

Change in Dest. Trip-End from Ref. Demand: Commute



Change in Orig. Trip-End from Ref. Demand: Other



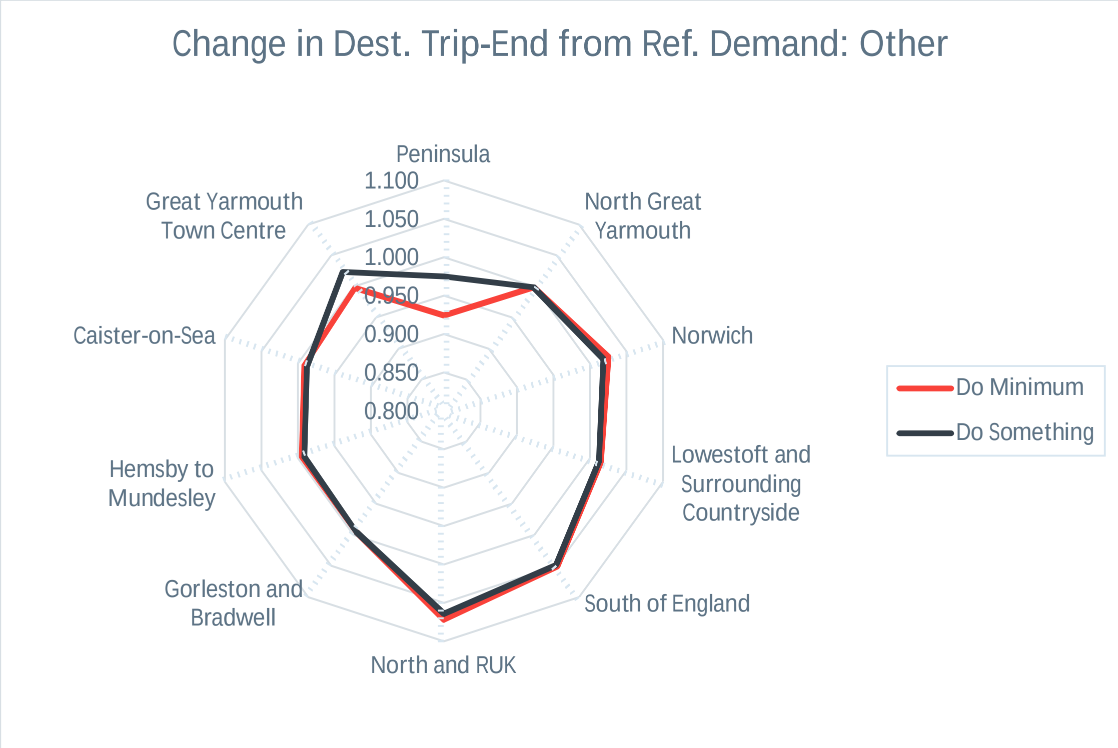
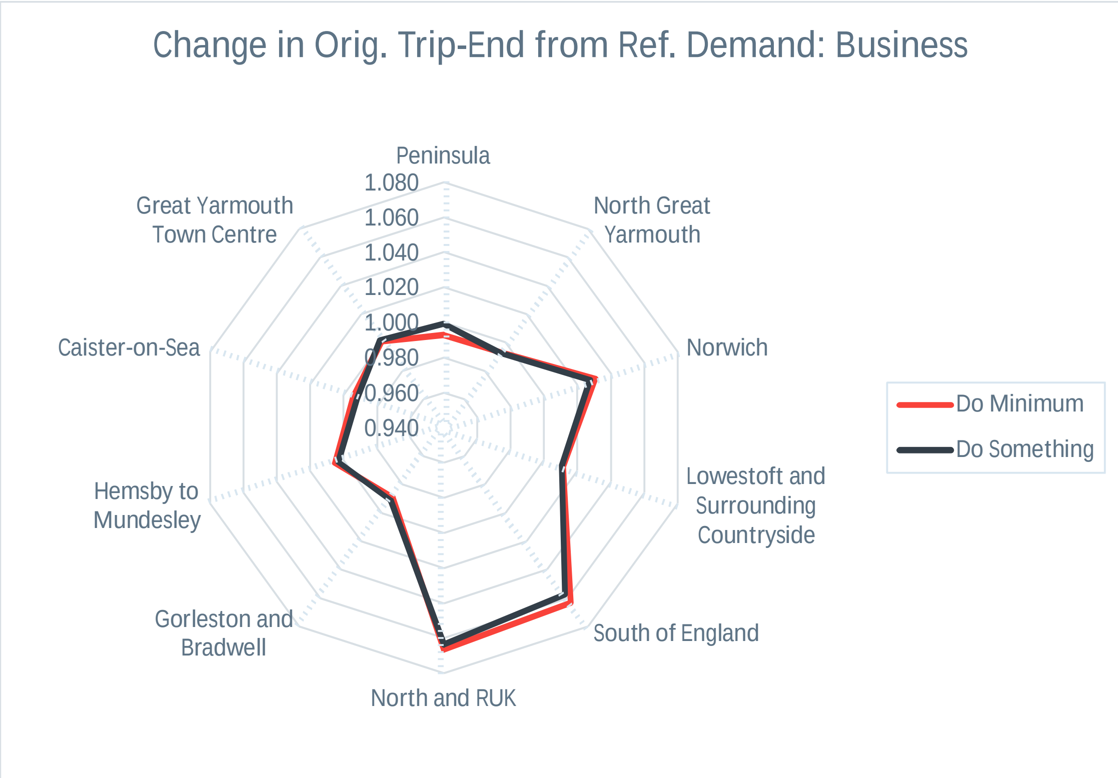
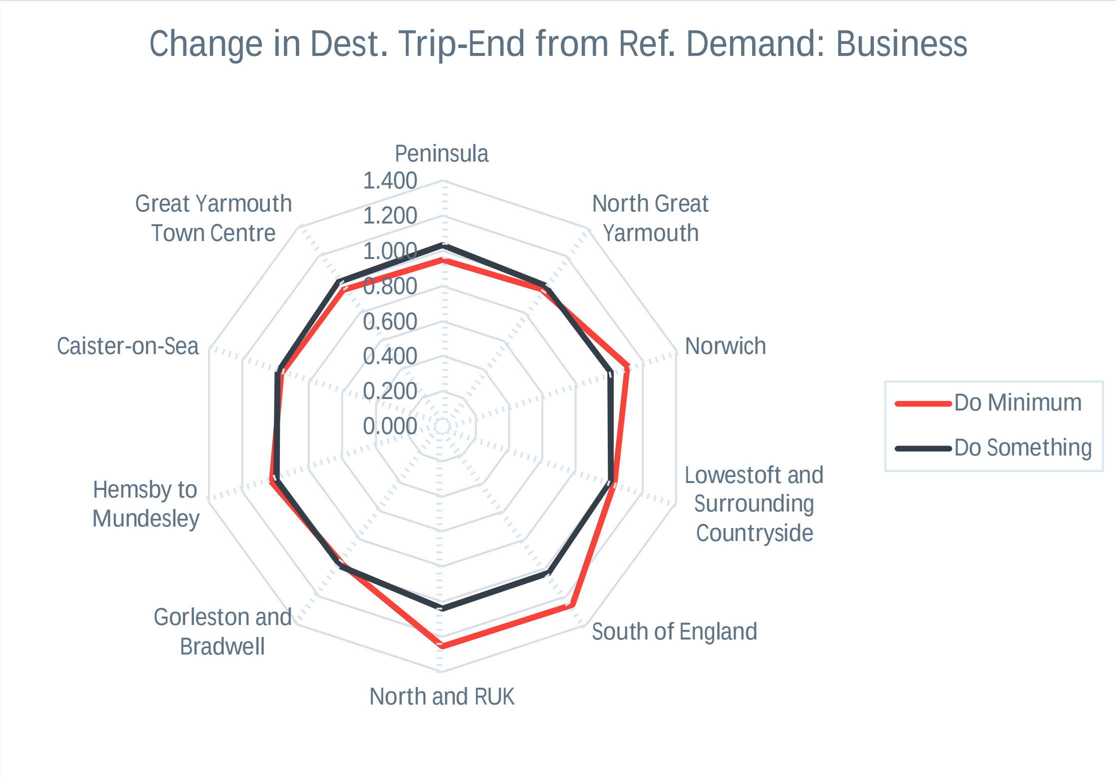
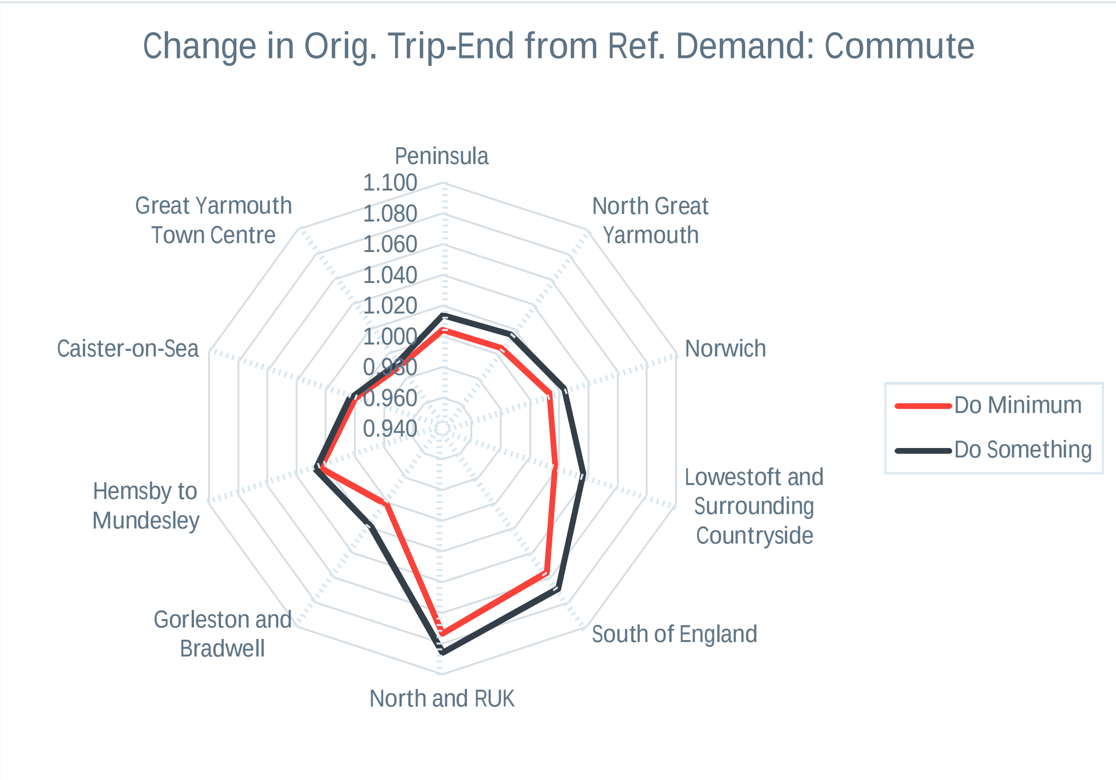


Plate 14 - Constrained Matrix Changes at Sector Trip End Level – 2038

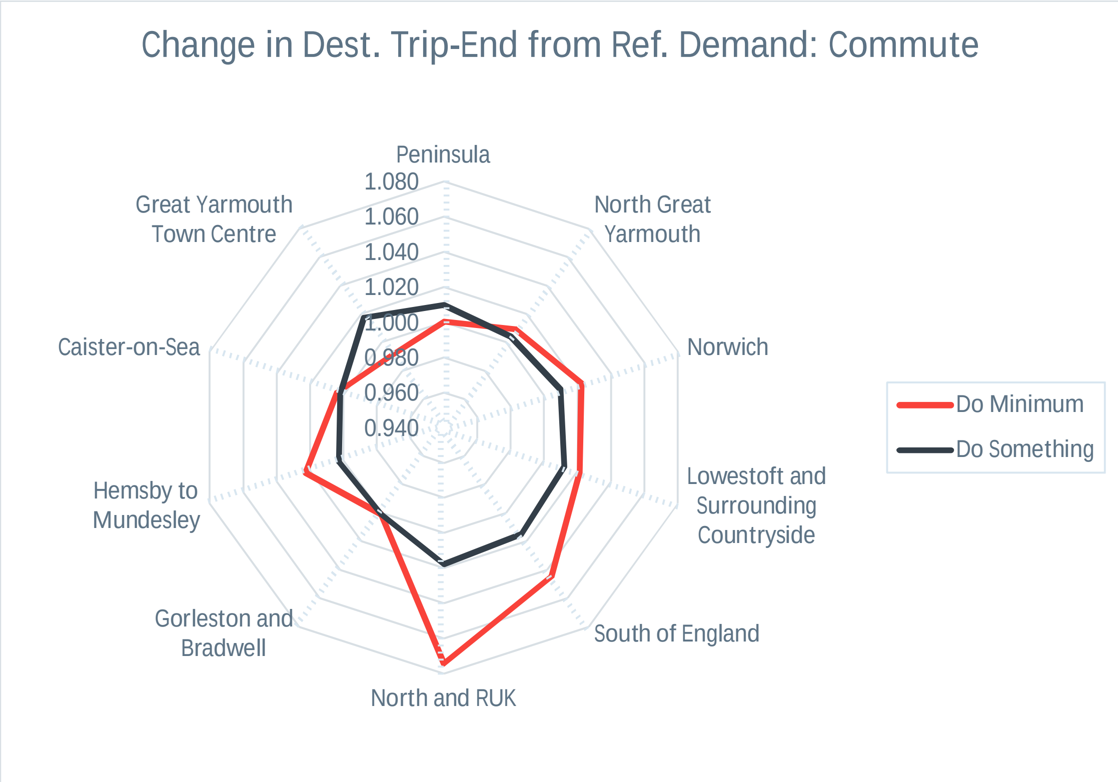




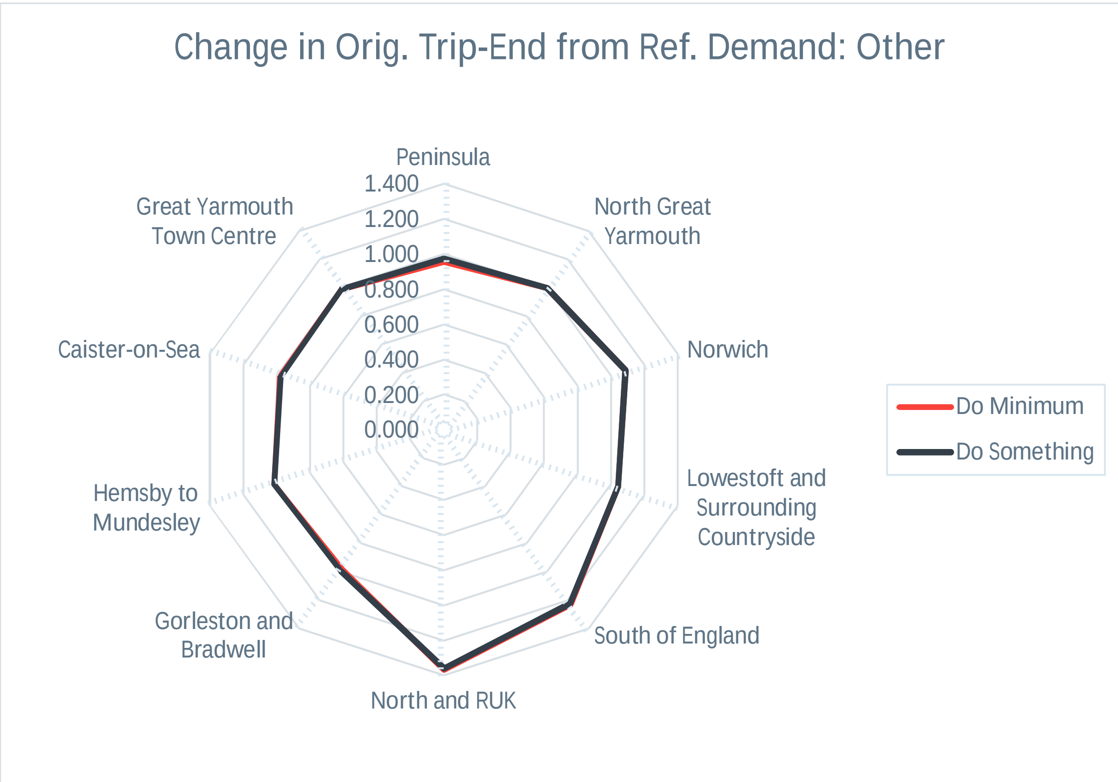
Change in Dest. Trip-End from Ref. Demand: Business
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Do Minimum
Do Something



Change in Orig. Trip-End from Ref. Demand: Commute
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.100
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
Do Minimum
Do Something



Change in Dest. Trip-End from Ref. Demand: Commute
Peninsula
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
Do Minimum
Do Something



Change in Orig. Trip-End from Ref. Demand: Other
Peninsula
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
Do Minimum
Do Something

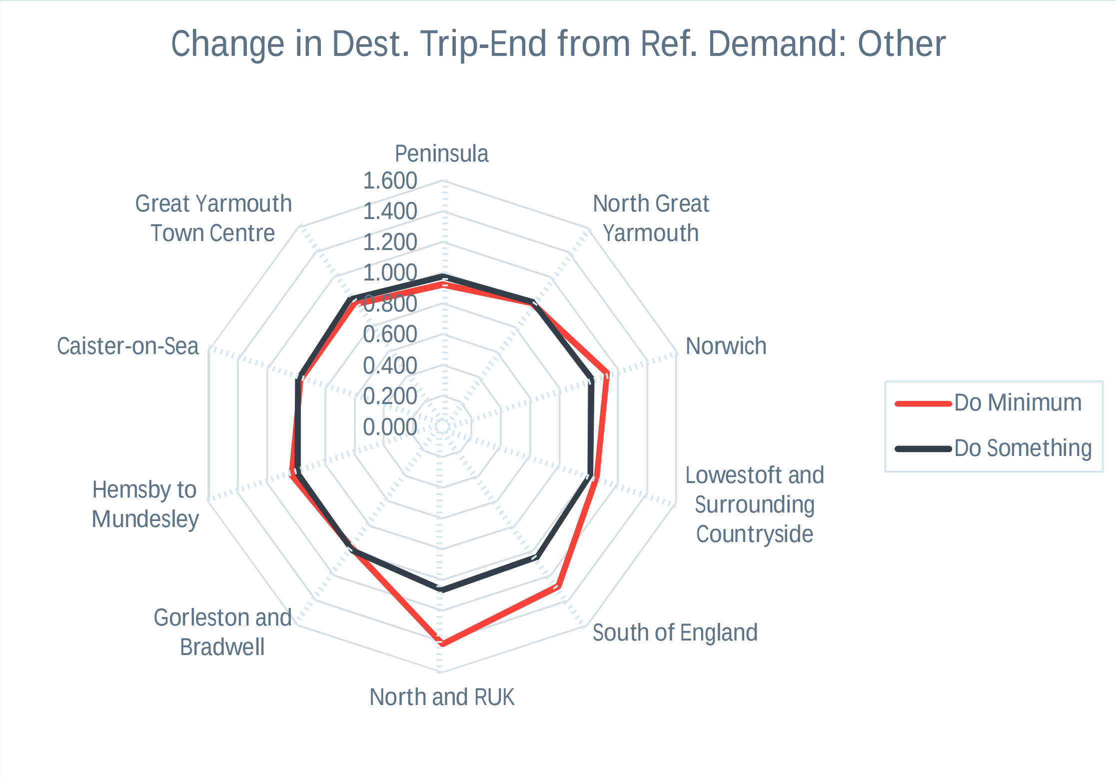
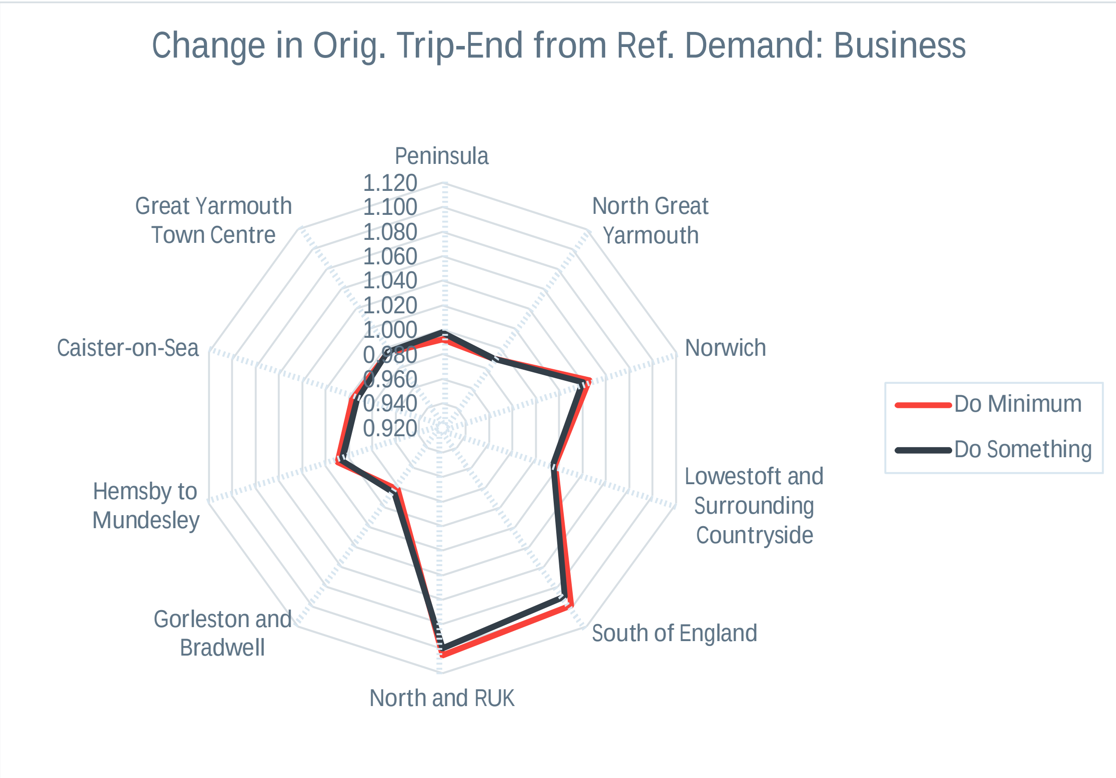
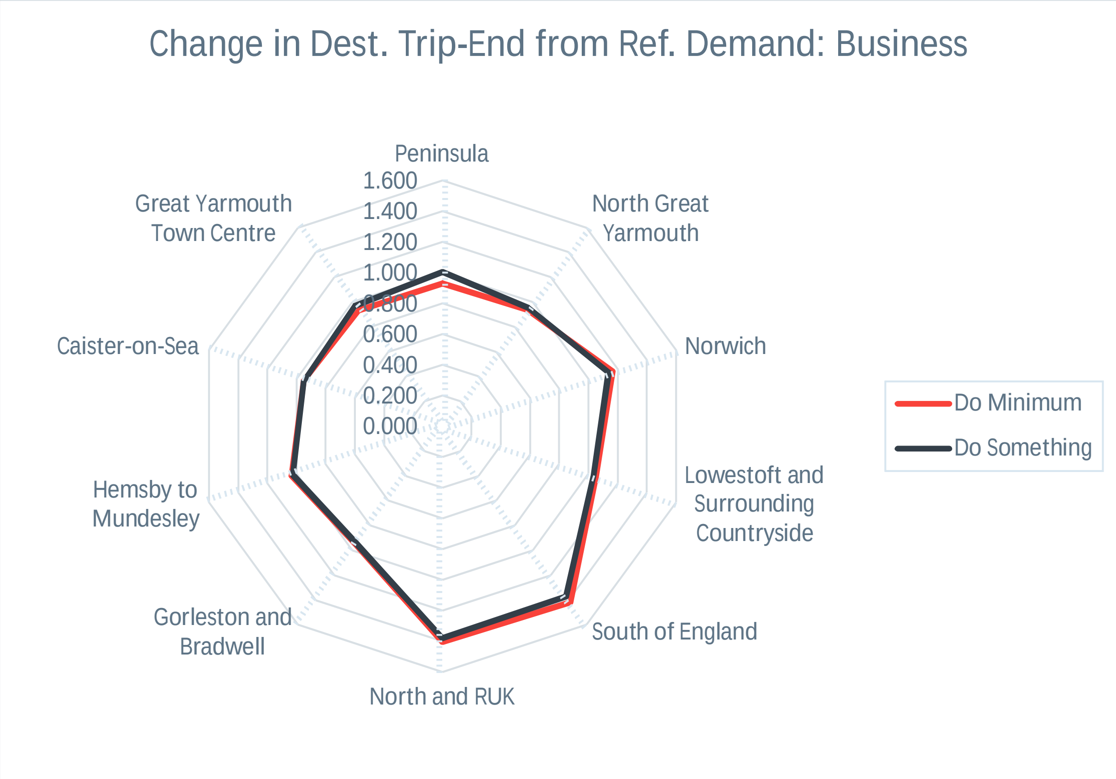
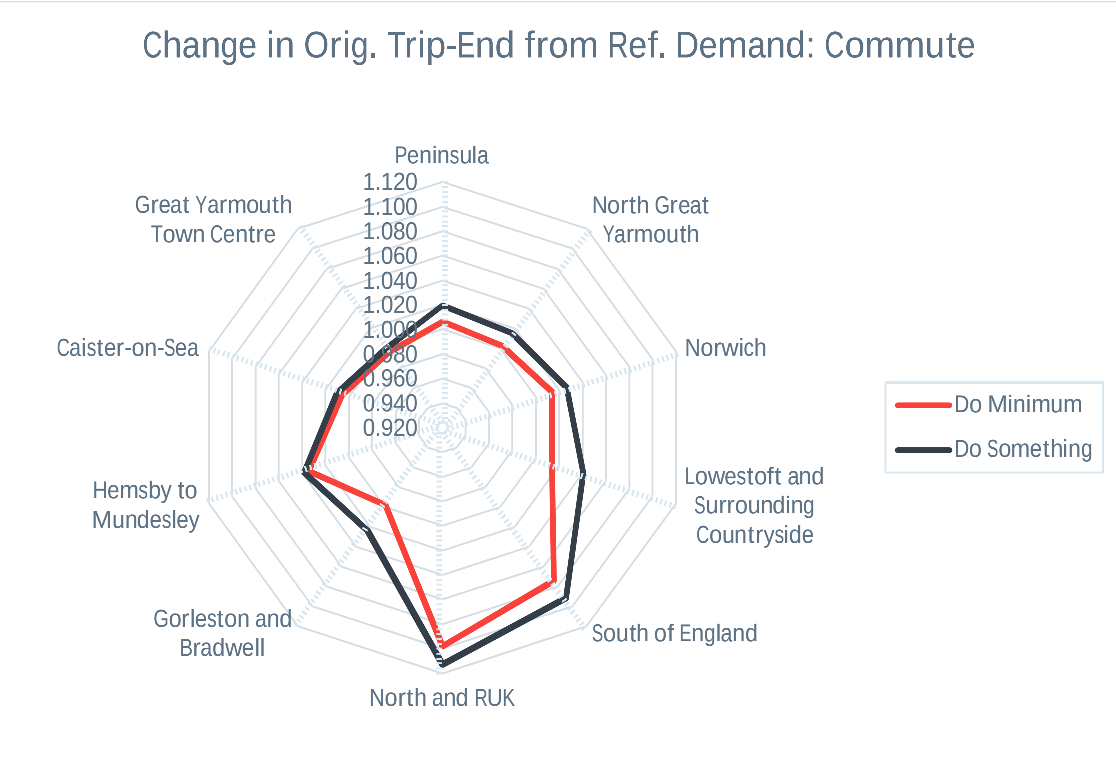
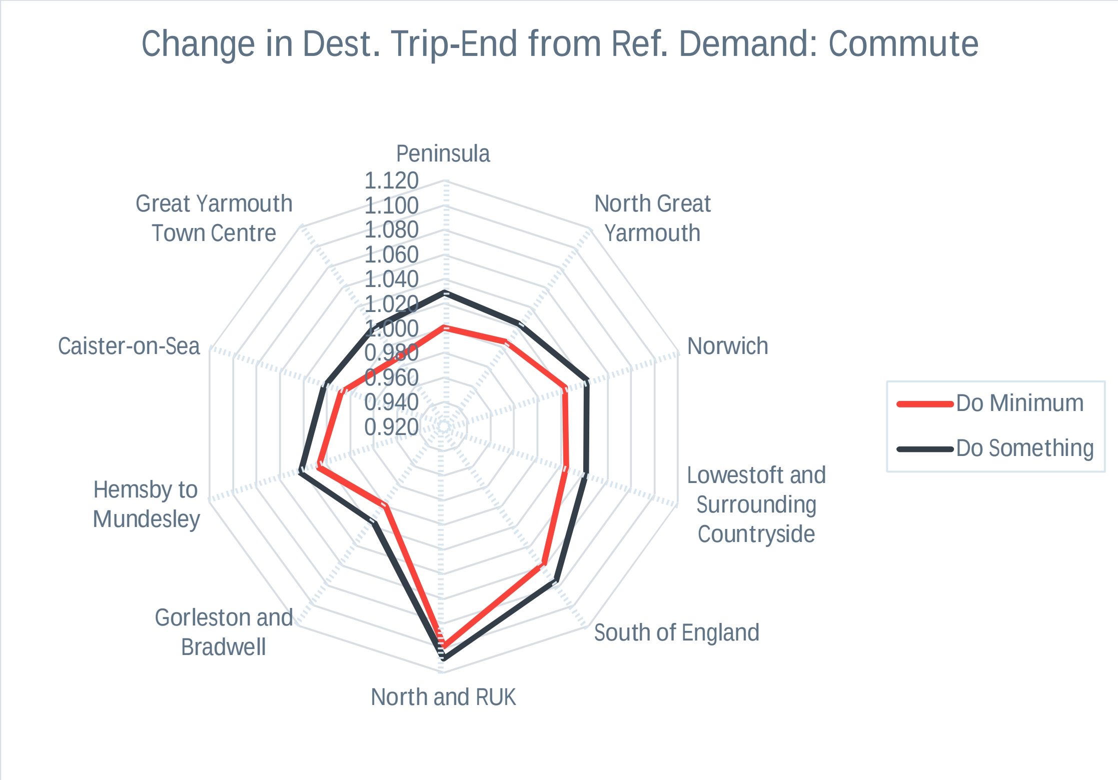


Plate 15 - Constrained Matrix Changes at Sector Trip End Level – 2051

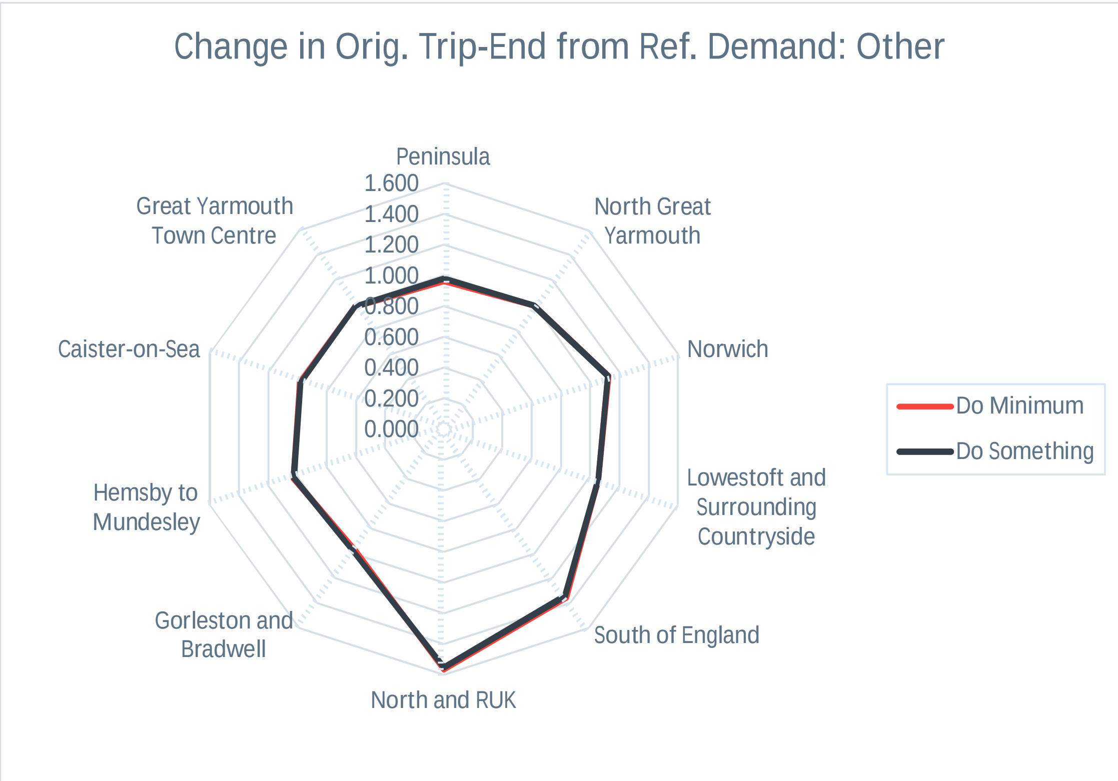



Change in Dest. Trip-End from Ref. Demand: Business
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Do Minimum
Do Something

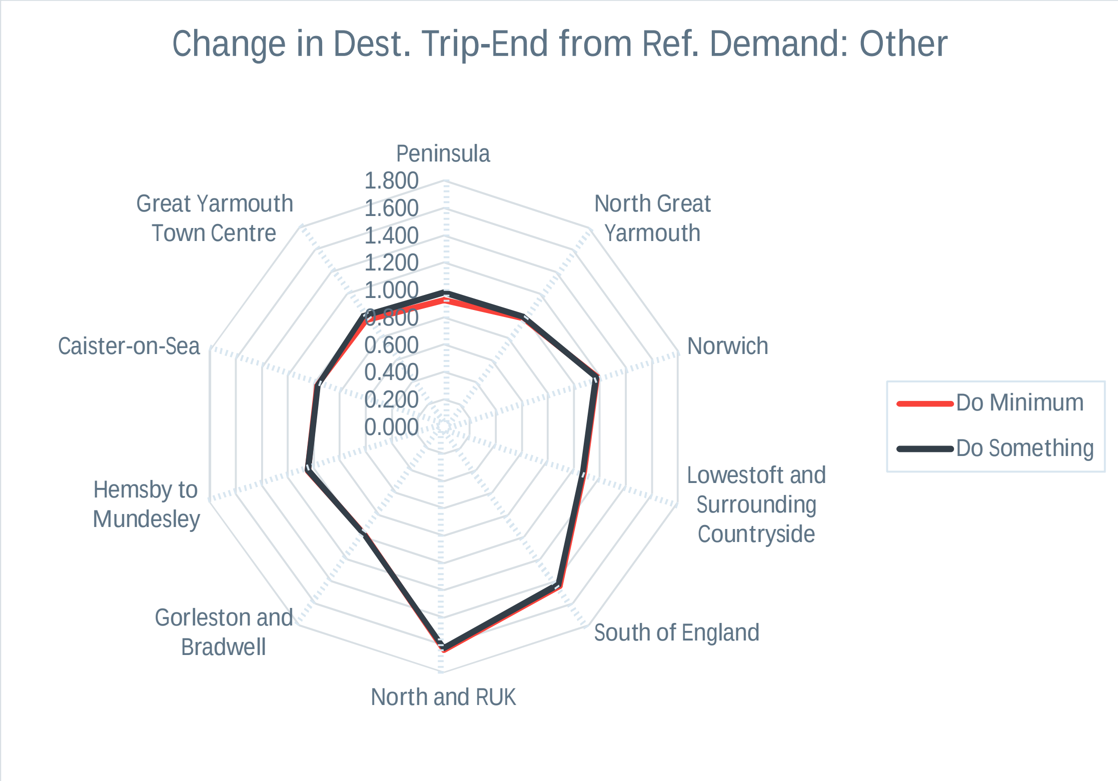

Change in Orig. Trip-End from Ref. Demand: Commute
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.120
1.100
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
Do Minimum
Do Something



Change in Dest. Trip-End from Ref. Demand: Commute
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.120
1.100
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
Do Minimum
Do Something



Change in Orig. Trip-End from Ref. Demand: Other
Peninsula
North Great Yarmouth
Norwich
Lowestoft and Surrounding Countryside
South of England
North and RUK
Gorleston and Bradwell
Hemsby to Mundesley
Caister-on-Sea
Great Yarmouth Town Centre
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Do Minimum
Do Something



8.4. NETWORK STATISTICS

8.4.1. The following table and plates indicates how the total travel distance varies between the separate forecasts, for all three time period models.

Plate 16 - Total Travel Distance - Variable Demand

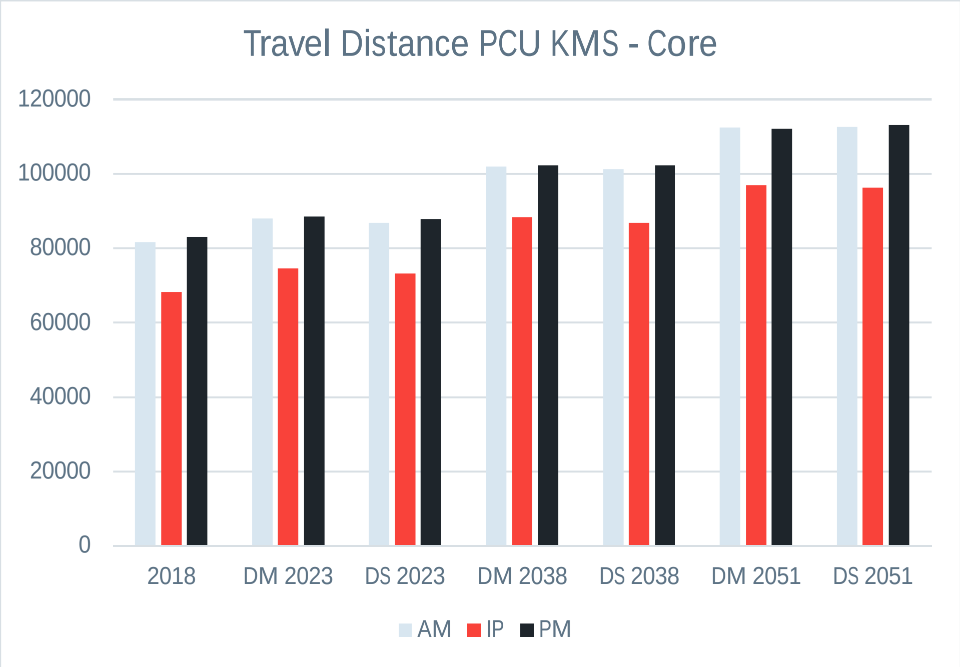


Plate 17 - Total Travel Time - Variable Demand

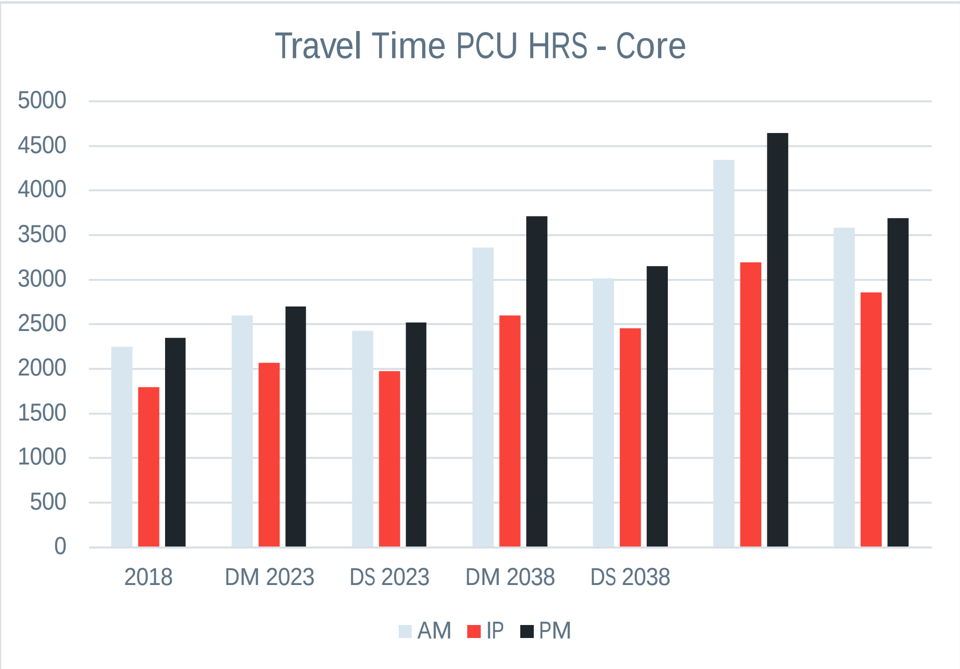


Plate 18 - Average Speed (Core) – Variable Demand

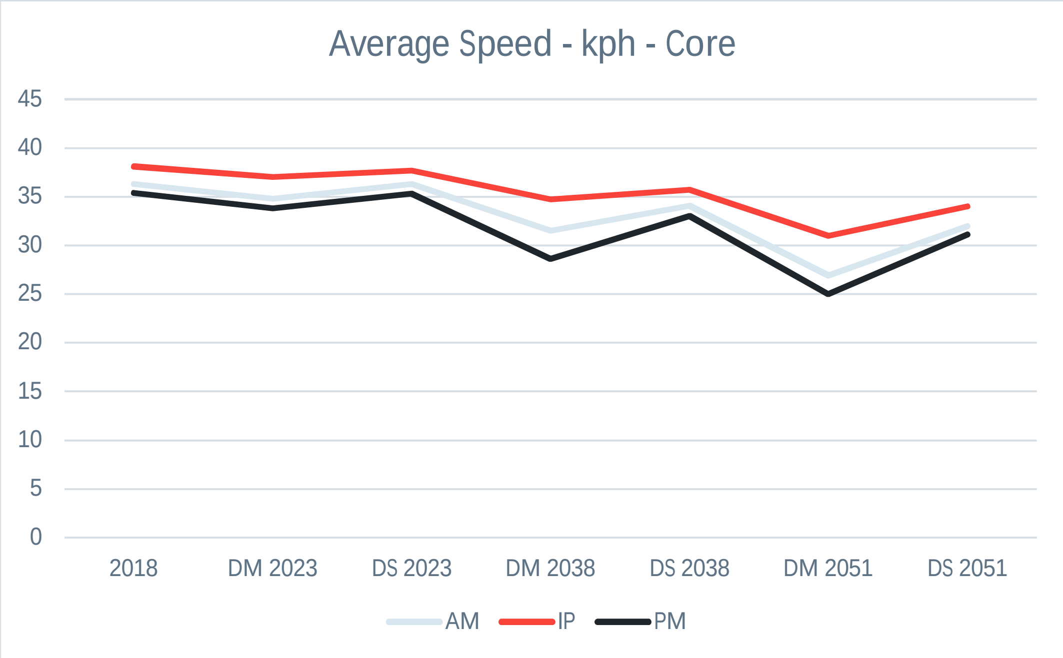


Table 24 - Core Scenario – Variable Demand

ATTRIBUTE	2016	DM 2023	DS 2023	DM 2038	DS 2038	DM 2051	DS 2051
PCU KMS							
AM	81,592	87,884	86,806	101,837	101,224	112,365	112,575
IP	68,180	74,471	73,129	88,249	86,754	96,796	96,111
PM	82,933	88,418	87,720	102,262	102,250	112,028	113,034
				PCU HRS			
AM	2,247	2,488	2,390	3,079	2,932	3,704	3,445
IP	1,790	1,996	1,929	2,490	2,408	2,921	2,786
PM	2,344	2,568	2,467	3,274	3,062	3,945	3,564
				Speed kph			
AM	36	35	36	33	35	30	33
IP	38	37	38	35	36	33	35
PM	35	34	36	31	33	28	32

9. SUMMARY AND CONCLUSIONS

9.1. SUMMARY

9.1.1. This report has described the methods and assumptions used in preparing the future year traffic forecasts using the updated 2018 base year traffic model for Great Yarmouth, in line with the Department for Transport's guidance. A projection from a 2018 present year has been conducted to the opening year, 2023, design year, 2038 and horizon year, 2051.

9.1.2. A number of tests using different transport demand and supply assumptions were used to test the sensitivity of the model and also the plausibility of the economic assessment process that was used is assessing the benefits of the Third River Crossing scheme.

9.1.3. Fixed matrix tests have been conducted. This has been followed by Variable Demand test for the Core scenario. In all cases the variable demand response has been found to be plausible and consistent with the inputs.

9.2. CONCLUSION

9.2.1. Forecasting results, with both fixed demand and variable demand, predict that the TRC will help to reduce total travel distance, reduce total travel time and increase average network speed in the study area.

9.2.2. As expected the Variable Demand process limits the difference in distance and time saving between the Do Minimum and the Do Something.

9.2.3. The results are considered appropriate to employ in a subsequent Economic Evaluation of the scheme.

Appendix A

ZONAL CORRESPONDENCE

Model Zone - TEMPro Correspondence

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
1	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
2	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
3	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
4	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
5	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
7	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
8	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
9	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
10	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
11	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
12	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
13	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
16	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
19	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
20	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
21	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
22	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
23	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
24	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
25	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
26	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
27	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
28	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
29	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
30	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
31	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
32	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
34	EAST	Great Yarmouth	Great Yarmouth 008 (E02005545)	6	3
35	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
36	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
39	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
40	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
41	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
42	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
43	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
44	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
45	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
46	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
47	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
48	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
49	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
50	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
51	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
52	EAST	Great Yarmouth	Great Yarmouth 010 (E02005547)	8	3
53	EAST	Great Yarmouth	Great Yarmouth 010 (E02005547)	8	3
54	EAST	Great Yarmouth	Great Yarmouth 010 (E02005547)	8	3
55	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	9	3
56	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	10	3
57	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	10	3
58	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
59	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
61	EAST	Great Yarmouth	Great Yarmouth 008 (E02005545)	6	3
62	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
63	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	9	3
64	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
65	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
66	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
67	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
68	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
69	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
70	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
71	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
72	EAST	Great Yarmouth	Great Yarmouth 010 (E02005547)	8	3
73	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	9	3
74	EAST	Great Yarmouth	Great Yarmouth 008 (E02005545)	6	3
75	EAST	Great Yarmouth	Great Yarmouth 008 (E02005545)	6	3
76	EAST	Great Yarmouth	Great Yarmouth 011 (E02005548)	9	3
77	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
78	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
80	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	12	3

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
81	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	12	3
83	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
84	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
85	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
86	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
87	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
88	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
89	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
90	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
91	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
92	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
126	EAST	South Norfolk	South Norfolk	16	2
127	EAST	South Norfolk	South Norfolk	16	2
131	EAST	South Norfolk	South Norfolk	16	2
132	EAST	South Norfolk	South Norfolk	16	2
133	EAST	South Norfolk	South Norfolk	16	2
134	EAST	South Norfolk	South Norfolk	16	2
135	EAST	South Norfolk	South Norfolk	16	2
136	EAST	South Norfolk	South Norfolk	16	2
137	EAST	South Norfolk	South Norfolk	16	2
138	EAST	South Norfolk	South Norfolk	16	2
139	EAST	South Norfolk	South Norfolk	16	2
140	EAST	South Norfolk	South Norfolk	16	2
141	EAST	South Norfolk	South Norfolk	16	2
142	EAST	South Norfolk	South Norfolk	16	2
143	EAST	South Norfolk	South Norfolk	16	2
144	EAST	South Norfolk	South Norfolk	16	2
145	EAST	South Norfolk	South Norfolk	16	2
146	EAST	South Norfolk	South Norfolk	16	2
147	EAST	South Norfolk	South Norfolk	16	2
148	EAST	South Norfolk	South Norfolk	16	2
149	EAST	South Norfolk	South Norfolk	16	2
150	EAST	South Norfolk	South Norfolk	16	2
152	EAST	Broadland	Broadland	14	1
153	EAST	Broadland	Broadland	14	1
154	EAST	Broadland	Broadland	14	1
157	EAST	Broadland	Broadland	14	1

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
158	EAST	Broadland	Broadland	14	1
159	EAST	South Norfolk	South Norfolk	16	2
160	EAST	South Norfolk	South Norfolk	16	2
161	EAST	South Norfolk	South Norfolk	16	2
162	EAST	South Norfolk	South Norfolk	16	2
163	EAST	Broadland	Broadland	14	1
164	EAST	Broadland	Broadland	14	1
167	EAST	South Norfolk	South Norfolk	16	2
168	EAST	South Norfolk	South Norfolk	16	2
169	EAST	South Norfolk	South Norfolk	16	2
170	EAST	South Norfolk	South Norfolk	16	2
171	EAST	South Norfolk	South Norfolk	16	2
172	EAST	South Norfolk	South Norfolk	16	2
173	EAST	South Norfolk	South Norfolk	16	2
174	EAST	South Norfolk	South Norfolk	16	2
175	EAST	South Norfolk	South Norfolk	16	2
176	EAST	South Norfolk	South Norfolk	16	2
177	EAST	Broadland	Broadland	14	1
178	EAST	Broadland	Broadland	14	1
179	EAST	Broadland	Broadland	14	1
180	EAST	Broadland	Broadland	14	1
181	EAST	Broadland	Broadland	14	1
182	EAST	Broadland	Broadland	14	1
183	EAST	Broadland	Broadland	14	1
184	EAST	Broadland	Broadland	14	1
185	EAST	Broadland	Broadland	14	1
186	EAST	Broadland	Broadland	14	1
187	EAST	Broadland	Broadland	14	1
188	EAST	Broadland	Broadland	14	1
189	EAST	Broadland	Broadland	14	1
192	EAST	South Norfolk	South Norfolk	16	2
193	EAST	South Norfolk	South Norfolk	16	2
194	EAST	Breckland	Breckland	20	6
195	EAST	South Norfolk	South Norfolk	16	2
196	EAST	Breckland	Breckland	20	6
197	EAST	Broadland	Broadland	14	1
198	EAST	Broadland	Broadland	14	1

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
202	EAST	Breckland	Breckland	20	6
203	EM	South Holland	South Holland	19	11
204	EM	South Holland	South Holland	19	11
205	EM	South Holland	South Holland	19	11
206	EM	South Holland	South Holland	19	11
207	EM	South Holland	South Holland	19	11
208	EAST	North Norfolk	North Norfolk	17	4
209	EAST	North Norfolk	North Norfolk	17	4
210	EAST	South Norfolk	South Norfolk	16	2
211	EAST	South Norfolk	South Norfolk	16	2
212	WM		WM	31	11
212	EM	Leicester	Leicester	31	11
212	EM	Rutland	Rutland	31	11
212	EM	Blaby	Blaby	31	11
212	EM	Harborough	Harborough	31	11
212	EM	Hinckley and Bosworth	Hinckley and Bosworth	31	11
212	EM	Oadby and Wigston	Oadby and Wigston	31	11
212	EM	Corby	Corby	31	11
212	EM	Daventry	Daventry	31	11
212	EM	East Northamptonshire	East Northamptonshire	31	11
212	EM	Kettering	Kettering	31	11
212	EM	Northampton	Northampton	31	11
212	EM	South Northamptonshire	South Northamptonshire	31	11
212	EM	Wellingborough	Wellingborough	31	11
213	LON		LON	27	10
214	EAST	Cambridge	Cambridge	25	9
215	SW		SW	30	9
215	SE	Luton	Luton	30	9
215	SE	Bracknell Forest	Bracknell Forest	30	9
215	SE	West Berkshire	West Berkshire	30	9
215	SE	Reading	Reading	30	9
215	SE	Slough	Slough	30	9
215	SE	Windsor and Maidenhead	Windsor and Maidenhead	30	9
215	SE	Wokingham	Wokingham	30	9

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
215	SE	Milton Keynes	Milton Keynes	30	9
215	SE	Southampton	Southampton	30	9
215	SE	Isle of Wight	Isle of Wight	30	9
215	EAST		Bedfordshire	30	9
215	SE	Aylesbury Vale	Aylesbury Vale	30	9
215	SE	Chiltern	Chiltern	30	9
215	SE	South Bucks	South Bucks	30	9
215	SE	Wycombe	Wycombe	30	9
215	EAST	East Cambridgeshire	East Cambridgeshire	30	9
215	EAST	South Cambridgeshire	South Cambridgeshire	30	9
215	EAST	Braintree	Braintree	30	9
215	EAST	Uttlesford	Uttlesford	30	9
215	SE	Basingstoke and Deane	Basingstoke and Deane	30	9
215	SE	Eastleigh	Eastleigh	30	9
215	SE	Fareham	Fareham	30	9
215	SE	Gosport	Gosport	30	9
215	SE	Hart	Hart	30	9
215	SE	New Forest	New Forest	30	9
215	SE	Rushmoor	Rushmoor	30	9
215	SE	Test Valley	Test Valley	30	9
215	SE	Winchester	Winchester	30	9
215	EAST	Dacorum	Dacorum	30	9
215	EAST	East Hertfordshire	East Hertfordshire	30	9
215	EAST	North Hertfordshire	North Hertfordshire	30	9
215	EAST	St Albans	St Albans	30	9
215	EAST	Stevenage	Stevenage	30	9
215	EAST	Three Rivers	Three Rivers	30	9
215	EAST	Watford	Watford	30	9
215	EAST	Welwyn Hatfield	Welwyn Hatfield	30	9
215	EM	South Northamptonshire	South Northamptonshire	30	11
215	SE	Cherwell	Cherwell	30	9
215	SE	Oxford	Oxford	30	9
215	SE	South Oxfordshire	South Oxfordshire	30	9
215	SE	Vale of White Horse	Vale of White Horse	30	9

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
215	SE	West Oxfordshire	West Oxfordshire	30	9
215	EAST	Forest Heath	Forest Heath	30	9
215	SE	Elmbridge	Elmbridge	30	9
215	SE	Runnymede	Runnymede	30	9
215	SE	Spelthorne	Spelthorne	30	9
215	SE	Surrey Heath	Surrey Heath	30	9
215	SE	Woking	Woking	30	9
216	EAST	St Edmundsbury	St Edmundsbury	26	9
217	EAST	Ipswich	Ipswich	23	9
221	EAST	King's Lynn and West Norfolk	King's Lynn and West Norfolk	24	7
222	NW		NW	32	12
222	YH		YH	32	12
222	NE		NE	32	12
222	EM	Derby	Derby	32	12
222	EM	Nottingham	Nottingham	32	12
222	EM	Amber Valley	Amber Valley	32	12
222	EM	Bolsover	Bolsover	32	12
222	EM	Chesterfield	Chesterfield	32	12
222	EM	Derbyshire Dales	Derbyshire Dales	32	12
222	EM	Erewash	Erewash	32	12
222	EM	High Peak	High Peak	32	12
222	EM	North East Derbyshire	North East Derbyshire	32	12
222	EM	South Derbyshire	South Derbyshire	32	12
222	EM	Charnwood	Charnwood	32	12
222	EM	Melton	Melton	32	12
222	EM	North West Leicestershire	North West Leicestershire	32	12
222	EM	Boston	Boston	32	12
222	EM	East Lindsey	East Lindsey	32	12
222	EM	Lincoln	Lincoln	32	12
222	EM	North Kesteven	North Kesteven	32	12
222	EM	South Holland	South Holland	32	11
222	EM	South Kesteven	South Kesteven	32	12
222	EM	West Lindsey	West Lindsey	32	12
222	EM	Ashfield	Ashfield	32	12
222	EM	Bassetlaw	Bassetlaw	32	12

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
222	EM	Broxtowe	Broxtowe	32	12
222	EM	Gedling	Gedling	32	12
222	EM	Mansfield	Mansfield	32	12
222	EM	Newark and Sherwood	Newark and Sherwood	32	12
222	EM	Rushcliffe	Rushcliffe	32	12
500	EAST	Norwich	Norwich	15	8
601	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
602	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
603	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
701	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
702	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
703	EAST	Great Yarmouth	Great Yarmouth 007 (E02005544)	5	3
704	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	12	3
705	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	10	3
706	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	10	3
707	EAST	Great Yarmouth	Great Yarmouth 010 (E02005547)	**8**	3
708	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
709	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
710	EAST	Great Yarmouth	Great Yarmouth 004 (E02005541)	3	3
711	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
712	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	12	3
713	EAST	Great Yarmouth	Great Yarmouth 003 (E02005540)	4	3
714	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1401	EAST	Great Yarmouth	Great Yarmouth 005 (E02005542)	2	3
1402	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1501	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1502	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1701	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1702	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1801	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1802	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
1803	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
3301	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	5	3
3302	EAST	Great Yarmouth	Great Yarmouth 009 (E02005546)	7	3
3701	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
3702	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
3703	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
3704	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
3801	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
3802	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
3803	EAST	Great Yarmouth	Great Yarmouth 006 (E02005543)	1	3
11002	EAST	Broadland	Broadland	14	1
12601	EAST	South Norfolk	South Norfolk	16	2
12602	EAST	South Norfolk	South Norfolk	16	2
12603	EAST	South Norfolk	South Norfolk	16	2
13004	EAST	South Norfolk	South Norfolk	16	2
13201	EAST	South Norfolk	South Norfolk	16	2
15101	EAST	South Norfolk	South Norfolk	16	2
15102	EAST	Broadland	Broadland	14	1
15201	EAST	Broadland	Broadland	14	1
15701	EAST	Broadland	Broadland	14	1
15901	EAST	Broadland	Broadland	14	1
15902	EAST	Broadland	Broadland	14	1
15903	EAST	South Norfolk	South Norfolk	16	2
15904	EAST	South Norfolk	South Norfolk	16	2
19001	EAST	Broadland	Broadland	14	1
19002	EAST	Broadland	Broadland	14	1
19101	EAST	South Norfolk	South Norfolk	16	2
19102	EAST	South Norfolk	South Norfolk	16	2
19901	EAST	North Norfolk	North Norfolk	17	4
19902	EAST	North Norfolk	North Norfolk	17	4
20001	EAST	Great Yarmouth	Great Yarmouth 002 (E02005539)	13	3
20002	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	12	3
20003	EAST	Great Yarmouth	Great Yarmouth 002 (E02005539)	13	3
20004	EAST	Great Yarmouth	Great Yarmouth 002 (E02005539)	**13**	3
20005	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	12	3
20006	EAST	Great Yarmouth	Great Yarmouth 001 (E02005538)	**12**	3
20007	EAST	Great Yarmouth	Great Yarmouth 002 (E02005539)	2	3
20008	EAST	Great Yarmouth	Great Yarmouth 012 (E02005549)	10	3
20009	EAST	Great Yarmouth	Great Yarmouth 013 (E02005550)	10	3
20010	EAST	Great Yarmouth	Great Yarmouth 012 (E02005549)	10	3
21801	EAST	Mid Suffolk	Mid Suffolk	21	9
21802	SE	Medway	Medway	29	9

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
21802	SE	Brighton and Hove	Brighton and Hove	29	9
21802	SE	Portsmouth	Portsmouth	29	9
21802	SE	Eastbourne	Eastbourne	29	9
21802	SE	Hastings	Hastings	29	9
21802	SE	Lewes	Lewes	29	9
21802	SE	Rother	Rother	29	9
21802	SE	Wealden	Wealden	29	9
21802	SE	East Hampshire	East Hampshire	29	9
21802	SE	Havant	Havant	29	9
21802	SE	Ashford	Ashford	29	9
21802	SE	Canterbury	Canterbury	29	9
21802	SE	Dartford	Dartford	29	9
21802	SE	Dover	Dover	29	9
21802	SE	Gravesham	Gravesham	29	9
21802	SE	Maidstone	Maidstone	29	9
21802	SE	Sevenoaks	Sevenoaks	29	9
21802	SE	Shepway	Shepway	29	9
21802	SE	Swale	Swale	29	9
21802	SE	Thanet	Thanet	29	9
21802	SE	Tonbridge and Malling	Tonbridge and Malling	29	9
21802	SE	Tunbridge Wells	Tunbridge Wells	29	9
21802	SE	Guildford	Guildford	29	9
21802	SE	Mole Valley	Mole Valley	29	9
21802	SE	Reigate and Banstead	Reigate and Banstead	29	9
21802	SE	Tandridge	Tandridge	29	9
21802	SE	Waverley	Waverley	29	9
21802	SE	Adur	Adur	29	9
21802	SE	Arun	Arun	29	9
21802	SE	Chichester	Chichester	29	9
21802	SE	Crawley	Crawley	29	9
21802	SE	Horsham	Horsham	29	9
21802	SE	Mid Sussex	Mid Sussex	29	9
21802	SE	Worthing	Worthing	29	9
21803	EAST	Babergh	Babergh	28	9
21803	EAST	Tendring	Tendring	28	9
21803	EAST	Colchester	Colchester	28	9

ZONE	REGION	AUTHORITY	DETAILED DESCRIPTION	TEMPRO	DISTRICT
21803	EAST	Chelmsford	Chelmsford	28	9
21803	EAST	Maldon	Maldon	28	9
21803	EAST	Brentwood	Brentwood	28	9
21803	EAST	Basildon	Basildon	28	9
21803	EAST	Rochford	Rochford	28	9
21803	EAST	Southend-on-Sea	Southend-on-Sea	28	9
21803	EAST	Castle Point	Castle Point	28	9
21803	EAST	Thurrock	Thurrock	28	9
21901	EAST	Waveney	Waveney	18	5
21902	EAST	Suffolk Coastal	Suffolk Coastal	22	9
22001	EAST	Waveney	Waveney 001 (E02006302)	11	5
22002	EAST	Waveney	Waveney 001 (E02006302)	11	5
22003	EAST	Waveney	Waveney 001 (E02006302)	11	5
22004	EAST	Waveney	Waveney	18	5
22005	EAST	Waveney	Waveney	18	5
22006	EAST	Waveney	Waveney	18	5
22007	EAST	Waveney	Waveney	18	5

Appendix B

TEMPRO 7.2 GROWTH

TEMPro 7.2 Growth 2018–2023 – AM Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.0818	1.0370	1.1021	1.0806	1.0756	1.0414
2	1.0451	1.0352	1.0786	1.0728	1.0498	1.0401
3	1.0458	1.0363	1.0715	1.0728	1.0465	1.0396
4	1.0203	1.0330	1.0598	1.0671	1.0305	1.0373
5	1.0156	1.0344	1.0550	1.0675	1.0267	1.0396
6	1.0584	1.0340	1.0851	1.0733	1.0576	1.0379
7	1.0484	1.0414	1.0897	1.0915	1.0535	1.0477
8	1.0665	1.0347	1.0770	1.0690	1.0578	1.0384
9	1.0394	1.0420	1.0652	1.0651	1.0433	1.0450
10	1.0580	1.0469	1.0800	1.0776	1.0569	1.0499
11	1.0385	1.0381	1.0570	1.0568	1.0405	1.0403
12	1.0460	1.0461	1.0547	1.0548	1.0473	1.0474

TEMPro 7.2 Growth 2018–2023 – Inter Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.0534	1.0601	1.0974	1.0981	1.0502	1.0503
2	1.0348	1.0364	1.0806	1.0811	1.0419	1.0417
3	1.0350	1.0364	1.0757	1.0757	1.0418	1.0407
4	1.0231	1.0215	1.0664	1.0667	1.0356	1.0346
5	1.0216	1.0188	1.0646	1.0643	1.0352	1.0350
6	1.0395	1.0442	1.0851	1.0856	1.0429	1.0424
7	1.0396	1.0406	1.0949	1.0952	1.0483	1.0473
8	1.0406	1.0441	1.0774	1.0785	1.0405	1.0411
9	1.0349	1.0347	1.0681	1.0679	1.0428	1.0428
10	1.0484	1.0494	1.0813	1.0819	1.0510	1.0504
11	1.0319	1.0320	1.0601	1.0601	1.0378	1.0378
12	1.0382	1.0382	1.0562	1.0562	1.0437	1.0437

TEMPro 7.2 Growth 2018–2023 – PM Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.0372	1.0776	1.0838	1.0940	1.0450	1.0709
2	1.0329	1.0423	1.0687	1.0715	1.0405	1.0474
3	1.0349	1.0420	1.0667	1.0637	1.0422	1.0478
4	1.0302	1.0191	1.0580	1.0538	1.0371	1.0308
5	1.0306	1.0142	1.0560	1.0497	1.0385	1.0277
6	1.0325	1.0549	1.0724	1.0779	1.0394	1.0547
7	1.0396	1.0459	1.0817	1.0803	1.0478	1.0511
8	1.0343	1.0595	1.0667	1.0685	1.0394	1.0537
9	1.0383	1.0361	1.0590	1.0595	1.0439	1.0423
10	1.0460	1.0556	1.0747	1.0739	1.0495	1.0543
11	1.0343	1.0346	1.0527	1.0528	1.0387	1.0389
12	1.0412	1.0410	1.0517	1.0517	1.0451	1.0450

TEMPro 7.2 Growth 2018–2038 – AM Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.3037	1.1270	1.3672	1.2889	1.2768	1.1401
2	1.1670	1.1192	1.2790	1.2588	1.1760	1.1341
3	1.1608	1.1195	1.2592	1.2562	1.1620	1.1316
4	1.0752	1.1132	1.2152	1.2392	1.1068	1.1285
5	1.0408	1.1132	1.1887	1.2331	1.0796	1.1307
6	1.2337	1.1209	1.3279	1.2719	1.2220	1.1342
7	1.1898	1.1284	1.3225	1.3077	1.1936	1.1466
8	1.2114	1.1188	1.2814	1.2507	1.1892	1.1321
9	1.1089	1.1202	1.2131	1.2143	1.1224	1.1309
10	1.1677	1.1246	1.2642	1.2531	1.1658	1.1365
11	1.1258	1.1240	1.1852	1.1844	1.1317	1.1305
12	1.1395	1.1402	1.1731	1.1734	1.1450	1.1455

TEMPro 7.2 Growth 2018–2038 – Inter Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.1908	1.2204	1.3463	1.3505	1.1763	1.1757
2	1.1258	1.1344	1.2849	1.2868	1.1437	1.1425
3	1.1213	1.1270	1.2718	1.2709	1.1410	1.1359
4	1.0850	1.0787	1.2361	1.2365	1.1232	1.1200
5	1.0685	1.0575	1.2227	1.2217	1.1146	1.1141
6	1.1540	1.1747	1.3196	1.3222	1.1572	1.1559
7	1.1399	1.1509	1.3321	1.3339	1.1577	1.1545
8	1.1359	1.1458	1.2818	1.2841	1.1389	1.1407
9	1.1007	1.0995	1.2277	1.2271	1.1249	1.1252
10	1.1376	1.1419	1.2739	1.2766	1.1438	1.1413
11	1.1075	1.1078	1.1955	1.1956	1.1240	1.1240
12	1.1184	1.1183	1.1792	1.1792	1.1352	1.1352

TEMPro 7.2 Growth 2018–2038 – PM Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.1289	1.2870	1.3058	1.3422	1.1547	1.2566
2	1.1137	1.1582	1.2501	1.2597	1.1373	1.1672
3	1.1169	1.1491	1.2391	1.2371	1.1375	1.1549
4	1.1062	1.0719	1.2112	1.1979	1.1267	1.1072
5	1.1017	1.0379	1.1954	1.1745	1.1237	1.0849
6	1.1179	1.2209	1.2797	1.3042	1.1419	1.2088
7	1.1257	1.1809	1.2863	1.2920	1.1510	1.1830
8	1.1181	1.1913	1.2422	1.2528	1.1347	1.1779
9	1.1113	1.1016	1.1950	1.1963	1.1277	1.1212
10	1.1252	1.1629	1.2459	1.2434	1.1379	1.1563
11	1.1138	1.1154	1.1738	1.1743	1.1263	1.1273
12	1.1266	1.1259	1.1652	1.1650	1.1392	1.1388

TEMPro 7.2 Growth 2018–2051 – AM Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.4833	1.2147	1.5754	1.4475	1.4467	1.2364
2	1.2739	1.2028	1.4306	1.3978	1.2898	1.2278
3	1.2610	1.2026	1.4038	1.3942	1.2660	1.2246
4	1.1252	1.1938	1.3225	1.3652	1.1764	1.2197
5	1.0808	1.1931	1.2886	1.3571	1.1407	1.2215
6	1.3801	1.2064	1.5086	1.4208	1.3649	1.2290
7	1.3112	1.2147	1.4888	1.4608	1.3191	1.2443
8	1.3355	1.2022	1.4426	1.3897	1.3081	1.2254
9	1.1880	1.2036	1.3235	1.3270	1.2100	1.2218
10	1.2699	1.2112	1.4039	1.3811	1.2737	1.2325
11	1.2140	1.2114	1.3029	1.3016	1.2253	1.2235
12	1.2344	1.2354	1.2945	1.2950	1.2462	1.2469

TEMPro 7.2 Growth 2018–2051 – Inter Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.3031	1.3496	1.5328	1.5397	1.2885	1.2872
2	1.2060	1.2190	1.4324	1.4354	1.2382	1.2361
3	1.1960	1.2036	1.4136	1.4117	1.2314	1.2260
4	1.1418	1.1292	1.3513	1.3517	1.2042	1.1999
5	1.1194	1.1014	1.3336	1.3321	1.1926	1.1922
6	1.2506	1.2821	1.4878	1.4920	1.2614	1.2589
7	1.2258	1.2434	1.4929	1.4954	1.2571	1.2529
8	1.2160	1.2306	1.4327	1.4349	1.2301	1.2334
9	1.1689	1.1679	1.3360	1.3352	1.2099	1.2102
10	1.2251	1.2288	1.4016	1.4051	1.2391	1.2356
11	1.1818	1.1822	1.3126	1.3126	1.2113	1.2114
12	1.1977	1.1975	1.2993	1.2992	1.2290	1.2290

TEMPro 7.2 Growth 2018–2051 – PM Peak

DISTRICT	TEMPRO 7.2 OD CAR GROWTH					
	Commute		Other		Emp.Bus	
	O	D	O	D	O	D
1	1.2112	1.4527	1.4766	1.5358	1.2562	1.4128
2	1.1894	1.2564	1.3859	1.4025	1.2299	1.2749
3	1.1922	1.2382	1.3701	1.3677	1.2290	1.2548
4	1.1781	1.1166	1.3209	1.2991	1.2131	1.1775
5	1.1711	1.0720	1.3002	1.2679	1.2090	1.1478
6	1.1961	1.3550	1.4342	1.4730	1.2385	1.3423
7	1.2047	1.2918	1.4306	1.4425	1.2485	1.3000
8	1.1947	1.2979	1.3759	1.3948	1.2259	1.2889
9	1.1860	1.1725	1.2962	1.2969	1.2153	1.2057
10	1.2077	1.2591	1.3670	1.3673	1.2317	1.2582
11	1.1928	1.1950	1.2827	1.2834	1.2156	1.2169
12	1.2117	1.2107	1.2783	1.2781	1.2356	1.2350

Appendix C

DAILY DEMAND MATRICES

Base Year 2018 Matrices

PURPOSE	FORMAT	AM PERIOD	IP PERIOD	PM PERIOD	OP PERIOD	24HR TOTAL
HB Trips						
HB Commute (PA)	from Home	6,566	2,698	1,113	2,885	13,262
	return Home	597	2,507	4,901	1,940	9,945
	Total	7,163	5,205	6,014	4,825	23,207
HB Education (PA)	from Home	866	1,326	747	586	3,525
	return Home	340	1,874	4,324	1,478	8,016
	Total	1,206	3,200	5,071	2,065	11,541
HB Other (PA)	from Home	11,340	18,063	5,311	4,758	39,472
	return Home	3,401	20,647	11,738	10,332	46,118
	Total	14,741	38,710	17,049	15,090	85,590
HB Business (PA)	from Home	683	488	125	301	1,596
	return Home	68	584	551	321	1,524
	Total	750	1,072	676	622	3,120
NHB Trips						
NHB Other (OD)	Total	5,995	23,099	13,866	10,204	53,164
NHB Business (OD)	Total	995	4,092	1,388	1,570	8,046

Opening Year 2023 Matrices

PURPOSE	FORMAT	AM PERIOD	IP PERIOD	PM PERIOD	OP PERIOD	24HR TOTAL
HB Trips						
HB Commute (PA)	from Home	6,830	2,771	1,121	2,994	13,716
	return Home	619	2,616	5,117	2,013	10,364
	Total	7,449	5,387	6,238	5,007	24,081
HB Education (PA)	from Home	964	1,456	830	651	3,900
	return Home	360	2,149	4,783	1,641	8,933
	Total	1,323	3,605	5,613	2,292	12,834
HB Other (PA)	from Home	12,128	19,488	5,766	5,089	42,471

PURPOSE	FORMAT	AM PERIOD	IP PERIOD	PM PERIOD	OP PERIOD	24HR TOTAL
	return Home	3,623	22,105	12,291	11,050	49,069
	Total	15,751	41,592	18,057	16,139	91,540
HB Business (PA)	from Home	719	511	134	317	1,680
	return Home	70	613	581	338	1,603
	Total	789	1,124	715	655	3,283
NHB Trips						
NHB Other (OD)	Total	6,348	24,597	14,707	10,843	56,496
NHB Business (OD)	Total	1,021	4,244	1,428	1,623	8,317

Opening Year 2038 Matrices

PURPOSE	FORMAT	AM PERIOD	IP PERIOD	PM PERIOD	OP PERIOD	24HR TOTAL
HB Trips						
HB Commute (PA)	from Home	7,473	2,994	1,183	3,258	14,909
	return Home	660	2,839	5,602	2,190	11,291
	Total	8,133	5,833	6,785	5,449	26,200
HB Education (PA)	from Home	1,189	1,800	994	801	4,784
	return Home	420	2,811	5,708	2,020	10,958
	Total	1,609	4,611	6,702	2,821	15,742
HB Other (PA)	from Home	14,259	23,200	6,870	5,939	50,269
	return Home	4,101	25,584	13,975	12,895	56,555
	Total	18,360	48,784	20,845	18,834	106,823
HB Business (PA)	from Home	790	570	148	350	1,858
	return Home	74	680	646	374	1,774
	Total	865	1,250	794	724	3,633
NHB Trips						
NHB Other (OD)	Total	7,304	28,951	17,070	12,664	65,989
NHB Business (OD)	Total	1,121	4,597	1,541	1,761	9,020

Opening Year 2051 Matrices

PURPOSE	FORMAT	AM PERIOD	IP PERIOD	PM PERIOD	OP PERIOD	24HR TOTAL
HB Trips						
HB Commute (PA)	from Home	8,053	3,195	1,282	3,497	16,027
	return Home	721	3,025	5,986	2,351	12,083
	Total	8,774	6,220	7,268	5,847	28,109
HB Education (PA)	from Home	1,324	1,987	1,084	886	5,280
	return Home	466	3,094	6,321	2,235	12,116
	Total	1,790	5,081	7,405	3,121	17,396
HB Other (PA)	from Home	15,848	25,599	7,529	6,595	55,571
	return Home	4,601	28,634	15,493	14,319	63,047
	Total	20,449	54,234	23,022	20,913	118,618
HB Business (PA)	from Home	855	618	160	379	2,012
	return Home	81	737	699	405	1,922
	Total	936	1,355	858	784	3,933
NHB Trips						
NHB Other (OD)	Total	8,043	32,102	18,867	14,014	73,026
NHB Business (OD)	Total	1,220	4,949	1,671	1,901	9,741

Appendix D

CONVERGENCE STATISTICS

SCENARIO	ITERATION	PERCENTAGE OF LINKS WITH FLOW CHANGE (P) < 1%	RAAD	GAP
DM AM 23	16	99.5	0.030	0.0038
	17	99.7	0.023	0.003
	18	99.8	0.019	0.0028
	19	99.8	0.016	0.0026
DM IP 23	23	99.8	0..007	0.0002
	24	99.6	0.009	0.00015
	25	99.7	0.006	0.00016
	26	99.7	0.007	0.00016
DM PM 23	27	99.6	0.026	0.0032
	28	99.6	0.032	0.0026
	29	99.7	0.025	0.0021
	30	99.8	0.026	0.0039
DM AM 38	28	99.8	0.015	0.0039
	29	99.8	0.011	0.0031
	30	99.8	0.013	0.0026
	31	99.8	0.013	0.0023
DM IP 38	18	99.7	0.023	0.0015
	19	99.8	0.016	0.00091
	20	99.7	0.024	0.0012
	21	99.7	0.022	0.00075
DM PM 38	41	99.5	0.030	0.0079
	42	99.6	0.020	0.0058
	43	99.6	0.020	0.0071
	44	99.5	0.020	0.0071
DM AM 51	69	99.6	0.015	0.0032
	70	99.6	0.013	0.0026
	71	99.6	0.015	0.0017
	72	99.7	0.010	0.0032
DM IP 51	18	99.7	0.035	0.0058
	19	99.7	0.033	0.0051
	20	99.7	0.036	0.0054

	21	99.8	0.024	0.0044
DM PM 51	64	99.5	0.021	0.0029
	65	99.6	0.020	0.0021
	66	99.6	0.017	0.0019
	67	99.9	0.013	0.0018

Do Minimum Assignments

SCENARIO	ITERATION	PERCENTAGE OF LINKS WITH FLOW CHANGE (P) < 1%	RAAD	GAP
DM AM 23	17	99.6	0.032	0.0017
	18	99.6	0.028	0.0014
	19	99.8	0.024	0.0015
	20	99.7	0.022	0.0014
DM IP 23	20	99.6	0..008	0.00016
	21	99.6	0.007	0.00016
	22	99.6	0.007	0.00016
	23	99.7	0.007	0.00015
DM PM 23	23	99.7	0.032	0.0044
	24	99.6	0.032	0.0034
	25	99.6	0.034	0.0044
	26	99.7	0.033	0.0031
DM AM 38	38	99.6	0.017	0.0018
	39	99.8	0.017	0.0018
	40	99.7	0.020	0.0018
	41	99.9	0.015	0.0013
DM IP 38	23	99.6	0.023	0.00085
	24	99.8	0.022	0.00093
	25	99.7	0.023	0.00072
	26	99.7	0.022	0.00073
DM PM 38	42	99.9	0.031	0.0091
	43	99.8	0.035	0.0086
	44	99.8	0.028	0.0075
	45	99.7	0.030	0.0038
DM AM 51	68	99.8	0.014	0.0028

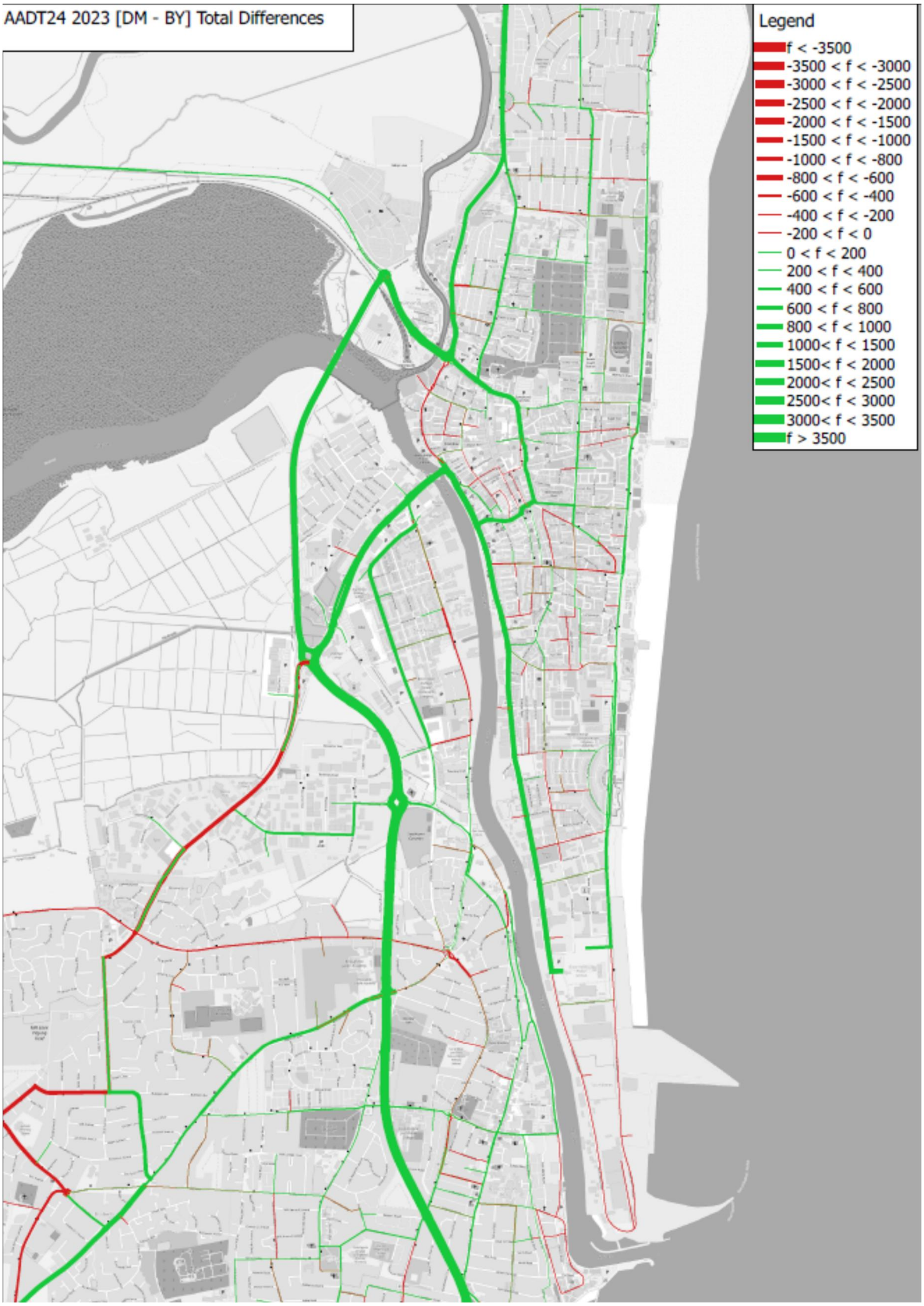
	69	99.7	0.019	0.0037
	70	99.6	0.016	0.0016
	71	99.8	0.012	0.0018
DM IP 51	28	99.7	0.023	0.0036
	29	99.9	0.019	0.0034
	30	99.8	0.024	0.0082
	31	99.9	0.025	0.0029
DM PM 51	78	99.6	0.011	0.0023
	79	99.6	0.012	0.0025
	80	99.7	0.014	0.0017
	81	100.0	0.008	0.0025

Do Something Assignment

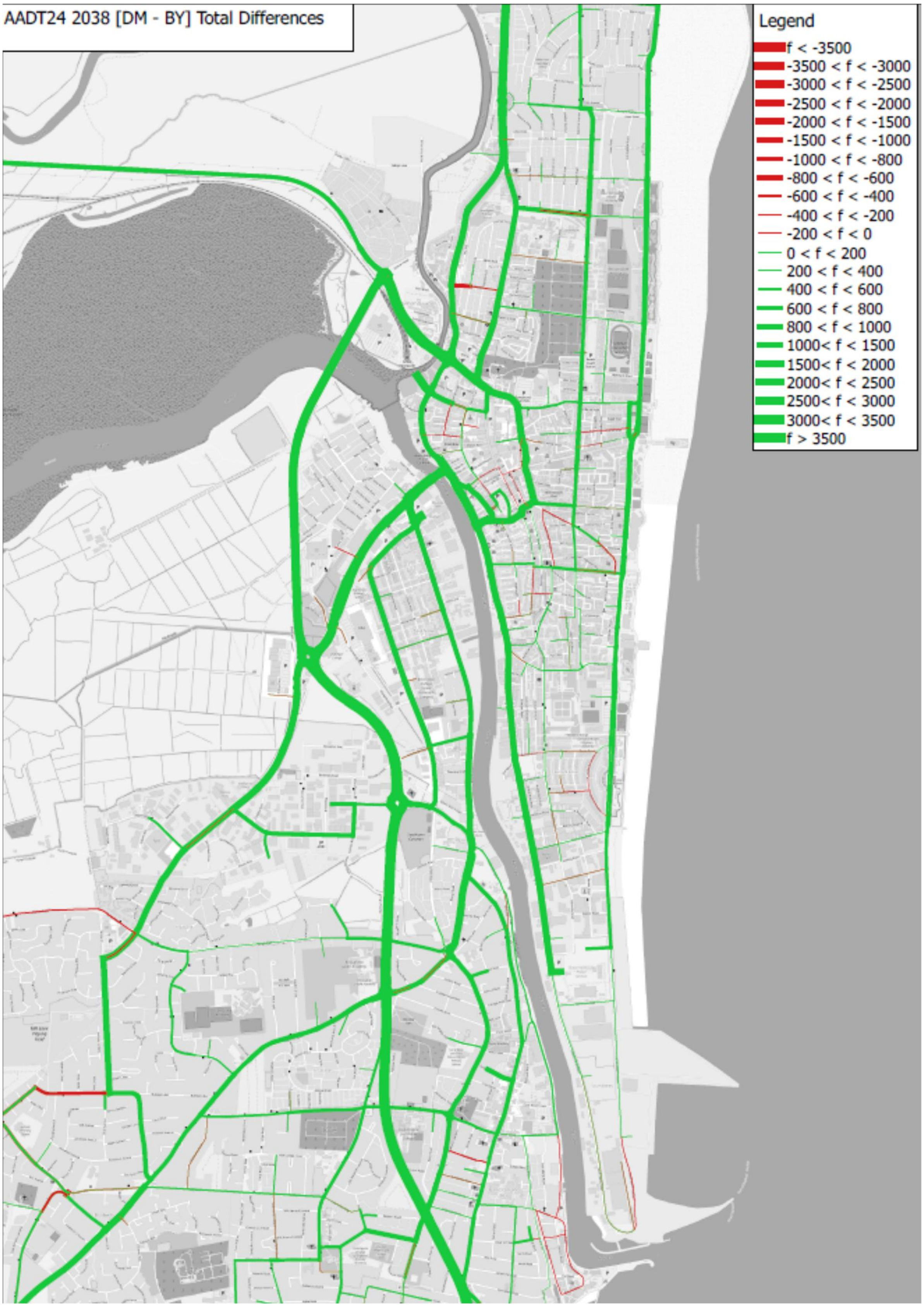
Appendix E

FIXED TRAFFIC FLOW CHANGES

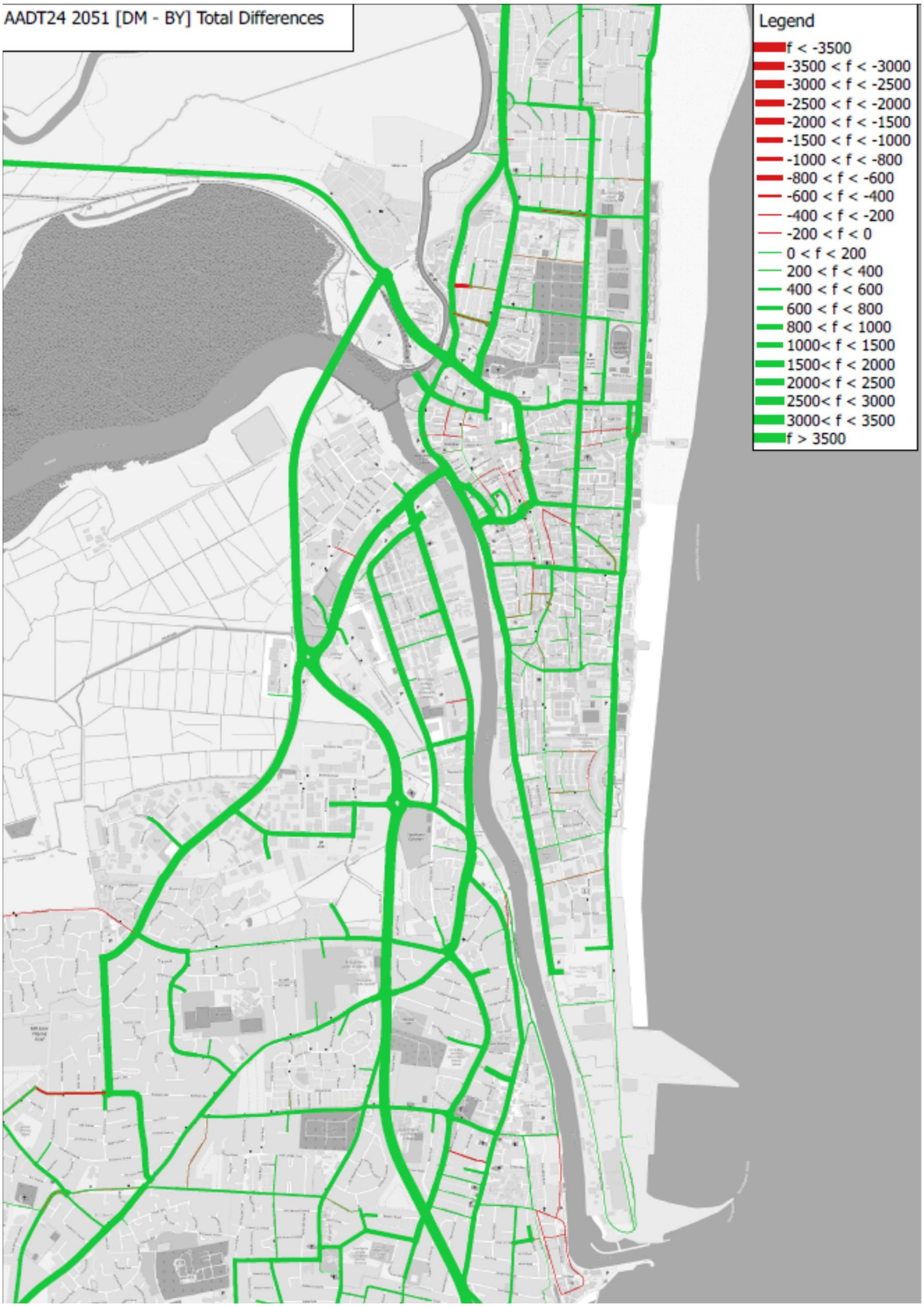
2023 DM vs Base AADT Change



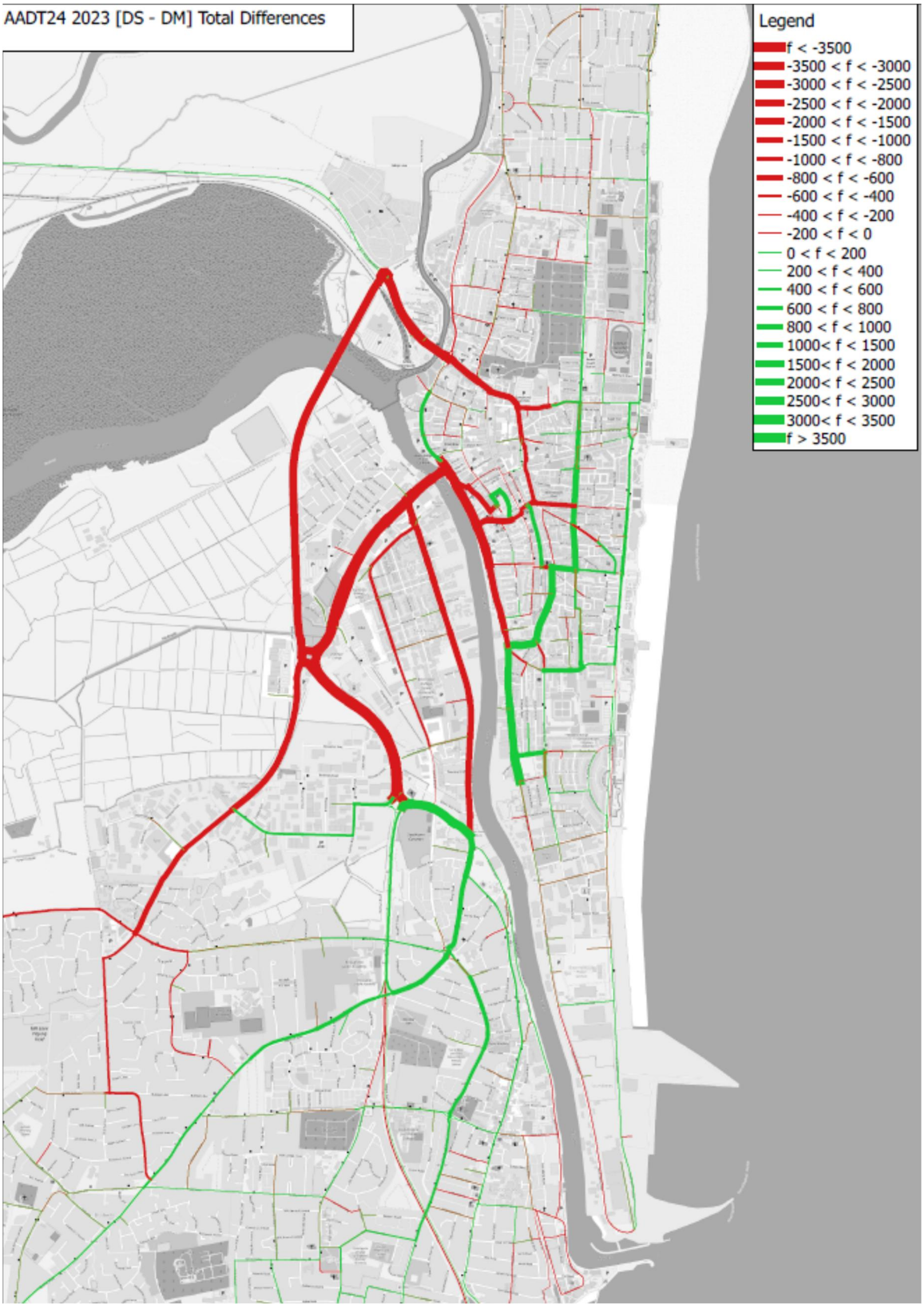
2038 DM vs Base AADT Change



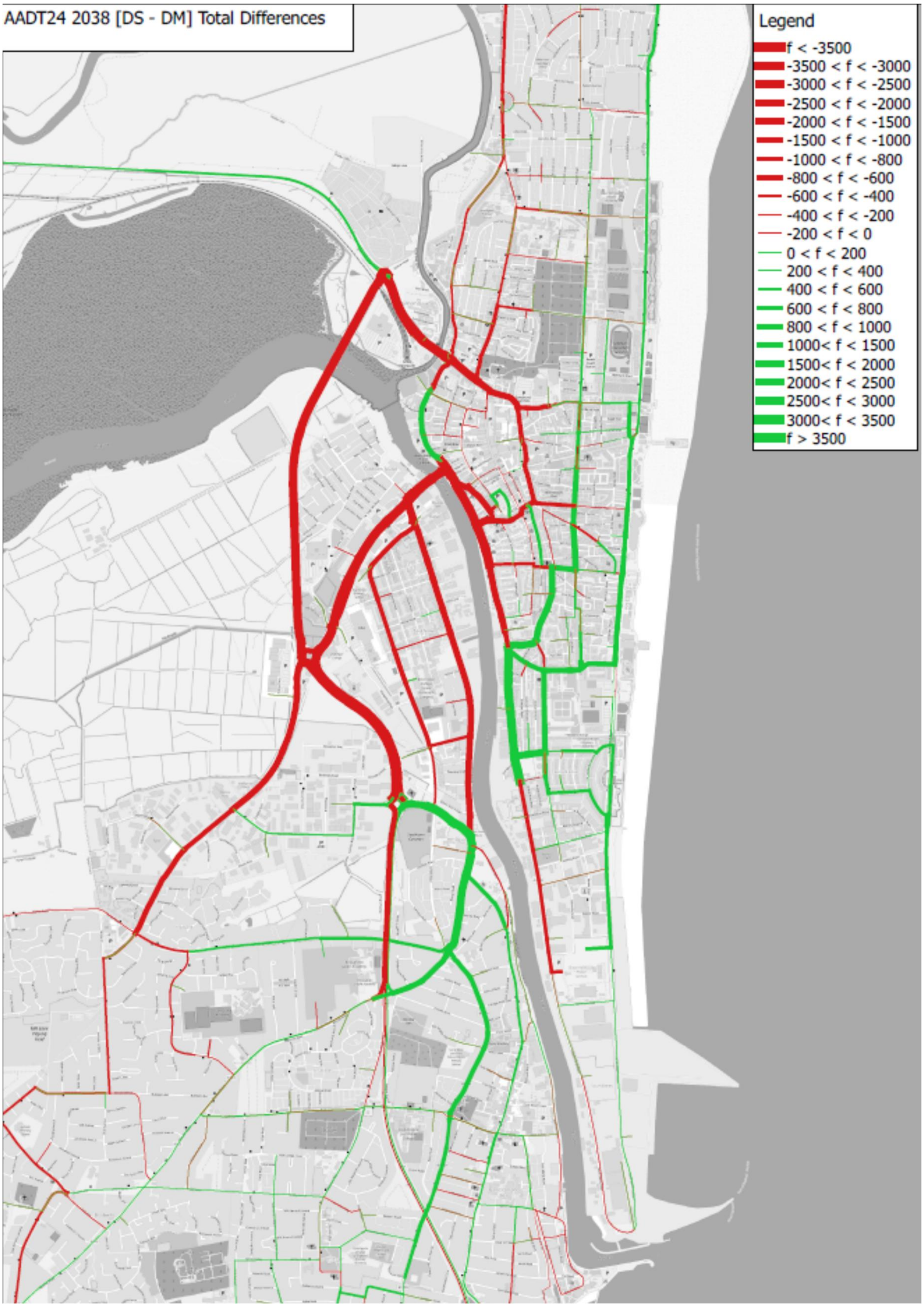
2051 DM vs Base AADT Change



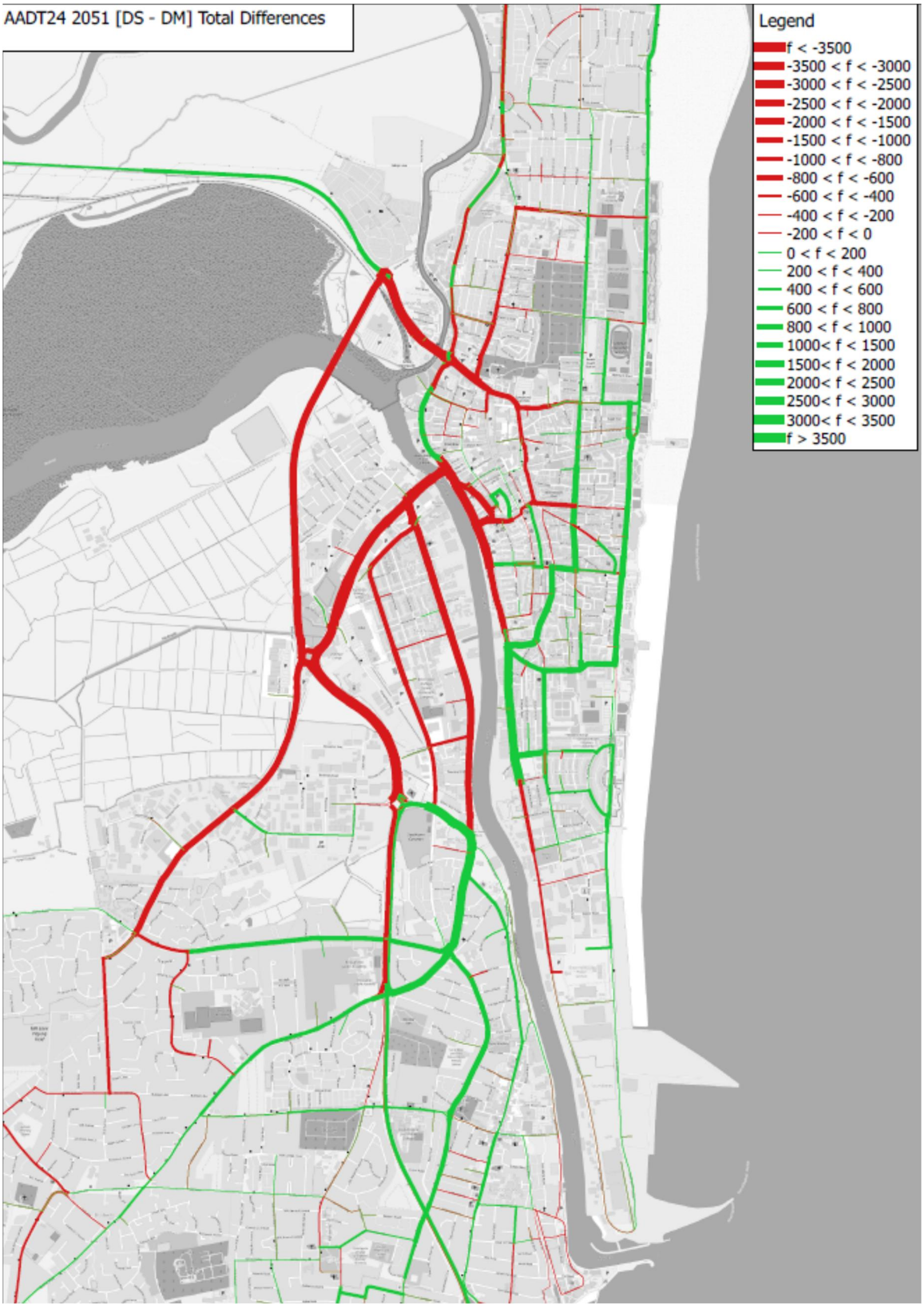
2023 DS vs DM AADT Change



2038 DS vs DM AADT Change



2051 DS vs DM AADT Change


AADT24 2051 [DS - DM] Total Differences
Legend
f < -3500
-3500 < f < -3000
-3000 < f < -2500
-2500 < f < -2000
-2000 < f < -1500
-1500 < f < -1000
-1000 < f < -800
-800 < f < -600
-600 < f < -400
-400 < f < -200
-200 < f < 0
0 < f < 200
200 < f < 400
400 < f < 600
600 < f < 800
800 < f < 1000
1000< f < 1500
1500< f < 2000
2000< f < 2500
2500< f < 3000
3000< f < 3500
f > 3500

Appendix F

REFERENCE MATRIX COMPRESSION

2023 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	5	5	0	4	2	0	16	5	4	3
2	3	16	2	5	2	6	21	5	8	9
3	1	2	0	4	0	0	22	1	1	3
4	8	9	12	3	3	14	84	6	1	17
5	2	2	0	0	0	0	5	1	0	0
6	2	2	0	5	0	0	10	1	1	1
7	12	29	4	50	14	13	194	13	3	22
8	5	16	1	10	1	1	31	2	14	14
9	4	10	3	1	0	9	9	15	15	10
10	2	9	2	2	1	3	8	4	3	1

UC2	1	2	3	4	5	6	7	8	9	10
1	18	21	9	24	1	2	55	7	30	6
2	91	32	22	29	4	12	140	21	19	20
3	33	20	1	25	0	0	145	40	19	15
4	75	70	29	18	4	27	477	20	3	43
5	6	10	0	5	0	0	30	6	0	5
6	11	23	1	14	0	0	67	14	4	4
7	143	171	142	302	44	26	1,119	49	20	174
8	75	94	98	33	13	43	152	175	84	47
9	48	60	37	11	3	19	54	53	41	44
10	13	12	6	32	3	1	31	8	4	3

UC3	1	2	3	4	5	6	7	8	9	10
1	84	86	15	3	1	1	110	20	32	57
2	71	276	12	28	6	8	262	41	114	145
3	8	9	1	20	0	0	79	9	8	16
4	20	43	29	32	5	21	548	13	4	46
5	1	7	0	2	0	0	16	4	0	0
6	2	10	1	18	0	0	42	3	1	3
7	181	248	33	345	22	29	2,819	108	33	256
8	78	135	5	27	3	3	199	22	139	97

	1	2	3	4	5	6	7	8	9	10
9	50	157	15	4	2	11	117	130	253	128
10	39	148	12	13	2	4	105	29	43	25

LGV	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	21	17	6	24	2	2	37	5	13	11
2	37	55	8	21	6	4	79	21	48	22
3	8	5	0	10	0	0	28	3	13	4
4	33	30	12	13	3	138	148	9	5	35
5	4	4	0	3	0	0	20	1	1	0
6	9	6	1	56	0	0	61	1	3	2
7	57	89	40	160	13	52	643	44	33	49
8	27	49	3	24	2	3	54	10	89	29
9	15	25	14	8	1	10	14	47	85	12
10	9	31	7	6	1	2	19	15	14	6

HGV	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0	11	1	29	0	1	18	12	19	2
2	6	0	55	4	0	13	11	15	73	0
3	9	65	0	7	0	0	18	5	0	1
4	18	2	3	65	1	62	173	4	7	4
5	0	3	0	1	0	0	23	9	1	5
6	1	1	0	23	0	0	71	0	1	0
7	51	5	22	124	74	51	25	8	5	24
8	17	4	0	21	0	0	12	6	8	0
9	11	31	3	2	0	8	2	7	0	0
10	7	0	7	1	0	6	22	1	0	0

2023 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	6	17	5	11	0	3	27	3	3	18
2	20	13	3	6	2	5	29	15	13	8
3	6	1	0	3	0	0	22	1	2	2
4	2	3	1	5	1	6	68	4	1	6
5	1	1	0	1	0	0	5	1	0	2
6	3	2	0	6	0	0	13	2	5	5
7	19	26	19	58	5	11	178	24	11	32
8	6	10	1	6	1	2	27	3	16	8
9	3	10	2	2	1	8	8	15	14	7
10	6	7	5	7	2	15	11	8	6	1

UC2	1	2	3	4	5	6	7	8	9	10
1	5	25	6	9	2	4	41	11	8	11
2	26	8	6	9	6	2	63	21	16	4
3	11	3	0	3	0	0	47	29	10	2
4	10	2	1	9	6	20	106	2	1	14
5	1	1	0	7	0	0	17	2	1	1
6	3	1	0	16	0	0	30	10	2	1
7	34	35	28	124	14	14	263	38	10	34
8	13	9	21	6	2	8	38	40	15	4
9	10	8	8	3	1	2	36	14	11	3
10	7	3	7	8	1	3	24	6	4	0

UC3	1	2	3	4	5	6	7	8	9	10
1	134	95	9	12	2	5	189	29	53	70
2	107	287	21	51	5	6	391	133	226	181
3	11	10	1	14	1	0	87	8	16	12
4	9	35	17	51	2	29	602	30	10	82
5	1	3	2	2	0	0	24	3	2	5
6	5	3	0	21	0	1	47	4	10	10
7	190	320	79	522	19	41	3,455	204	125	359
8	30	90	9	39	3	5	191	28	186	72
9	40	167	18	10	3	11	110	157	291	99
10	61	143	43	51	4	18	167	62	92	23

LGV	1	2	3	4	5	6	7	8	9	10
1	29	43	1	15	1	2	41	15	10	19
2	31	48	4	16	5	2	66	21	46	19
3	2	3	0	4	0	0	15	1	2	1
4	19	17	2	14	2	43	108	3	3	11
5	3	2	0	2	0	0	11	1	1	1
6	3	1	0	34	0	0	31	1	2	2
7	60	79	8	128	7	17	641	18	13	49
8	18	18	2	8	1	1	26	4	35	8
9	9	50	4	5	1	2	22	26	78	17
10	20	24	5	4	1	3	18	10	13	6

HGV	1	2	3	4	5	6	7	8	9	10
1	0	1	3	23	8	4	33	6	12	7
2	15	1	6	3	3	84	7	19	82	0
3	7	6	0	8	0	0	20	0	0	8
4	18	3	7	1	5	53	186	2	1	1
5	6	6	0	3	0	0	53	1	1	5
6	2	53	0	22	0	0	37	0	0	0
7	29	4	32	146	54	28	17	8	3	13
8	16	32	0	3	1	0	9	4	3	6
9	10	39	0	1	0	0	3	2	0	0

10	18	0	3	1	6	0	14	8	0	0

2023 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	6	19	0	10	2	1	11	5	7	1
2	16	14	2	8	2	1	31	7	6	8
3	10	2	0	9	0	0	41	1	4	2
4	1	3	1	2	1	9	56	11	0	2
5	1	1	0	2	0	0	16	1	0	0
6	1	5	0	5	0	0	27	1	10	1
7	9	36	31	83	5	11	167	26	12	11
8	3	5	1	4	2	2	18	1	15	7
9	5	6	2	2	0	1	4	12	12	4
10	4	10	4	4	0	1	13	10	5	1

UC2	1	2	3	4	5	6	7	8	9	10

1	20	79	31	82	13	9	141	76	37	19
2	28	30	23	46	6	8	110	34	25	11
3	23	15	0	24	0	1	162	81	46	6
4	5	17	5	16	5	36	326	34	24	16
5	1	5	0	4	0	0	81	11	3	2
6	7	11	0	14	0	0	72	36	20	1
7	49	87	159	477	31	48	885	229	74	44
8	16	18	41	22	7	13	71	156	48	14
9	8	16	20	5	1	4	21	67	31	6
10	4	25	16	16	3	5	51	34	17	1

UC3	1	2	3	4	5	6	7	8	9	10
1	155	61	10	38	0	1	198	48	30	93
2	95	340	22	71	12	6	273	82	144	210
3	21	15	1	20	0	1	116	8	32	17
4	3	35	4	37	5	43	567	45	3	18
5	0	4	0	8	0	0	58	4	0	2
6	3	12	0	15	0	0	59	5	19	3
7	105	356	79	753	17	59	3,492	256	205	223
8	18	63	9	40	5	4	126	20	180	73
9	24	138	14	12	1	1	69	168	307	71
10	109	264	33	31	2	3	118	92	99	25

LGV	1	2	3	4	5	6	7	8	9	10
1	19	23	4	21	6	2	39	27	18	15
2	23	48	3	38	6	3	95	36	48	26
3	2	3	0	7	0	1	30	1	4	6
4	9	22	5	13	5	90	142	19	17	9
5	3	1	0	2	0	0	23	1	1	1
6	2	1	0	43	0	0	58	1	4	1
7	30	54	18	150	5	33	651	28	46	43
8	16	12	2	9	1	1	25	5	35	14
9	7	39	2	6	1	1	23	32	82	16
10	11	18	4	6	0	0	11	12	15	5

HGV	1	2	3	4	5	6	7	8	9	10
1	0	0	10	4	0	0	22	0	1	5
2	11	0	67	2	1	3	3	3	71	0
3	0	57	0	2	0	0	13	0	1	13
4	8	2	0	15	0	12	89	1	2	1
5	2	5	0	0	0	0	20	0	0	0
6	1	8	0	10	0	0	20	0	7	5
7	22	2	17	94	12	11	14	25	3	17
8	7	5	3	5	6	0	3	4	4	0
9	4	21	0	7	0	0	2	3	0	0
10	3	0	0	6	1	0	3	0	0	0

2038 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	5	5	0	4	2	0	18	5	4	4
2	3	16	2	5	2	6	22	5	8	9
3	1	2	0	4	0	0	24	1	2	4

4	8	10	12	3	4	15	88	6	1	17
5	2	2	0	0	0	0	5	1	0	0
6	2	2	0	5	0	0	11	1	1	1
7	13	30	5	54	15	16	214	14	6	28
8	5	17	1	11	1	2	34	2	14	15
9	5	10	3	1	0	9	13	15	16	11
10	3	9	2	2	1	3	14	5	4	2

UC2	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	19	20	10	26	1	2	61	8	31	10
2	89	32	23	31	4	12	141	21	19	23
3	36	21	4	26	1	1	167	42	20	20
4	75	71	31	19	5	27	489	21	4	46
5	7	10	1	5	0	0	33	7	1	5
6	12	24	2	15	0	0	73	15	4	6
7	153	171	159	326	47	31	1,242	58	30	209
8	75	93	102	36	14	46	171	180	86	55
9	54	61	39	13	4	20	78	55	41	51
10	23	14	9	34	4	2	68	11	7	7

UC3	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	84	87	15	4	1	1	125	20	38	69
2	70	278	12	30	6	8	278	42	120	161
3	9	11	3	22	1	1	92	11	10	20
4	20	46	33	35	5	24	609	11	7	55
5	1	7	0	2	0	0	18	5	0	1
6	2	12	1	20	0	1	45	3	1	4
7	206	293	42	391	25	32	3,285	119	88	404
8	71	135	8	30	4	5	210	22	148	115
9	81	165	15	6	2	12	207	136	257	151
10	68	168	13	17	2	4	231	39	61	43

LGV	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	27	24	7	28	3	4	51	7	16	15
2	49	71	11	29	6	7	106	26	62	32

3	9	7	1	13	1	1	35	5	16	6
4	42	40	17	22	4	174	187	17	14	42
5	5	5	1	5	0	0	24	2	3	1
6	11	8	1	77	1	0	72	3	7	3
7	82	123	50	195	15	68	832	60	57	69
8	34	57	7	37	4	9	80	16	104	34
9	20	35	18	13	2	13	30	53	104	16
10	13	37	8	10	2	3	31	17	17	8

HGV	1	2	3	4	5	6	7	8	9	10
1	1	12	3	32	0	2	23	14	21	2
2	8	1	62	9	1	14	22	17	75	0
3	11	73	0	9	1	0	22	5	2	2
4	23	7	5	71	3	71	192	7	15	5
5	2	4	0	2	0	0	26	9	2	5
6	2	1	0	27	0	0	75	1	2	0
7	58	9	26	141	83	58	35	11	8	26
8	19	5	0	25	1	1	15	6	9	1
9	12	32	4	6	1	9	4	8	0	0
10	8	0	7	2	1	7	24	2	1	0

2038 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	7	17	6	12	0	3	29	3	3	20
2	20	13	3	6	2	5	29	15	13	9
3	6	1	0	3	0	0	24	1	2	2
4	2	3	1	5	1	7	71	4	1	6
5	1	1	0	1	0	0	5	1	0	2
6	3	2	0	6	0	0	15	2	6	5
7	20	26	21	61	6	13	197	25	14	40
8	6	10	1	7	1	3	29	3	17	9
9	4	10	2	2	1	9	11	16	14	9
10	7	7	6	8	2	15	20	9	7	3

UC2	1	2	3	4	5	6	7	8	9	10
1	5	25	6	9	2	4	42	11	9	13
2	25	7	6	10	6	2	60	20	16	4
3	11	3	1	4	0	0	52	30	11	4
4	11	2	1	9	6	21	111	3	2	15
5	2	2	0	7	0	0	18	2	1	1
6	3	1	0	16	0	0	32	10	3	2
7	34	35	31	127	15	16	292	41	14	48
8	13	9	21	7	2	8	41	41	15	6
9	10	8	8	3	1	2	41	15	11	5
10	9	4	8	9	1	4	40	8	5	3

UC3	1	2	3	4	5	6	7	8	9	10
1	136	98	10	14	2	6	200	30	70	100
2	109	289	22	56	5	7	406	137	237	202
3	12	11	4	16	1	1	99	12	18	17
4	10	39	20	57	2	32	674	36	13	98
5	2	3	2	3	0	1	27	4	3	5

6	5	4	1	23	0	2	52	5	11	11
7	201	339	96	583	22	47	4,045	225	212	569
8	31	93	12	45	3	6	210	35	201	87
9	55	176	21	13	3	12	189	172	312	133
10	91	167	49	61	5	20	373	80	132	51

LGV	1	2	3	4	5	6	7	8	9	10
1	38	54	2	19	2	3	60	17	14	25
2	42	64	5	21	5	3	90	24	57	26
3	2	4	0	5	0	0	17	2	3	2
4	23	23	3	21	3	55	135	7	7	14
5	3	3	0	4	0	0	14	2	2	1
6	4	2	0	45	1	0	37	2	3	2
7	83	110	10	156	9	22	828	28	27	64
8	21	22	2	13	2	2	37	7	42	10
9	13	62	4	10	2	3	36	31	96	21
10	25	31	5	7	1	4	30	11	16	9

HGV	1	2	3	4	5	6	7	8	9	10
1	1	2	5	25	9	5	38	7	14	7
2	17	2	8	9	4	91	18	21	85	1
3	8	8	0	9	0	0	23	0	1	8
4	22	8	8	4	8	60	206	3	4	1
5	7	6	1	5	0	1	59	1	2	5
6	3	57	0	25	0	0	41	1	2	1
7	35	10	35	161	60	32	26	11	6	16
8	18	35	0	4	1	1	12	4	4	7
9	12	41	1	2	1	1	5	3	0	1
10	19	1	4	1	6	1	16	8	1	1

2038 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	7	19	1	10	2	1	12	5	7	2
2	16	13	3	8	1	1	31	7	6	9
3	11	2	0	10	0	0	45	1	5	3
4	2	3	1	2	1	10	61	12	0	2
5	1	1	0	2	0	0	17	1	0	0
6	1	5	0	5	0	0	29	2	10	1
7	11	36	33	87	6	12	184	28	15	18
8	3	5	1	4	2	2	19	1	15	8
9	5	7	2	2	0	2	7	13	12	5
10	5	11	5	4	0	1	20	11	7	2

UC2	1	2	3	4	5	6	7	8	9	10
1	19	74	33	81	13	10	143	73	40	35
2	25	28	23	46	6	8	98	31	23	11
3	24	15	2	26	0	2	178	83	48	11
4	5	18	6	16	6	38	342	38	26	19
5	2	5	1	4	0	0	86	12	4	3
6	8	11	1	16	0	0	78	39	21	2
7	47	83	179	481	33	53	948	233	94	112
8	15	18	42	23	8	13	75	154	48	20

9	9	16	22	6	1	5	39	67	29	13
10	11	26	23	20	4	6	115	45	27	11

UC3	1	2	3	4	5	6	7	8	9	10
1	157	65	10	41	1	1	208	47	54	117
2	99	347	23	75	12	7	302	84	154	233
3	22	16	4	23	1	2	133	14	35	21
4	4	40	5	41	5	46	634	51	6	24
5	0	5	1	9	0	0	64	5	1	3
6	4	13	1	17	0	1	64	7	20	4
7	126	388	94	830	20	66	4,020	278	289	386
8	20	65	11	44	5	4	139	24	191	86
9	34	149	16	15	1	2	129	179	323	94
10	128	291	36	40	3	4	262	108	129	46

LGV	1	2	3	4	5	6	7	8	9	10
1	23	31	4	26	6	3	60	31	24	21
2	31	62	5	47	7	5	128	43	64	35
3	3	5	0	10	0	1	37	3	6	7
4	13	27	7	21	6	114	181	27	25	13
5	3	1	0	3	0	0	27	3	2	2
6	3	3	1	59	0	0	69	3	6	1
7	43	77	22	185	7	43	840	44	69	58
8	18	16	3	15	2	2	38	8	41	16
9	10	47	4	12	2	3	40	38	100	19
10	13	22	5	9	0	1	21	13	18	6

HGV	1	2	3	4	5	6	7	8	9	10
1	0	0	10	7	0	0	24	1	3	5
2	12	0	78	7	1	3	10	5	73	0
3	1	64	0	2	0	0	17	0	2	14
4	11	5	0	15	0	14	96	1	8	3
5	3	6	0	0	0	0	23	0	1	1
6	2	9	0	11	0	0	23	0	8	5
7	24	5	21	106	15	12	17	29	8	19

8	8	6	3	5	6	0	6	4	5	2
9	4	21	0	9	0	0	5	3	0	0
10	3	0	0	7	1	0	4	0	0	0

2051 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	6	6	1	5	2	1	20	5	5	4
2	4	18	2	5	2	6	26	5	9	10
3	1	2	0	5	0	0	26	2	2	4
4	8	10	13	3	4	16	93	7	2	18
5	2	2	0	0	0	0	6	1	0	0
6	2	3	0	5	0	0	12	2	2	1
7	13	33	6	57	16	17	230	16	7	30
8	5	18	1	12	1	2	37	3	15	16
9	6	12	3	1	1	10	16	16	17	12

10	3	10	2	2	1	4	15	5	5	3

UC2	1	2	3	4	5	6	7	8	9	10
1	21	24	11	28	1	3	72	9	32	13
2	94	36	25	33	5	13	165	24	22	28
3	37	24	6	28	1	2	183	45	22	23
4	77	74	32	21	5	28	510	23	5	48
5	7	10	1	5	0	0	35	7	1	6
6	12	26	3	16	0	0	78	16	5	7
7	154	194	172	349	49	35	1,339	69	37	223
8	77	99	106	39	15	48	189	188	90	59
9	55	66	41	15	4	21	89	58	44	54
10	22	17	11	35	4	2	74	13	8	9

UC3	1	2	3	4	5	6	7	8	9	10
1	89	101	16	5	1	2	156	23	43	82
2	80	307	14	34	7	9	348	48	135	189
3	10	14	5	23	1	1	102	13	12	22
4	20	51	35	38	6	25	658	12	9	60
5	1	7	0	3	0	0	19	5	1	1
6	2	13	2	22	0	2	48	4	2	5
7	197	356	48	427	27	35	3,621	128	111	437
8	71	148	10	34	4	7	231	27	159	120
9	86	186	17	8	2	13	249	147	280	168
10	67	189	14	20	3	5	259	42	68	59

LGV	1	2	3	4	5	6	7	8	9	10
1	31	31	8	31	3	5	63	9	19	18
2	58	83	14	35	7	9	128	29	73	39
3	11	9	1	16	1	1	41	6	19	7
4	49	48	21	29	6	204	219	24	22	47
5	5	6	1	6	0	1	28	3	4	1
6	12	10	1	93	1	0	81	5	9	3
7	102	151	59	224	17	81	986	72	77	85
8	39	64	10	47	5	13	102	22	117	37

9	23	44	20	18	3	15	43	58	119	20
10	16	42	9	12	2	3	41	18	20	10

HGV	1	2	3	4	5	6	7	8	9	10
1	1	14	4	35	1	4	28	15	23	2
2	10	1	68	13	1	15	33	18	77	1
3	12	80	0	12	1	1	25	5	3	3
4	28	11	6	77	4	79	210	9	23	7
5	3	5	0	3	0	0	29	9	2	5
6	4	1	0	31	0	0	79	1	3	0
7	64	14	30	157	92	64	46	14	11	27
8	20	5	1	29	1	1	18	6	9	1
9	14	33	5	9	1	10	7	8	0	1
10	8	0	8	3	1	7	26	3	1	0

2051 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	8	18	6	13	0	4	32	4	4	21
2	21	14	3	6	2	5	33	16	14	10
3	6	2	0	4	0	0	25	2	3	3
4	3	3	1	5	1	7	75	5	2	7
5	1	1	0	1	0	0	6	1	0	2
6	3	2	0	7	0	0	16	2	6	6
7	22	30	22	65	6	15	209	27	16	43
8	6	11	2	8	1	3	31	4	18	10
9	4	11	3	3	1	9	13	17	15	9
10	8	8	6	8	2	16	21	9	8	4

UC2	1	2	3	4	5	6	7	8	9	10
1	6	26	7	10	2	5	46	12	9	14
2	27	8	7	10	6	2	66	22	17	5
3	12	3	1	4	0	1	56	31	11	4
4	12	2	2	9	6	22	116	3	2	16
5	2	2	0	7	0	0	19	2	1	1
6	4	1	0	17	0	0	35	11	3	2
7	38	36	34	132	16	17	313	43	16	47
8	14	9	22	7	2	9	44	43	16	6
9	11	9	9	3	1	3	44	16	12	5
10	11	4	9	9	1	4	41	8	6	2

UC3	1	2	3	4	5	6	7	8	9	10
1	140	107	10	15	3	6	205	32	75	103
2	119	318	26	63	6	8	501	150	261	240
3	12	13	7	18	2	2	107	14	21	20
4	11	45	21	62	2	35	726	41	16	105
5	2	3	3	3	0	1	30	4	3	6
6	5	4	2	25	1	4	56	6	12	12
7	211	418	108	626	24	52	4,494	246	262	621
8	33	102	14	50	4	7	230	39	214	92
9	59	195	24	16	4	14	231	185	340	147
10	94	194	52	66	5	21	406	84	145	73

LGV	1	2	3	4	5	6	7	8	9	10
1	45	63	2	22	2	3	75	19	17	29
2	51	77	6	26	6	3	109	27	66	33
3	3	6	0	7	1	0	20	2	4	3
4	27	27	4	27	4	64	157	10	11	16
5	4	3	1	5	0	1	16	2	2	1
6	5	3	0	55	1	0	42	3	4	2
7	102	135	13	179	11	27	982	37	39	76
8	24	26	3	17	2	3	46	9	47	11
9	17	72	5	14	2	4	48	36	111	25
10	28	36	5	9	1	4	40	12	18	11

HGV	1	2	3	4	5	6	7	8	9	10
1	2	3	6	27	10	7	42	8	17	8
2	19	3	10	14	5	99	30	24	89	1
3	9	10	0	10	1	1	25	0	2	9
4	25	13	10	7	11	67	225	3	7	2
5	8	7	1	7	0	1	65	1	3	5
6	4	61	1	29	1	0	44	1	3	1
7	41	16	38	175	66	36	35	13	10	18
8	20	38	1	5	2	2	14	4	4	8
9	13	42	1	4	2	1	7	3	0	1
10	19	1	5	2	7	1	19	9	2	1

2051 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	7	20	1	10	2	1	12	5	8	2
2	17	14	3	9	2	2	35	8	7	10
3	11	3	1	10	0	0	47	2	6	4
4	2	4	2	3	1	10	65	12	1	3
5	1	1	0	3	0	0	18	1	0	0
6	2	6	0	6	0	0	31	2	11	2
7	13	41	36	91	6	13	198	30	18	20
8	3	6	2	5	2	2	20	2	16	8
9	6	7	2	2	0	2	8	13	13	6
10	6	12	5	5	0	1	21	12	7	2

UC2	1	2	3	4	5	6	7	8	9	10
1	20	79	35	84	13	11	150	76	41	34
2	27	30	23	47	6	8	106	33	24	12
3	25	16	4	26	1	2	194	88	49	13
4	5	19	7	17	6	39	367	41	28	20
5	2	6	1	5	0	0	90	13	4	3
6	8	11	2	16	0	0	84	42	22	3
7	49	93	198	502	36	59	1,051	256	98	115
8	16	20	45	25	8	14	85	163	51	22
9	9	17	23	7	1	5	40	70	30	13
10	11	29	26	21	4	7	120	47	27	10

UC3	1	2	3	4	5	6	7	8	9	10

1	161	71	11	43	1	1	203	47	57	117
2	113	382	26	82	13	9	366	94	173	260
3	23	19	7	25	1	2	145	17	38	23
4	6	45	6	44	6	48	683	56	9	27
5	1	6	1	9	0	1	68	6	2	3
6	4	14	2	19	1	2	68	8	22	5
7	159	466	104	890	22	71	4,440	301	331	421
8	23	73	13	48	6	5	152	28	203	91
9	39	167	19	18	1	2	158	191	352	103
10	142	321	38	43	3	4	292	112	140	67

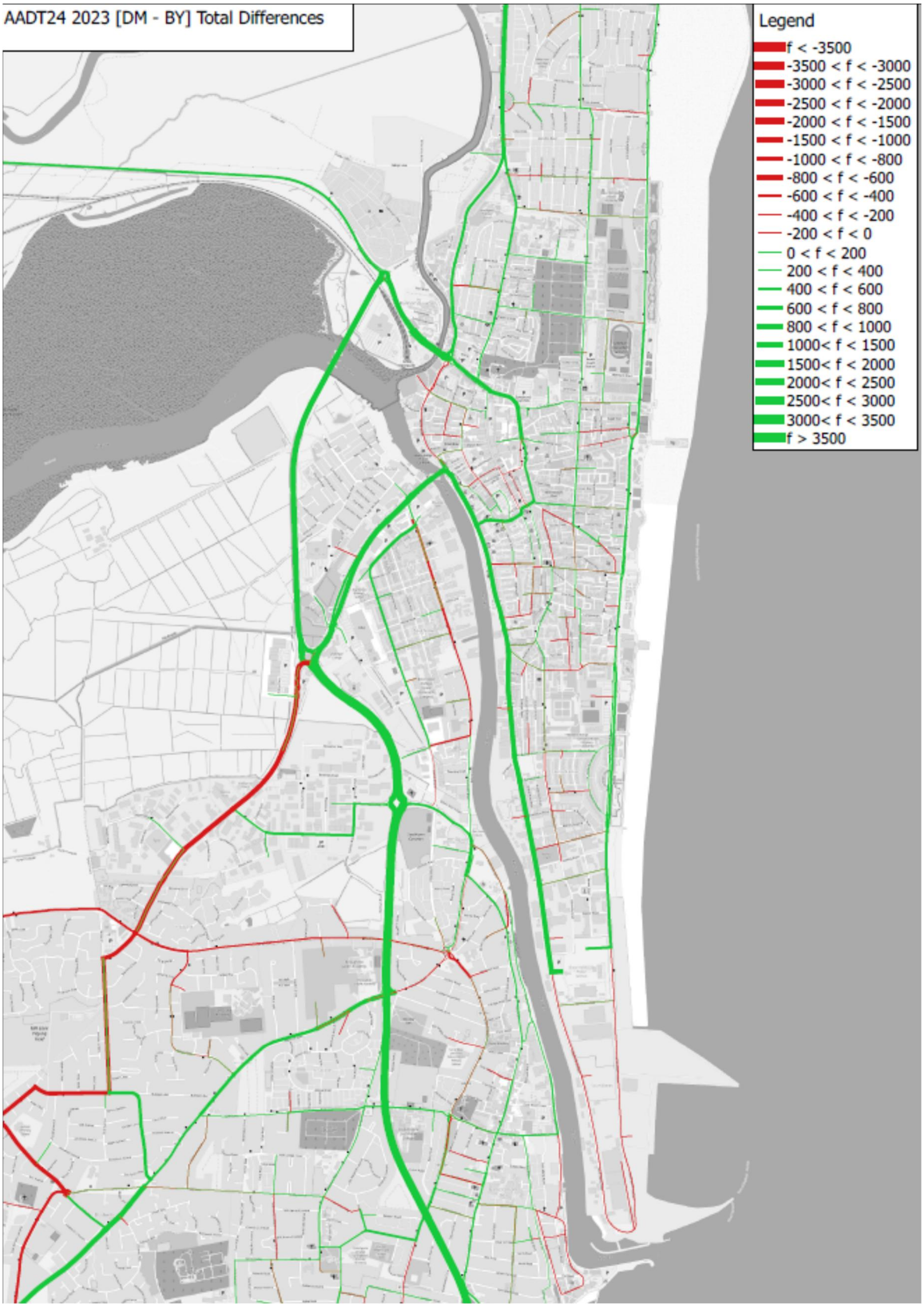
LGV	1	2	3	4	5	6	7	8	9	10
1	27	37	5	31	7	4	77	34	28	25
2	38	74	6	55	7	6	156	49	78	43
3	3	6	1	12	1	2	43	4	8	8
4	15	32	9	28	7	133	213	34	32	16
5	4	2	0	5	0	1	31	3	3	2
6	3	3	1	72	1	0	78	4	8	2
7	55	95	26	214	9	51	995	57	87	70
8	19	19	3	19	2	3	48	10	47	18
9	12	54	4	17	2	5	54	44	114	22
10	15	25	5	10	0	1	30	15	20	8

HGV	1	2	3	4	5	6	7	8	9	10
1	0	1	11	9	1	1	25	1	3	5
2	14	0	89	12	2	3	16	6	74	0
3	2	70	0	2	0	0	20	0	4	16
4	14	8	0	15	0	15	103	1	13	4
5	4	7	0	0	0	0	25	0	1	1
6	4	11	0	12	0	0	26	0	8	5
7	26	8	26	118	17	13	19	32	12	20
8	9	7	3	6	6	0	8	4	5	3
9	5	22	0	11	0	0	8	3	0	0
10	3	0	0	8	2	0	4	1	0	0

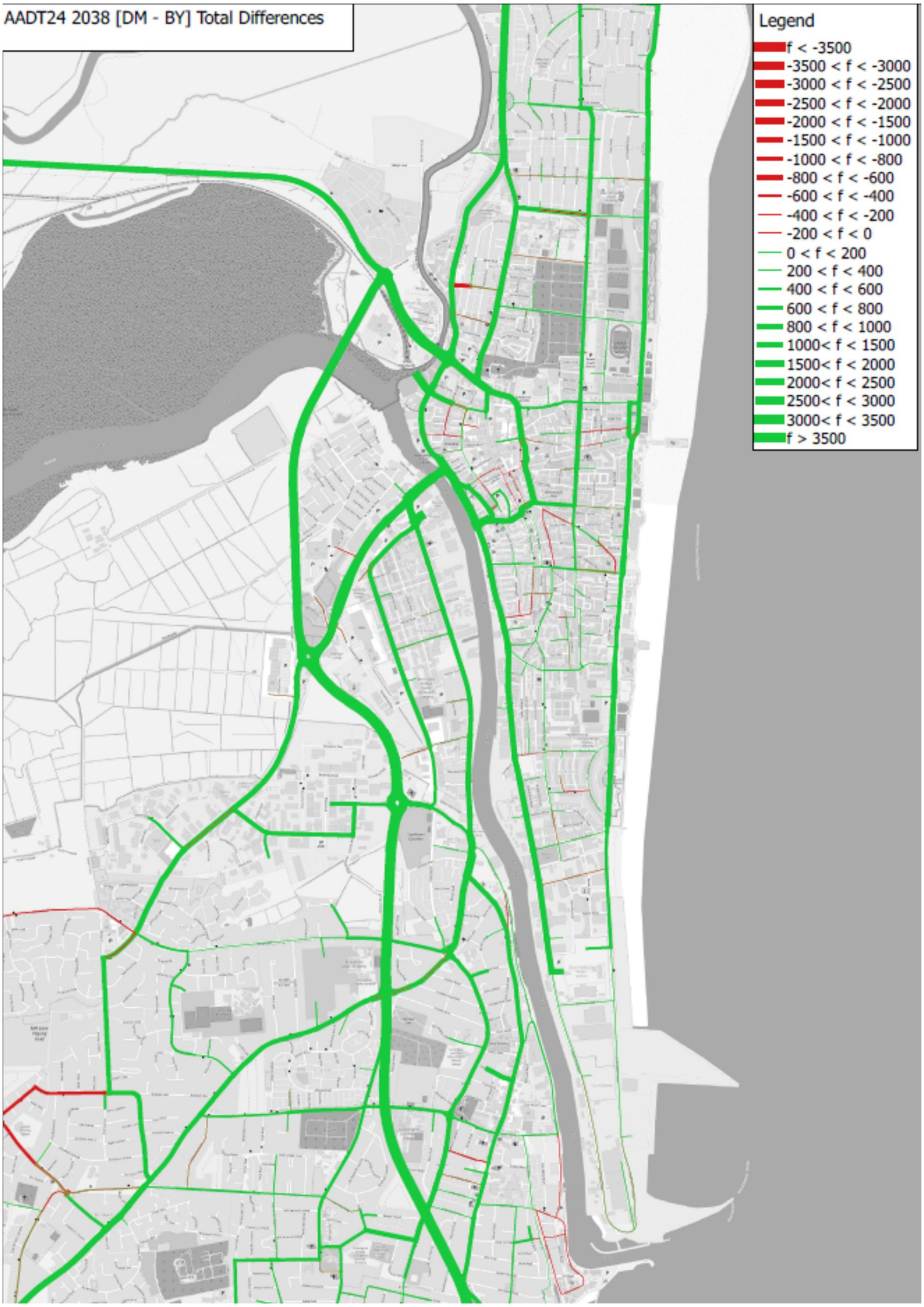
Appendix G

VDM TRAFFIC FLOW CHANGES

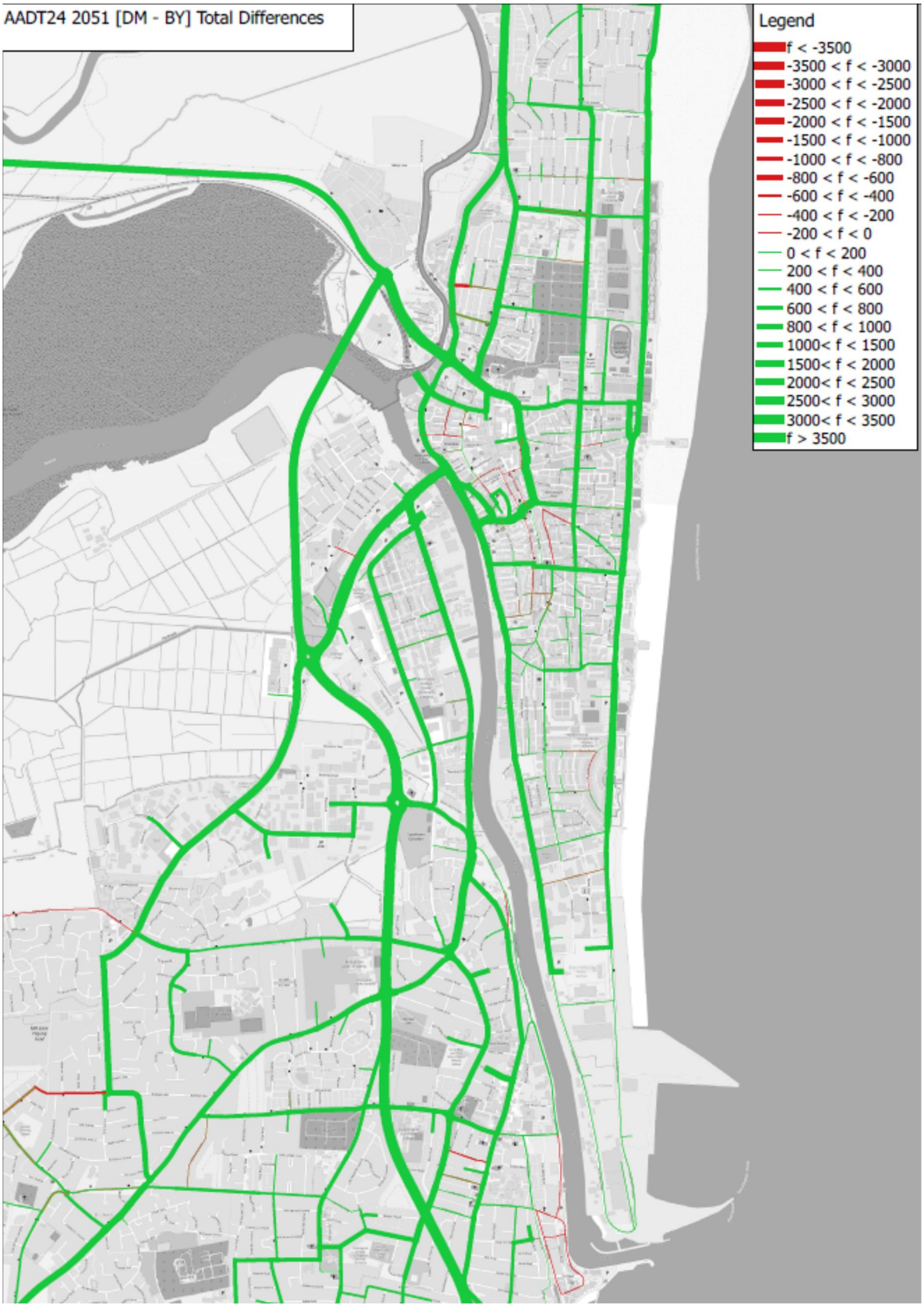
2023 DM vs BASE AADT Change



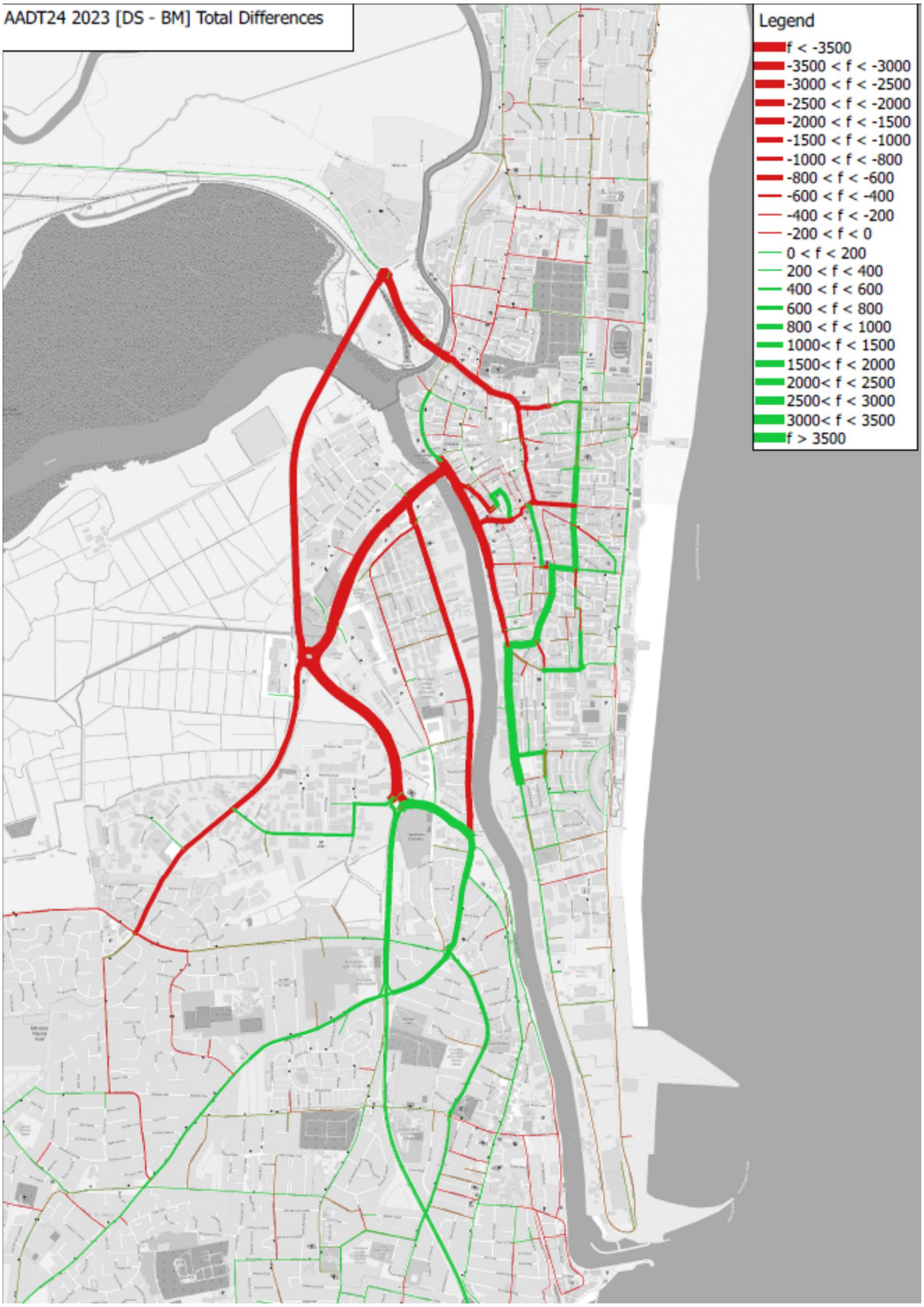
2038 DM vs BASE AADT Change



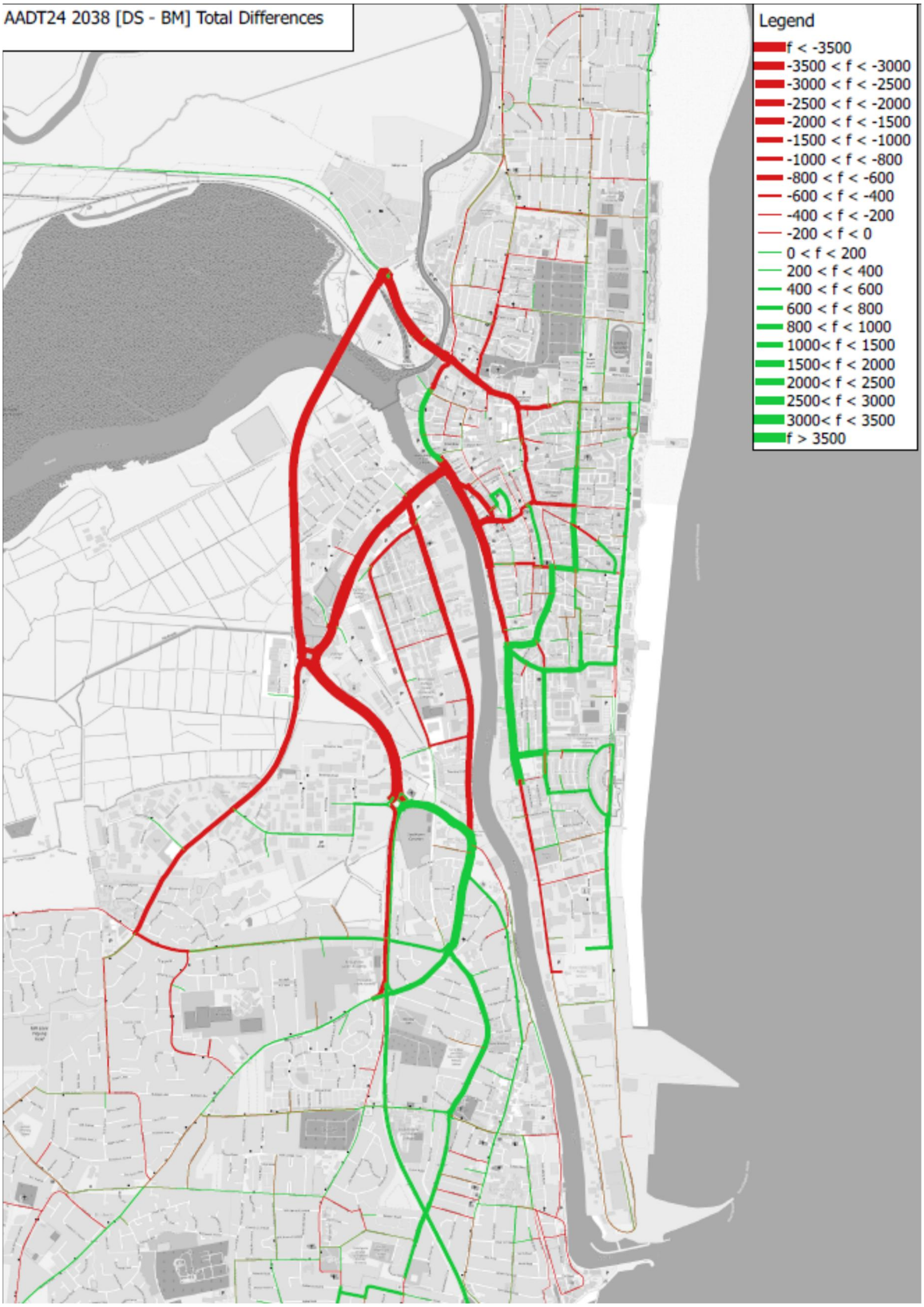
2051 DM vs BASE AADT Change



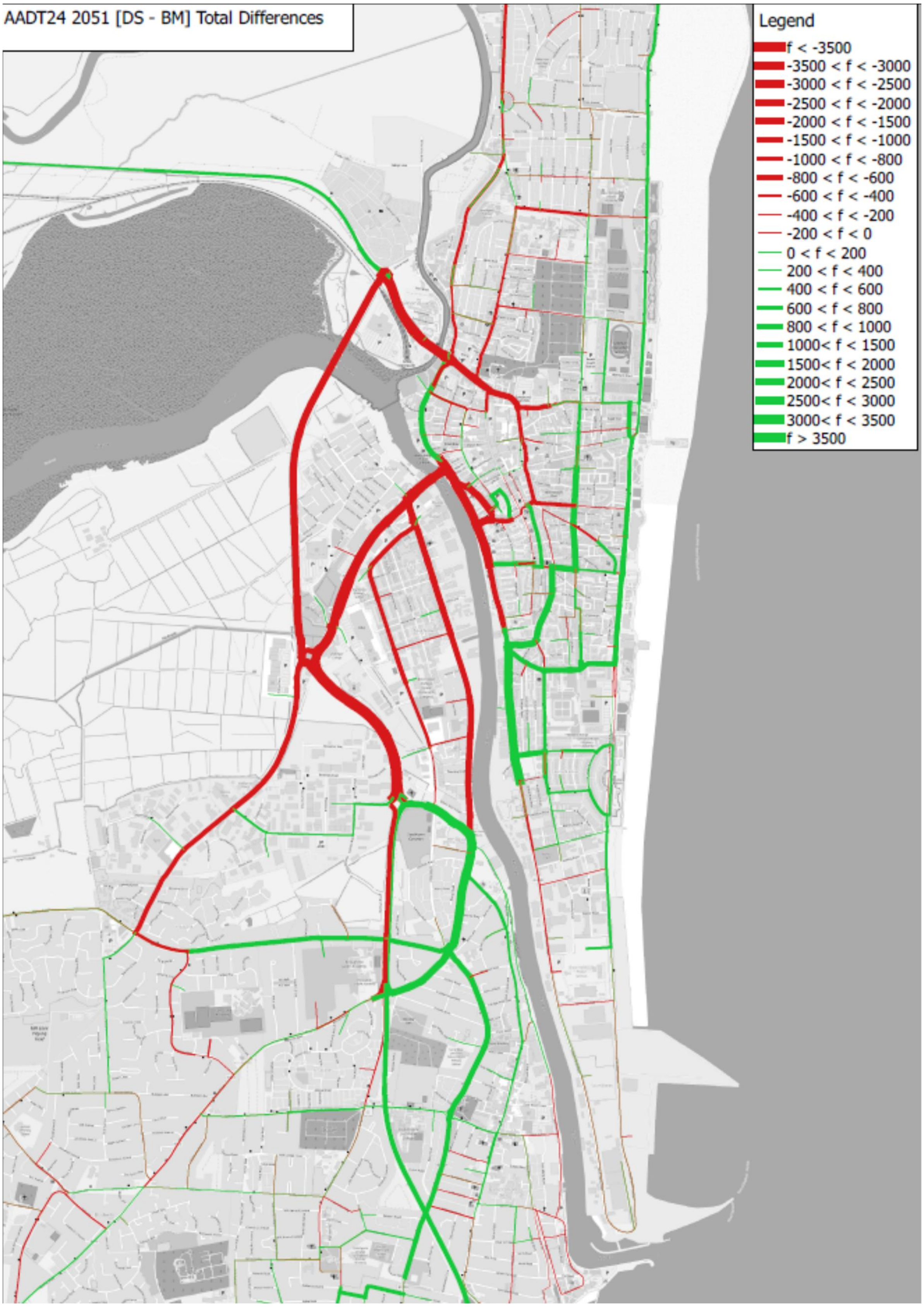
2023 DS vs DM AADT Change



2038 DS vs DM AADT Change



2051 DS vs DM AADT Change



Appendix H

VDM MATRIX SECTOR COMPRESSION

DM VDM versus REFERENCE. Volume Change by Sector

2023 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	0.0	0.1	0.0	0.0	0.1	0.1	-0.5	0.0	0.0	0.1
2	0.0	0.1	0.0	0.0	0.1	0.2	-0.7	0.1	0.1	0.1
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	-0.1	-0.1	0.4	0.0	0.1	0.7	-0.7	0.0	0.0	-0.2
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
7	-2.3	-1.0	0.2	0.7	0.9	0.8	1.1	-0.2	-0.4	-1.0
8	-0.3	0.2	0.0	0.1	0.1	0.2	-0.8	0.1	0.2	0.1
9	-0.2	0.0	0.1	0.0	0.0	0.6	-0.7	0.3	0.0	0.0
10	0.0	0.0	0.0	0.0	0.1	0.1	-0.3	0.1	0.0	0.0

UC2	1	2	3	4	5	6	7	8	9	10
1	0.4	1.0	0.1	-0.1	0.0	0.1	-3.9	-0.1	-0.1	0.8
2	4.0	0.8	-0.3	-0.9	-0.1	-0.2	-6.6	0.4	0.2	0.7
3	1.5	0.0	0.0	-0.1	0.0	0.0	-3.1	1.0	0.6	0.0
4	-1.3	-2.2	0.0	-0.3	-0.3	0.2	1.7	-0.7	-0.1	-1.3
5	0.2	-0.1	0.0	-0.1	0.0	0.0	0.3	0.3	0.0	-0.1
6	0.7	0.4	0.0	0.3	0.0	0.0	-0.8	0.6	0.3	0.0
7	-10.3	-6.6	-3.4	0.6	-0.2	-0.8	14.7	-5.0	-2.3	-4.6
8	2.1	2.3	2.9	-0.4	0.4	1.1	-15.3	3.5	1.8	1.0
9	0.1	0.8	1.2	-0.3	0.1	0.4	-6.3	1.5	0.0	1.2
10	1.6	0.2	-0.2	-0.8	-0.1	0.0	-0.5	0.1	0.1	0.1

UC3	1	2	3	4	5	6	7	8	9	10
1	0.2	3.8	0.6	0.5	0.1	0.1	-17.0	0.2	-0.4	2.7
2	5.3	5.3	0.3	0.4	0.0	0.3	-11.5	1.3	1.9	2.6
3	0.3	0.1	0.0	0.4	0.0	0.0	0.4	0.3	0.2	0.1
4	2.1	-0.7	0.2	0.3	0.3	2.1	2.7	0.1	0.1	-1.6
5	0.1	0.2	0.0	0.1	0.0	0.0	0.5	0.3	0.0	0.0
6	0.3	0.2	0.0	1.3	0.0	0.0	2.2	0.3	0.1	0.1

UC1	1	2	3	4	5	6	7	8	9	10
7	-62.3	-13.8	0.7	4.6	1.4	1.9	32.2	-8.5	-10.0	-11.0
8	-5.9	3.3	0.5	0.7	0.3	0.5	-25.5	1.6	3.1	1.5
9	-4.4	2.7	1.0	0.5	0.3	1.1	-16.9	4.5	1.8	1.1
10	2.3	0.7	0.1	0.2	0.1	-0.2	-4.3	0.1	0.3	0.2

2023 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	0.0	0.1	0.1	0.2	0.0	0.1	-0.8	0.0	-0.1	0.2
2	0.2	0.1	0.0	0.0	0.1	0.2	-1.1	0.2	0.1	0.1
3	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.1	0.4	-0.2	0.0	0.0	-0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0
7	-2.0	-0.9	0.7	0.8	0.3	0.6	2.3	-0.4	-0.9	-1.0
8	-0.1	0.1	0.0	0.1	0.1	0.1	-0.7	0.1	0.2	0.1
9	-0.1	0.0	0.1	0.0	0.0	0.4	-0.8	0.3	0.0	0.0
10	-0.1	-0.1	0.1	0.1	0.1	0.7	-0.8	0.0	-0.1	0.0

UC2	1	2	3	4	5	6	7	8	9	10
1	0.1	0.7	0.1	0.1	0.1	0.2	-2.4	0.3	0.0	0.5
2	0.9	0.2	-0.1	-0.2	-0.1	0.0	-1.6	0.6	0.3	0.1
3	0.1	0.0	0.0	-0.1	0.0	0.0	-1.1	0.8	0.3	-0.1
4	-0.2	0.0	0.0	-0.2	0.2	0.2	0.8	-0.1	0.0	-0.4
5	0.1	0.0	0.0	0.3	0.0	0.0	-0.1	0.1	0.0	0.0
6	0.2	0.0	0.0	0.4	0.0	0.0	-0.1	0.3	0.1	0.0
7	-2.8	-1.2	-0.5	1.1	0.1	0.0	7.2	-3.2	-1.2	-0.7
8	0.4	0.3	0.6	-0.2	0.1	0.2	-3.1	1.1	0.4	0.1
9	0.0	0.1	0.2	-0.1	0.0	0.1	-1.7	0.4	0.0	0.1
10	0.3	0.0	-0.1	-0.4	0.0	0.0	-0.6	-0.1	0.0	0.0

UC1	1	2	3	4	5	6	7	8	9	10

UC3	1	2	3	4	5	6	7	8	9	10
1	0.3	3.9	0.6	1.8	0.1	0.5	-41.9	-0.1	-1.5	3.8
2	5.1	3.7	0.3	0.4	0.1	0.2	-15.8	4.0	3.1	2.2
3	0.4	0.2	0.0	0.3	0.0	0.0	1.0	0.4	0.8	0.0
4	1.0	-0.3	0.4	0.5	0.1	2.4	6.9	0.5	0.1	-0.9
5	0.1	0.1	0.0	0.1	0.0	0.0	1.0	0.3	0.2	0.2
6	0.3	0.2	0.0	1.8	0.0	0.0	2.8	0.3	0.7	0.6
7	-44.7	-14.7	2.0	7.6	0.8	3.5	69.9	-14.7	-19.5	-11.2
8	-1.6	2.4	0.5	0.6	0.3	0.5	-15.8	1.6	4.4	0.4
9	-1.9	2.0	1.0	0.2	0.3	1.1	-17.3	4.4	1.9	0.4
10	-0.6	-0.7	0.2	0.5	0.2	0.9	-7.4	0.0	0.2	0.2

2023 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	0.0	0.1	0.1	0.0	0.0	0.1	-1.6	-0.1	-0.1	0.1
2	0.3	0.2	0.1	0.0	0.1	0.1	-1.3	0.1	0.1	0.2
3	0.1	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0	0.0
5	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0
6	0.0	0.2	0.0	0.2	0.0	0.0	0.4	0.1	0.3	0.0
7	-1.1	-1.1	0.4	-0.2	0.2	0.3	2.3	-0.7	-0.9	-0.3
8	0.0	0.1	0.0	0.0	0.1	0.2	-0.5	0.1	0.2	0.1
9	-0.1	0.1	0.1	0.0	0.0	0.1	-0.5	0.2	0.0	0.0
10	0.1	0.1	0.1	0.0	0.0	0.0	-0.6	0.1	0.0	0.0

UC2	1	2	3	4	5	6	7	8	9	10
1	0.4	3.0	1.6	-0.9	-0.1	0.6	-19.9	1.9	0.0	1.6

UC1	1	2	3	4	5	6	7	8	9	10
2	1.1	0.7	-0.2	-1.7	-0.1	0.0	-5.4	0.8	0.3	0.4
3	0.1	-0.1	0.0	-0.3	0.0	0.0	-5.5	2.5	1.4	-0.1
4	0.6	-0.3	-0.1	-0.3	0.0	0.9	2.2	-0.8	-0.7	-0.5
5	0.1	-0.1	0.0	-0.2	0.0	0.0	-0.3	0.5	0.2	-0.1
6	0.2	0.0	0.0	0.0	0.0	0.0	-2.7	1.0	0.6	0.0
7	-9.9	-5.9	-2.7	4.6	0.4	-0.4	28.4	-21.7	-9.5	-0.9
8	0.0	0.5	1.2	-0.5	0.4	0.6	-11.8	3.9	2.4	0.2
9	-0.2	0.2	0.9	0.0	0.1	0.3	-4.7	2.6	-0.1	0.1
10	0.5	0.4	-0.3	-0.4	-0.1	0.0	-1.8	0.1	0.4	0.1

UC3	1	2	3	4	5	6	7	8	9	10
1	0.9	3.1	0.7	1.9	0.1	0.3	-41.3	-1.3	-2.4	3.8
2	2.9	4.0	0.2	-1.3	0.2	0.3	-15.3	2.0	2.4	3.0
3	0.6	0.2	0.0	0.1	0.0	0.0	0.6	0.4	1.2	0.2
4	0.4	0.1	0.1	0.2	0.1	3.3	4.5	0.6	0.2	-0.1
5	0.0	0.1	0.0	0.4	0.0	0.0	1.8	0.2	0.0	0.1
6	0.2	0.8	0.0	1.3	0.0	0.0	2.1	0.4	1.4	0.2
7	-26.6	-13.2	1.8	6.4	0.8	2.0	39.9	-16.0	-22.3	-4.4
8	-0.6	1.7	0.5	0.4	0.3	0.5	-9.6	1.6	4.7	1.4
9	-0.8	2.3	0.6	0.1	0.0	0.1	-12.4	4.1	1.4	1.0
10	-1.7	0.5	0.1	-0.7	0.0	0.1	-5.2	0.6	0.8	0.2

2038 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.1	0.0	0.1	0.0	0.4	0.3	-0.8	0.1	-0.1	0.0
2	-0.2	-0.1	0.2	0.2	0.3	0.8	-2.0	0.4	0.1	0.0
3	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.1	0.1	0.1
4	-0.2	-0.3	1.5	0.0	0.7	3.6	-3.4	0.2	0.0	-0.5

UC1	1	2	3	4	5	6	7	8	9	10
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
6	0.0	0.5	0.0	0.4	0.0	0.0	0.2	0.1	0.0	0.1
7	-2.8	-3.0	0.8	2.0	4.8	4.8	-5.4	0.4	-1.2	-3.5
8	-0.3	-0.4	0.1	0.5	0.4	0.7	-1.3	0.1	0.0	-0.2
9	-0.7	-0.4	0.6	0.1	0.3	3.3	-2.6	0.6	-0.5	-0.5
10	-0.1	-0.3	0.3	0.1	0.5	0.9	-1.5	0.2	-0.1	0.1

UC2	1	2	3	4	5	6	7	8	9	10
1	1.2	1.1	0.1	-0.4	0.0	0.1	-4.0	0.0	-0.6	1.6
2	4.2	2.3	0.7	-2.1	0.0	0.5	-10.7	1.3	0.5	1.9
3	2.6	1.1	0.0	1.2	0.0	0.0	-8.2	3.8	3.3	1.0
4	-4.9	-3.1	0.9	0.3	-0.1	1.2	18.5	-1.5	-0.1	-2.1
5	0.4	-0.3	0.0	0.2	0.0	0.0	2.4	1.3	0.3	-0.2
6	1.6	2.9	0.0	2.1	0.0	0.0	2.4	2.4	1.4	0.6
7	-14.2	-9.1	-9.3	8.1	0.0	-2.0	56.1	-7.0	-5.5	-14.1
8	4.7	6.5	10.1	-0.9	1.6	3.8	-22.5	9.3	5.1	3.2
9	-1.2	2.3	5.7	-1.1	0.5	2.5	-18.1	3.3	0.5	3.1
10	4.9	0.9	0.0	-1.1	-0.2	0.0	-10.0	0.3	0.7	1.4

UC3	1	2	3	4	5	6	7	8	9	10
1	-0.4	2.9	3.0	0.6	0.8	0.7	-20.5	1.5	-2.3	5.5
2	-1.2	6.6	2.2	1.4	0.5	2.0	-22.6	3.2	3.2	4.8
3	1.1	0.6	0.0	2.0	0.0	0.0	2.7	1.0	1.4	1.1
4	0.1	-2.1	3.3	1.1	2.5	14.3	-0.5	0.1	0.1	-3.0
5	0.3	1.4	0.0	0.3	0.0	0.0	3.8	1.6	0.2	0.4
6	1.5	1.1	0.0	8.3	0.0	0.0	14.9	1.5	0.7	1.2
7	-66.0	-24.8	4.9	21.4	9.6	12.5	38.3	-4.1	-29.5	-43.4
8	-4.8	2.9	1.6	1.8	1.9	3.4	-23.5	1.5	4.7	1.9
9	-17.9	4.5	5.4	1.3	2.1	7.5	-57.3	11.7	1.5	5.3
10	6.6	2.9	1.7	1.0	1.0	0.6	-29.3	1.9	0.3	3.5

2038 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.2	-0.2	0.5	0.8	0.1	0.5	-1.3	0.1	-0.4	-0.1
2	-0.2	-0.2	0.3	0.3	0.3	1.2	-2.4	0.5	-0.3	-0.2
3	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.1	0.1
4	-0.1	-0.1	0.1	0.1	0.3	2.5	-2.0	0.2	0.0	-0.2
5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0
6	0.1	0.1	0.0	0.6	0.0	0.0	0.2	0.1	0.3	0.1
7	-2.6	-2.1	3.2	2.3	1.6	3.6	-3.4	0.2	-2.2	-3.3
8	-0.1	-0.1	0.1	0.3	0.4	0.7	-0.8	0.1	-0.1	-0.1
9	-0.4	-0.4	0.4	0.0	0.2	2.3	-1.9	0.4	-0.6	-0.4
10	-0.6	-0.4	0.1	0.0	0.4	3.2	-1.9	-0.3	-0.4	0.2

UC2	1	2	3	4	5	6	7	8	9	10
1	0.2	1.3	0.4	0.0	0.1	0.8	-0.7	0.8	-0.2	1.3
2	1.4	0.5	0.3	-0.3	-0.1	0.2	-1.1	1.9	0.7	0.3
3	0.3	0.2	0.0	0.0	0.0	0.0	-2.6	3.1	1.5	0.2
4	-0.5	-0.1	-0.1	0.1	0.7	1.7	4.5	-0.2	-0.1	-0.3
5	0.2	0.0	0.0	1.3	0.0	0.0	0.7	0.4	0.3	0.1
6	0.5	0.0	0.0	2.7	0.0	0.0	2.7	1.2	0.6	0.3
7	-2.0	-0.8	-1.0	5.5	0.8	0.5	14.1	-3.2	-2.3	-3.5
8	0.9	0.8	2.1	-0.4	0.2	0.6	-3.6	1.8	1.1	0.3
9	0.0	0.3	1.1	-0.2	0.2	0.5	-3.7	1.0	0.1	0.4
10	1.0	0.2	0.3	0.1	0.1	0.4	-3.4	0.3	0.4	0.8

UC3	1	2	3	4	5	6	7	8	9	10
1	-1.4	1.0	1.9	2.4	0.4	2.6	-34.3	0.3	-8.2	6.3
2	0.8	3.0	2.8	3.0	0.7	1.7	-25.3	7.1	2.9	3.5
3	1.7	1.0	0.0	1.9	0.0	0.0	7.2	1.4	4.3	1.8
4	1.0	-0.4	2.5	2.1	0.6	16.5	19.9	2.7	0.4	1.1

UC1	1	2	3	4	5	6	7	8	9	10
5	0.4	0.5	0.0	1.0	0.0	0.0	6.1	1.6	1.7	1.6
6	1.6	1.2	0.0	12.3	0.0	0.0	20.1	1.8	4.5	4.5
7	-39.8	-24.1	11.2	24.4	4.6	22.3	41.5	-6.4	-43.9	-52.2
8	-1.2	3.6	2.0	3.2	1.9	3.2	-11.5	2.6	8.0	1.7
9	-8.4	2.6	5.8	0.7	2.1	7.1	-38.1	12.5	-0.4	-0.2
10	3.5	0.2	4.0	4.7	1.5	6.5	-38.5	2.9	-0.4	6.9

2038 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.1	-0.1	0.2	0.0	0.0	0.3	-1.7	-0.2	-0.5	0.2
2	0.3	-0.1	0.4	0.3	0.6	0.5	-3.3	0.4	0.0	0.1
3	0.1	0.1	0.0	0.9	0.0	0.0	1.6	0.1	0.4	0.1
4	-0.1	0.0	0.1	0.0	0.2	2.4	-1.0	0.6	0.0	0.0
5	0.1	0.1	0.0	0.3	0.0	0.0	2.2	0.1	0.1	0.0
6	0.2	0.6	0.0	1.1	0.0	0.0	2.3	0.5	1.7	0.3
7	-1.6	-3.2	1.6	-1.2	1.3	1.6	-3.0	-0.8	-2.6	-1.9
8	0.0	0.1	0.1	0.1	0.2	0.7	-0.5	0.1	0.2	0.2
9	-0.3	-0.1	0.3	0.0	0.0	0.4	-1.4	0.3	-0.5	-0.1
10	0.1	0.1	0.6	-0.1	0.1	0.1	-1.9	0.4	-0.2	0.3

UC2	1	2	3	4	5	6	7	8	9	10
1	0.7	3.6	2.5	-5.4	-0.1	1.4	-17.3	4.7	-1.7	7.3
2	1.3	1.7	0.7	-3.1	-0.2	0.7	-6.3	1.9	0.5	0.9
3	0.5	0.7	0.0	0.4	0.0	0.0	-15.0	8.4	7.1	0.4
4	0.0	-1.5	0.0	0.3	0.3	5.9	9.3	-3.0	-2.8	-0.7
5	0.1	-0.1	0.0	0.1	0.0	0.0	0.5	1.9	1.1	-0.1
6	0.5	0.7	0.0	0.5	0.0	0.0	-5.2	3.5	3.2	0.2
7	-8.5	-8.7	-8.0	20.3	1.8	1.4	54.9	-25.7	-22.1	-18.4

UC1	1	2	3	4	5	6	7	8	9	10
8	0.2	1.0	4.0	-1.3	1.3	1.9	-11.1	7.5	4.3	0.8
9	-1.0	0.5	4.6	-0.1	0.3	1.7	-10.0	5.9	0.1	1.6
10	2.6	1.6	1.1	-1.1	-0.1	0.8	-17.4	1.6	2.4	3.5

UC3	1	2	3	4	5	6	7	8	9	10
1	-0.5	0.4	2.1	1.2	0.2	1.1	-45.9	-0.8	-12.4	7.4
2	1.3	1.6	1.9	-2.9	1.7	1.9	-28.5	3.8	3.5	3.7
3	2.5	1.7	0.0	1.7	0.0	0.0	8.4	1.6	6.2	2.0
4	0.3	-0.7	0.7	0.9	0.7	20.8	20.3	0.9	0.7	0.3
5	0.2	0.7	0.0	2.6	0.0	0.0	11.8	0.9	0.4	0.5
6	1.2	5.1	0.0	8.9	0.0	0.0	15.5	2.4	8.8	1.6
7	-30.3	-33.6	7.9	23.4	5.3	12.1	5.8	-11.3	-65.8	-39.8
8	0.0	4.0	2.0	1.5	1.8	2.6	-5.0	1.9	10.1	5.0
9	-3.6	4.7	3.3	0.2	0.6	0.8	-32.7	9.9	-1.3	0.4
10	4.8	1.8	3.4	-0.1	0.4	1.1	-34.0	2.9	0.4	4.1

2051 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.1	-0.1	0.2	0.0	0.7	0.5	-1.2	0.2	-0.2	-0.1
2	-0.2	-0.1	0.4	0.2	0.6	1.7	-4.0	0.7	0.1	0.0
3	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.2	0.1	0.1
4	-0.4	-0.6	2.6	0.1	1.3	6.0	-5.7	0.2	0.0	-1.2
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
6	0.0	0.8	0.0	0.6	0.0	0.0	0.4	0.1	0.1	0.1
7	-3.2	-5.8	1.3	3.8	8.3	8.5	-10.1	0.7	-1.6	-6.6
8	-0.3	-0.7	0.2	0.7	0.7	1.3	-1.8	0.2	0.0	-0.4
9	-0.8	-0.8	1.0	0.1	0.5	5.5	-3.9	1.0	-0.8	-1.1
10	-0.1	-0.5	0.4	0.1	0.8	1.7	-2.5	0.4	-0.2	0.0

UC2	1	2	3	4	5	6	7	8	9	10

UC1	1	2	3	4	5	6	7	8	9	10
1	2.6	2.4	-0.1	-2.1	-0.1	0.1	-4.4	0.0	-0.9	2.6
2	8.4	4.6	1.9	-5.0	-0.1	0.9	-23.0	2.3	1.2	4.5
3	3.1	2.1	0.0	2.0	0.0	0.0	-17.0	6.4	5.0	1.8
4	-11.4	-7.9	1.5	0.8	-0.1	1.9	24.3	-3.0	-0.7	-5.9
5	0.2	-0.8	0.0	0.4	0.0	0.0	3.4	2.1	0.4	-0.4
6	2.0	4.6	0.0	3.1	0.0	0.0	2.5	3.6	2.1	1.0
7	-21.7	-22.7	-18.9	16.0	0.1	-4.1	85.6	-13.5	-9.5	-25.5
8	8.1	11.1	15.9	-2.5	2.3	6.1	-35.7	14.9	7.1	6.2
9	0.3	4.4	8.6	-2.9	0.7	3.7	-25.8	4.6	2.1	5.1
10	5.8	2.4	0.3	-3.6	-0.3	0.1	-11.4	0.6	0.6	2.4

UC3	1	2	3	4	5	6	7	8	9	10
1	0.4	4.5	4.6	0.5	1.4	1.4	-23.5	2.7	-1.9	5.7
2	0.2	10.9	3.7	0.9	0.9	3.7	-44.3	5.3	5.9	8.1
3	1.5	1.1	0.0	3.1	0.0	0.0	3.1	1.8	2.5	1.5
4	-1.8	-5.1	5.2	1.9	4.2	24.2	-6.2	-0.3	-0.3	-7.7
5	0.4	2.3	0.0	0.5	0.0	0.0	6.4	2.8	0.4	0.6
6	2.4	2.2	0.0	13.7	0.0	0.0	24.4	2.6	1.5	2.2
7	-67.4	-49.1	7.4	36.3	16.6	20.2	19.4	-5.4	-36.3	-68.5
8	-4.4	4.0	2.7	1.8	3.4	6.9	-29.6	2.4	6.9	1.7
9	-21.4	7.1	8.4	1.2	3.8	12.8	-75.4	17.2	4.4	3.0
10	6.0	6.3	2.8	1.1	1.8	1.3	-39.3	3.3	0.9	3.9

2051 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.2	-0.4	0.8	1.2	0.1	1.1	-2.3	0.3	-0.6	-0.3
2	-0.4	-0.3	0.5	0.4	0.6	2.2	-4.3	0.8	-0.4	-0.3
3	0.0	0.1	0.0	0.5	0.0	0.0	0.7	0.1	0.2	0.1

UC1	1	2	3	4	5	6	7	8	9	10
4	-0.2	-0.2	0.1	0.1	0.5	4.1	-3.0	0.3	0.0	-0.5
5	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.1	0.0	0.0
6	0.1	0.2	0.0	1.0	0.0	0.0	0.4	0.2	0.4	0.2
7	-4.0	-4.4	5.0	4.2	2.7	6.4	-6.2	0.5	-3.3	-6.1
8	-0.1	-0.1	0.2	0.4	0.6	1.3	-1.3	0.1	-0.1	-0.2
9	-0.5	-0.6	0.6	0.0	0.3	3.8	-3.0	0.6	-0.9	-0.7
10	-0.8	-0.6	0.3	-0.1	0.6	5.2	-3.4	-0.4	-0.8	0.0

UC2	1	2	3	4	5	6	7	8	9	10
1	0.8	2.3	0.5	-0.5	0.1	1.1	-1.5	1.4	-0.1	1.9
2	2.5	0.9	0.7	-0.8	-0.4	0.4	-3.6	3.5	1.4	0.7
3	0.4	0.4	0.0	0.0	0.0	0.0	-4.6	4.9	2.3	0.4
4	-1.4	-0.2	-0.1	0.4	1.1	2.4	8.4	-0.4	-0.3	-1.2
5	0.2	-0.1	0.0	1.9	0.0	0.0	1.3	0.7	0.4	0.1
6	0.8	0.1	0.0	3.8	0.0	0.0	3.7	1.8	1.0	0.6
7	-3.5	-2.0	-2.0	10.3	1.4	0.6	21.8	-5.6	-3.8	-4.0
8	1.6	1.4	3.4	-0.8	0.4	1.0	-6.3	2.8	1.6	0.6
9	0.2	0.6	1.8	-0.5	0.4	0.8	-6.8	1.4	0.6	0.5
10	1.5	0.5	0.9	-0.4	0.1	0.8	-4.0	0.6	0.5	0.9

UC3	1	2	3	4	5	6	7	8	9	10
1	-0.2	2.7	2.5	2.7	0.6	4.1	-36.3	1.2	-8.7	5.9
2	2.4	6.3	5.5	3.6	1.2	3.4	-51.0	11.3	6.0	7.0
3	2.4	2.1	0.0	3.1	0.0	0.0	11.0	2.5	7.3	2.8
4	0.6	-1.9	3.8	3.8	1.0	27.6	33.7	3.6	-0.2	-1.8
5	0.5	1.0	0.0	1.6	0.0	0.0	10.3	2.7	3.1	2.6
6	2.6	2.4	0.0	20.7	0.0	0.0	33.9	3.3	7.9	7.7
7	-43.8	-49.7	17.2	40.2	7.8	37.4	11.3	-9.2	-57.8	-80.5
8	-0.5	5.5	3.6	4.2	3.3	5.8	-16.2	4.2	12.4	2.1
9	-8.8	4.5	9.6	0.4	3.7	12.3	-50.3	18.5	0.8	-1.2
10	2.1	1.2	6.6	5.3	2.5	10.8	-53.0	3.5	-1.1	6.6

2051 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.1	-0.1	0.2	0.0	0.0	0.4	-1.9	-0.2	-0.6	0.1
2	0.3	-0.2	0.8	0.4	1.1	1.0	-5.5	0.6	0.0	0.1
3	0.2	0.2	0.0	1.4	0.0	0.0	2.6	0.2	0.7	0.2
4	-0.2	0.0	0.2	0.0	0.4	3.9	-1.4	0.7	0.0	0.0
5	0.1	0.1	0.0	0.5	0.0	0.0	3.7	0.2	0.1	0.0
6	0.4	1.2	0.0	1.9	0.0	0.0	4.1	0.9	2.8	0.6
7	-2.6	-6.6	2.7	-2.1	2.4	2.9	-7.0	-1.1	-4.1	-3.2
8	0.0	0.1	0.2	0.1	0.4	1.1	-0.7	0.1	0.2	0.3
9	-0.3	-0.1	0.5	0.0	0.1	0.7	-1.9	0.4	-0.7	-0.2
10	0.1	0.1	0.9	-0.1	0.1	0.2	-3.2	0.5	-0.3	0.2

UC2	1	2	3	4	5	6	7	8	9	10
1	1.3	6.5	3.4	-12.0	-0.4	2.0	-23.5	8.0	-0.5	8.5
2	2.3	3.1	1.5	-6.2	-0.4	1.1	-12.0	3.0	1.0	1.8
3	0.5	1.5	0.0	1.0	0.0	0.0	-24.8	13.5	10.7	0.9
4	-0.5	-3.6	0.0	0.8	0.5	8.4	17.7	-7.4	-6.6	-2.2
5	0.0	-0.2	0.0	0.2	0.0	0.0	1.0	2.9	1.5	-0.3
6	0.7	1.1	0.0	0.7	0.0	0.0	-8.4	5.7	4.8	0.4
7	-10.1	-17.1	-18.3	29.0	2.6	1.0	83.0	-46.8	-29.0	-20.3
8	0.6	1.7	6.7	-2.2	2.1	3.0	-17.9	12.1	5.6	1.5
9	-0.9	0.8	6.8	-0.6	0.5	2.5	-12.0	7.9	0.5	1.4
10	2.8	3.4	2.0	-2.7	-0.2	1.3	-19.8	3.5	2.5	4.1

UC3	1	2	3	4	5	6	7	8	9	10
1	1.3	1.3	2.8	0.2	0.3	1.8	-47.3	-0.2	-13.1	7.2
2	2.3	3.4	3.5	-5.1	2.7	3.5	-48.6	5.9	5.1	7.7
3	3.8	3.1	0.0	2.7	0.0	0.0	13.3	2.8	10.0	3.3

UC1	1	2	3	4	5	6	7	8	9	10
4	-0.2	-3.2	1.0	1.6	1.1	34.0	33.5	-0.7	0.3	-0.9
5	0.3	1.3	0.0	4.2	0.0	0.0	19.0	1.7	1.0	0.8
6	2.2	8.9	0.0	15.1	0.0	0.0	25.5	4.4	14.6	3.0
7	-35.8	-63.1	10.6	33.1	9.2	19.7	-47.5	-17.4	-85.2	-57.3
8	0.5	6.5	3.3	1.4	3.1	4.5	-6.1	2.9	15.2	8.4
9	-3.5	7.9	5.5	-0.2	1.2	1.8	-40.5	13.8	-0.4	0.7
10	4.5	4.0	5.1	-1.6	0.5	2.0	-46.1	4.0	-0.1	4.4

DS VDM versus REFERENCE. Volume Change by Sector

2023 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.2	-0.1	0.0	0.2	0.1	0.0	-0.2	0.0	-0.1	0.0
2	-0.1	0.0	0.0	0.1	0.1	0.2	-0.4	0.1	0.1	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.4	0.0	0.2	-0.1	0.1	0.5	-1.7	0.0	0.0	0.5
5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	1.2	-0.3	0.1	-0.6	0.3	0.5	-1.7	-0.3	-0.4	1.8
8	-0.3	0.1	0.0	0.1	0.1	0.2	-0.7	0.1	0.1	0.1
9	-0.2	0.0	0.1	0.0	0.0	0.5	-0.6	0.2	0.0	0.0
10	0.0	-0.1	0.0	0.1	0.0	0.1	-0.1	0.0	0.0	0.0

UC2	1	2	3	4	5	6	7	8	9	10
1	-3.4	-0.4	-0.4	6.3	0.3	-0.1	3.6	-0.9	-1.9	-0.4
2	-6.6	1.7	0.0	1.0	0.1	0.0	2.2	0.9	0.8	-0.5
3	-3.3	0.3	0.0	0.2	0.0	0.0	1.9	1.8	0.9	-0.7
4	23.9	-0.2	0.1	-0.9	-0.4	0.3	-9.8	-0.3	0.1	2.6
5	1.2	0.1	0.0	0.3	0.0	0.0	0.1	0.2	0.0	0.2
6	-1.1	0.5	0.0	0.5	0.0	0.0	1.3	0.6	0.3	-0.3

UC1	1	2	3	4	5	6	7	8	9	10
7	28.1	-0.1	0.2	-6.9	-0.9	-0.3	4.0	-3.7	-1.4	12.2
8	-12.7	3.3	3.9	1.1	0.9	1.5	-7.7	5.0	2.9	-1.3
9	-7.6	2.4	2.1	0.6	0.3	0.9	-3.5	2.5	0.8	-0.7
10	-1.3	0.0	-0.4	1.8	0.0	0.0	2.0	-0.1	-0.1	-0.2

UC3	1	2	3	4	5	6	7	8	9	10
1	-2.8	0.7	0.0	1.4	0.1	0.0	-2.3	-0.8	-1.9	-0.7
2	2.0	3.9	0.2	1.0	0.2	0.3	-4.7	1.1	1.6	0.0
3	0.2	0.1	0.0	0.4	0.0	0.0	0.7	0.2	0.2	-0.2
4	9.6	0.6	0.5	0.0	0.2	1.9	-3.1	0.3	0.2	3.3
5	0.2	0.3	0.0	0.1	0.0	0.0	0.4	0.2	0.0	0.1
6	0.2	0.2	0.0	1.2	0.0	0.0	2.1	0.2	0.1	0.0
7	-16.9	-5.3	0.7	-1.6	0.9	1.7	3.9	-8.0	-9.7	23.9
8	-7.1	2.9	0.5	1.0	0.3	0.5	-23.8	1.6	3.0	1.1
9	-5.6	2.5	0.9	0.6	0.3	1.1	-15.3	4.3	1.1	-0.3
10	-0.2	-2.7	-0.3	0.5	0.1	-0.2	3.0	-0.4	-1.0	-0.7

2023 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.3	-1.1	-0.2	1.6	0.0	0.0	1.3	-0.2	-0.3	-1.2
2	0.0	-0.3	-0.1	-0.1	0.0	0.1	-1.9	0.1	-0.2	-0.3
3	0.0	-0.1	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	-0.1
4	0.7	-0.1	0.0	-0.1	0.0	0.2	-2.3	0.0	-0.1	0.3
5	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0
7	2.6	-1.4	-0.2	-1.4	0.1	0.1	-5.4	-0.2	-1.6	0.1
8	0.0	0.0	0.0	0.0	0.1	0.1	-0.4	0.1	0.0	0.0
9	-0.3	-0.3	0.0	-0.1	0.0	0.3	-1.6	0.1	-0.2	-0.3
10	-0.3	-0.4	0.0	0.2	0.1	0.5	-1.1	-0.1	-0.3	-0.1

UC1	1	2	3	4	5	6	7	8	9	10

UC2	1	2	3	4	5	6	7	8	9	10
1	-1.0	-1.8	-0.9	2.5	0.4	0.0	2.7	-1.3	-1.4	-0.9
2	-1.7	0.3	0.0	0.0	0.0	0.0	-1.4	1.0	0.5	-0.1
3	-1.2	0.0	-0.1	-0.1	0.0	0.0	-0.6	1.0	0.4	-0.2
4	3.0	0.0	-0.1	-0.3	0.1	0.3	-2.6	0.0	-0.1	0.7
5	0.1	0.0	0.0	0.4	0.0	0.0	-0.2	0.1	0.0	0.0
6	-0.1	0.0	0.0	0.5	0.0	0.0	0.1	0.4	0.1	0.0
7	4.4	-0.4	-0.4	-3.3	-0.3	0.0	0.7	-0.4	-2.5	0.7
8	-1.6	0.5	0.8	0.0	0.1	0.3	-0.3	1.6	0.5	-0.1
9	-1.7	0.1	0.3	-0.1	0.0	0.1	-3.4	0.5	0.0	-0.2
10	-0.7	-0.2	-0.6	-0.2	0.0	-0.1	-0.3	-0.3	-0.2	-0.1

UC3	1	2	3	4	5	6	7	8	9	10
1	-5.8	-1.3	0.2	4.2	0.4	0.3	-12.1	2.9	-9.4	-1.4
2	0.1	-4.5	-0.5	-0.2	0.1	0.0	-31.4	2.8	-4.0	-6.2
3	0.0	-0.3	-0.5	0.0	-0.1	-0.1	-0.8	-0.2	0.2	-0.5
4	3.6	-0.7	0.0	-0.7	0.0	1.9	-14.1	0.1	-1.1	3.4
5	0.2	0.0	-0.1	0.1	0.0	-0.1	0.0	0.2	0.1	0.3
6	0.1	0.1	-0.1	1.4	0.0	-0.1	1.7	0.2	0.5	0.2
7	2.6	-25.3	-0.8	-9.3	0.0	2.1	-57.8	1.7	-47.8	4.6
8	1.7	1.7	0.1	0.5	0.2	0.4	0.3	1.0	1.3	-0.5
9	-8.1	-3.1	0.4	-0.6	0.2	0.8	-41.6	2.0	-6.0	-3.5
10	-4.8	-5.7	-0.6	1.8	0.2	0.5	-8.7	-1.3	-3.3	-2.5

2023 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.3	-0.3	0.0	0.9	0.1	0.0	0.3	0.1	-0.6	0.0

UC1	1	2	3	4	5	6	7	8	9	10
2	-0.2	-0.2	0.0	0.0	0.1	0.0	-1.0	0.0	-0.3	-0.1
3	-0.1	-0.1	0.0	0.0	0.0	0.0	-0.3	0.0	-0.1	0.0
4	0.4	0.0	0.0	-0.1	0.0	0.2	-1.4	0.1	-0.1	0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.0
7	0.4	-0.8	-0.2	-2.3	0.0	0.1	-2.3	0.1	-2.1	0.0
8	0.0	0.1	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.0
9	-0.2	-0.2	0.0	0.0	0.0	0.0	-1.2	0.1	-0.3	-0.1
10	-0.1	-0.2	0.0	0.1	0.0	0.0	-0.5	-0.1	-0.3	0.0

UC2	1	2	3	4	5	6	7	8	9	10
1	-3.6	-8.6	-3.9	25.3	0.8	-1.1	7.6	-9.4	-9.9	-2.7
2	-1.7	1.4	-0.1	0.1	0.1	0.0	-2.1	1.4	0.2	-0.1
3	-2.6	0.1	-0.3	-0.2	-0.1	-0.1	-3.0	2.1	2.1	-0.3
4	2.5	1.0	-0.5	-1.0	0.2	0.9	-8.4	1.5	0.7	0.5
5	0.2	0.1	-0.1	-0.4	0.0	0.0	-1.9	0.5	0.2	0.1
6	-0.7	0.2	-0.1	0.0	0.0	0.0	-1.2	1.2	1.0	-0.1
7	1.0	-0.7	0.8	-10.2	-0.4	0.8	3.7	0.9	-16.1	0.2
8	-1.6	1.2	1.6	0.3	0.3	0.7	-2.6	5.6	3.2	-0.4
9	-2.2	0.0	0.9	-0.1	0.0	0.2	-10.8	3.4	-0.6	-0.5
10	-0.4	-1.3	-1.2	0.6	0.0	-0.4	0.9	-1.3	-0.6	-0.2

UC3	1	2	3	4	5	6	7	8	9	10
1	-7.4	-3.1	0.0	8.5	0.1	0.1	-6.7	3.0	-12.4	-2.2
2	-1.9	-5.6	-0.4	0.0	0.5	0.0	-20.0	1.1	-4.2	-7.2
3	0.0	-0.3	-0.5	-0.1	-0.1	-0.1	-1.0	-0.4	0.3	-0.5
4	1.3	0.1	0.0	-0.9	0.1	2.7	-13.9	1.5	-1.1	0.0
5	0.0	0.2	-0.1	0.0	0.0	-0.1	-0.1	0.1	-0.1	0.1
6	0.0	0.5	-0.1	0.9	-0.1	-0.1	1.4	0.2	1.0	0.0
7	-2.7	-22.0	-0.4	-14.6	-0.1	0.9	-58.3	4.3	-50.0	1.3
8	1.0	1.1	0.3	1.5	0.2	0.7	2.5	2.3	2.2	-1.0
9	-4.3	-2.9	0.0	-0.7	0.0	-0.1	-30.7	2.1	-7.3	-2.5

UC1	1	2	3	4	5	6	7	8	9	10
10	-8.5	-9.3	-1.1	0.2	0.1	-0.1	-5.4	-1.4	-4.4	-2.6

2038 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.2	-1.0	0.1	0.2	0.3	0.2	-0.5	0.0	-0.3	0.6
2	-1.6	-2.1	-0.1	0.1	0.0	0.2	-8.0	-0.1	-0.8	0.0
3	0.0	-0.5	0.0	0.1	0.0	0.0	-0.1	0.1	0.0	0.4
4	1.3	-0.5	1.4	-0.1	0.7	3.6	-5.1	0.2	-0.1	0.5
5	0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
6	0.0	0.2	0.0	0.4	0.0	0.0	0.2	0.1	0.0	0.2
7	1.2	-7.6	0.6	0.0	4.0	4.4	-11.6	0.5	-1.4	5.1
8	0.0	-1.5	0.1	0.5	0.4	0.7	-0.5	0.2	0.0	1.1
9	-1.1	-2.1	0.5	0.1	0.2	3.1	-3.7	0.5	-0.9	0.4
10	1.3	0.2	0.4	0.3	0.7	1.3	4.8	0.6	0.5	1.1

UC2	1	2	3	4	5	6	7	8	9	10
1	-2.6	-4.1	-0.4	6.1	0.3	-0.1	5.9	-0.4	-2.2	4.1
2	-16.7	-5.6	-2.4	-0.5	-0.7	-0.3	-41.4	-0.9	-2.9	2.6
3	-3.3	-4.4	-0.2	1.4	0.0	-0.1	-1.8	4.4	3.2	5.3
4	22.9	-1.6	1.5	-0.2	-0.2	1.4	7.9	-0.4	0.0	5.9
5	1.7	-0.6	0.0	0.6	0.0	0.0	2.2	1.2	0.2	1.0
6	-0.4	1.6	-0.2	2.4	-0.1	-0.1	5.9	2.3	1.3	1.4
7	33.5	-37.4	-2.5	-0.6	-0.9	-0.5	37.8	-1.4	-5.4	49.0
8	-8.8	-0.8	11.1	1.9	2.1	4.1	-5.3	11.5	6.6	10.1
9	-12.0	-4.9	5.7	0.2	0.6	2.7	-20.5	4.6	0.4	7.3
10	10.1	2.9	3.0	3.3	0.8	0.8	36.5	3.8	4.0	5.0

UC3	1	2	3	4	5	6	7	8	9	10

UC1	1	2	3	4	5	6	7	8	9	10
1	-3.9	-12.8	2.2	1.5	0.8	0.6	-6.0	1.8	-5.2	11.3
2	-36.7	-49.0	-0.5	-1.0	-0.3	1.2	-158.3	-4.0	-19.0	-0.6
3	0.8	-3.7	-0.1	1.8	0.0	0.0	2.2	0.5	1.2	4.0
4	7.5	-6.2	4.0	0.3	2.3	14.4	-3.7	0.3	0.1	9.8
5	0.5	1.0	0.0	0.3	0.0	0.0	3.7	1.5	0.1	0.9
6	1.3	0.2	0.0	8.2	0.0	0.1	15.2	1.4	0.7	1.7
7	-14.5	-149.9	5.1	10.1	8.7	12.5	-12.3	4.8	-33.1	128.6
8	4.2	-10.9	1.7	1.8	1.8	3.3	1.4	1.0	7.1	22.8
9	-31.5	-25.2	4.9	1.1	2.0	7.2	-82.6	12.0	-7.5	21.8
10	34.7	22.6	3.3	4.8	1.8	1.1	121.6	11.3	18.0	22.9

2038 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.5	-3.2	0.1	2.1	0.0	0.4	0.4	-0.2	-0.7	0.4
2	-2.0	-3.5	-0.4	-0.1	0.1	0.4	-11.5	-0.6	-2.2	-0.1
3	0.0	-0.6	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.6
4	0.6	-0.5	0.0	0.0	0.3	2.3	-4.0	0.2	-0.1	0.5
5	0.0	-0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.2
6	0.0	-0.4	0.0	0.5	0.0	0.0	0.0	0.1	0.2	0.5
7	1.8	-11.1	2.4	0.0	1.3	3.0	-10.7	0.4	-2.6	8.0
8	-0.1	-1.0	0.1	0.2	0.4	0.7	-0.5	0.1	-0.2	0.8
9	-0.6	-2.3	0.3	0.0	0.2	2.2	-2.4	0.3	-0.9	0.8
10	0.8	-0.3	0.6	0.4	0.5	3.7	7.0	0.8	0.9	1.9

UC2	1	2	3	4	5	6	7	8	9	10
1	-0.8	-4.0	-0.7	2.6	0.5	0.5	5.0	-0.9	-1.5	2.1
2	-3.9	-3.0	-1.4	-0.6	-0.2	-0.5	-18.1	0.2	-1.1	0.9
3	-1.1	-2.2	-0.1	0.1	0.0	0.0	-0.8	3.1	1.5	2.7

UC1	1	2	3	4	5	6	7	8	9	10
4	3.1	-0.7	0.0	0.1	0.7	1.9	1.1	0.0	-0.1	1.9
5	0.3	-0.3	0.0	1.4	0.0	0.0	0.7	0.4	0.3	0.5
6	0.2	-0.7	0.0	3.0	0.0	0.0	3.8	1.2	0.5	1.1
7	5.9	-16.2	-0.3	0.9	0.4	0.9	10.4	-0.3	-2.6	16.1
8	-1.3	-0.7	2.2	0.1	0.3	0.7	-0.1	2.3	1.5	2.2
9	-1.7	-1.7	1.1	-0.1	0.2	0.5	-3.6	1.4	0.2	2.0
10	2.1	0.7	1.6	1.2	0.5	1.2	17.1	2.4	1.8	2.8

UC3	1	2	3	4	5	6	7	8	9	10
1	-7.1	-34.9	1.4	5.2	0.8	2.3	-2.4	3.0	-15.8	29.8
2	-34.2	-69.7	-4.6	-3.3	0.0	-0.2	-235.3	-7.8	-45.1	14.8
3	1.2	-4.6	-0.4	2.0	-0.1	0.0	7.3	0.8	3.7	6.9
4	3.9	-8.0	2.3	1.7	0.5	16.3	0.4	2.6	-0.2	17.0
5	0.5	-0.3	-0.1	0.9	0.0	0.0	5.2	1.5	1.6	2.5
6	1.3	-0.1	0.0	12.2	0.0	0.2	19.8	1.8	4.2	5.4
7	12.5	-242.1	9.4	10.7	3.8	21.5	-48.3	5.5	-59.1	203.4
8	1.6	-9.0	1.6	3.7	1.8	3.1	2.3	1.1	7.7	16.7
9	-14.4	-37.6	5.3	0.7	1.9	6.9	-49.9	13.4	-9.0	30.0
10	28.4	15.7	10.3	12.4	2.4	8.1	183.3	20.6	35.6	35.0

2038 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.4	-2.0	0.0	0.9	0.1	0.3	0.3	-0.2	-0.8	1.6
2	-1.6	-2.7	-0.4	-0.1	0.4	0.2	-9.5	-1.1	-1.9	0.2
3	0.0	-0.9	0.0	0.8	0.0	0.0	1.2	0.1	0.2	1.0
4	0.3	-0.2	0.1	-0.1	0.2	2.1	-2.3	0.6	0.0	0.4
5	0.1	-0.2	0.0	0.2	0.0	0.0	2.0	0.1	0.0	0.2
6	0.2	-0.1	0.0	1.0	0.0	0.0	2.2	0.5	1.6	0.8

UC1	1	2	3	4	5	6	7	8	9	10
7	0.5	-9.7	1.1	-3.3	0.9	1.4	-6.9	-0.4	-3.1	7.2
8	-0.1	-0.6	0.1	0.1	0.2	0.6	0.0	0.1	0.0	1.0
9	-0.4	-1.3	0.1	0.0	0.0	0.4	-1.8	0.2	-0.8	0.7
10	1.0	0.4	1.1	0.4	0.2	0.4	6.5	1.8	1.0	1.3

UC2	1	2	3	4	5	6	7	8	9	10
1	-2.9	-24.2	-3.0	24.0	1.4	-0.4	15.9	-8.4	-12.3	15.8
2	-8.6	-10.6	-8.4	-3.9	-1.0	-1.0	-71.3	-7.5	-12.8	1.5
3	-2.1	-4.5	-0.3	0.8	-0.1	0.0	-7.2	8.2	7.6	5.4
4	2.2	-2.1	-0.1	-0.2	0.5	6.3	1.0	2.1	0.8	3.9
5	0.3	-0.7	-0.1	-0.1	0.0	0.0	-0.8	2.1	1.1	1.3
6	-0.4	-0.9	0.1	0.5	0.0	0.0	-1.4	3.8	3.6	2.0
7	1.6	-76.4	1.1	5.9	1.3	3.6	46.2	-0.5	-23.6	63.1
8	-1.6	-2.6	4.3	0.1	1.2	2.1	-1.1	9.5	6.2	7.5
9	-3.2	-9.2	4.5	0.4	0.3	1.6	-13.6	7.5	-1.4	9.5
10	7.8	3.1	8.1	5.1	1.3	2.0	61.7	13.5	13.4	12.5

UC3	1	2	3	4	5	6	7	8	9	10
1	-9.2	-30.0	1.4	8.7	0.3	0.9	-9.1	2.1	-20.3	24.5
2	-20.4	-61.3	-2.7	-5.0	1.1	0.9	-152.1	-9.2	-32.8	11.9
3	1.7	-2.9	-0.4	2.1	-0.1	-0.1	9.1	1.1	5.1	4.8
4	1.6	-4.1	0.7	0.1	0.6	20.3	6.5	2.9	-0.1	6.4
5	0.2	-0.1	0.0	2.2	0.0	0.0	10.2	1.0	0.3	1.4
6	0.9	3.7	-0.1	8.8	0.0	0.0	15.9	2.5	8.2	2.5
7	-3.1	-189.6	7.4	4.2	4.5	12.0	-45.3	4.6	-78.6	146.9
8	1.0	-3.6	1.8	2.9	1.7	3.0	4.6	1.5	10.0	13.2
9	-7.0	-24.0	2.7	0.2	0.5	0.7	-42.1	10.0	-11.6	19.2
10	14.9	7.4	5.5	8.3	1.3	1.7	113.0	17.9	22.6	26.0

2051 AM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.2	-1.0	0.2	0.2	0.6	0.5	-0.4	0.1	-0.3	0.7
2	-1.3	-2.6	0.1	0.2	0.4	1.0	-8.6	0.1	-0.9	0.0
3	0.0	-0.4	0.0	0.2	0.0	0.0	0.1	0.2	0.1	0.5
4	1.3	-0.9	2.5	-0.1	1.3	6.1	-7.5	0.5	0.0	0.8
5	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
6	0.0	0.5	0.0	0.7	0.0	0.0	0.4	0.1	0.1	0.3
7	1.2	-7.7	1.1	0.9	6.9	8.1	-16.0	0.8	-1.5	3.8
8	-0.1	-1.7	0.2	0.8	0.6	1.3	-0.8	0.3	0.0	0.9
9	-1.2	-2.4	0.9	0.1	0.4	5.1	-4.7	0.9	-1.1	-0.1
10	0.8	0.3	0.6	0.3	1.0	2.1	4.0	0.8	0.5	1.5

UC2	1	2	3	4	5	6	7	8	9	10
1	-1.7	-3.4	-0.2	5.6	0.3	0.0	10.7	-0.3	-2.5	5.3
2	-12.2	-5.8	-1.4	-1.4	-0.7	0.0	-39.9	0.1	-2.1	5.3
3	-2.9	-3.6	0.0	2.5	0.1	0.1	-5.1	7.4	5.0	6.3
4	22.2	-2.6	2.4	0.2	-0.2	2.4	15.3	-0.8	-0.2	5.5
5	1.9	-0.7	0.1	0.8	0.0	0.0	3.4	2.0	0.4	1.1
6	0.1	3.1	-0.2	3.7	-0.1	-0.1	7.3	3.8	2.1	1.9
7	38.0	-34.9	-5.3	7.5	-0.5	-1.0	67.3	-2.4	-6.5	52.5
8	-7.9	2.2	17.3	2.1	3.2	6.3	-9.5	17.0	8.6	10.0
9	-11.3	-3.0	9.0	-0.4	1.0	4.1	-22.2	6.1	2.1	7.1
10	8.4	5.8	4.0	3.1	1.0	1.3	39.6	4.6	4.2	7.1

UC3	1	2	3	4	5	6	7	8	9	10
1	-3.4	-16.2	3.8	1.9	1.4	1.2	-0.3	3.0	-4.7	14.4
2	-31.1	-62.1	0.7	-0.4	0.2	2.7	-164.2	-1.5	-18.5	2.1
3	1.2	-3.2	0.1	3.0	0.0	0.0	3.1	1.4	2.4	4.6
4	6.5	-5.6	6.1	0.8	4.0	24.1	-7.3	0.5	0.2	7.9
5	0.6	2.1	0.0	0.5	0.0	0.0	6.2	2.7	0.3	1.2
6	2.0	1.2	0.0	13.6	0.0	0.2	24.7	2.6	1.5	2.7

UC1	1	2	3	4	5	6	7	8	9	10
7	-11.2	-135.6	8.7	22.3	15.3	21.0	-25.6	6.8	-32.8	120.1
8	3.5	-7.0	2.8	2.9	3.2	6.7	-1.3	2.2	9.8	19.8
9	-34.8	-29.0	7.8	1.0	3.6	12.4	-94.0	17.1	-5.7	22.0
10	27.7	26.1	4.3	5.1	2.6	1.9	115.8	11.6	20.0	31.4

2051 IP

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.6	-3.5	0.4	2.4	0.1	0.9	-0.3	0.0	-0.8	0.4
2	-2.3	-4.3	-0.2	0.1	0.4	1.2	-11.8	-0.3	-2.5	-0.2
3	0.0	-0.6	0.0	0.4	0.0	0.0	0.4	0.1	0.2	0.7
4	0.5	-0.5	0.1	0.0	0.5	3.8	-5.2	0.3	-0.1	0.4
5	0.0	-0.2	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.2
6	0.1	-0.4	0.0	0.9	0.0	0.0	0.2	0.2	0.4	0.7
7	2.1	-11.1	4.0	1.0	2.3	5.5	-15.6	0.5	-3.0	6.5
8	-0.1	-1.2	0.2	0.4	0.6	1.3	-1.0	0.1	-0.2	0.9
9	-0.7	-2.5	0.5	-0.1	0.3	3.7	-3.0	0.5	-1.2	0.6
10	0.6	-0.4	0.8	0.4	0.8	5.8	5.0	0.6	0.6	2.4

UC2	1	2	3	4	5	6	7	8	9	10
1	-0.4	-3.6	-0.5	2.8	0.6	0.8	7.3	-0.5	-1.5	2.6
2	-3.4	-2.9	-1.1	-0.6	-0.2	-0.4	-16.6	1.3	-0.6	2.0
3	-0.8	-2.3	0.0	0.2	0.0	0.1	-1.4	4.9	2.4	3.2
4	3.2	-0.7	0.0	0.4	1.1	2.9	4.4	-0.1	-0.1	1.8
5	0.3	-0.4	0.0	2.2	0.0	0.0	1.3	0.7	0.4	0.6
6	0.4	-0.8	0.0	4.5	0.0	0.0	5.5	1.9	0.9	1.5
7	7.7	-15.4	-0.4	4.5	0.9	1.3	17.1	-1.0	-3.0	15.8
8	-1.0	-0.5	3.4	0.1	0.4	1.2	-0.8	3.4	2.1	2.3
9	-1.6	-1.8	1.9	-0.1	0.4	0.8	-4.5	1.9	0.6	2.3

UC1	1	2	3	4	5	6	7	8	9	10
10	3.1	1.0	2.2	1.1	0.6	1.7	17.9	2.6	2.2	2.6

UC3	1	2	3	4	5	6	7	8	9	10
1	-6.4	-30.6	2.2	6.1	0.9	3.7	2.3	3.8	-15.9	26.6
2	-30.2	-86.2	-1.9	-0.7	0.6	1.3	-228.8	-2.1	-45.0	23.8
3	2.0	-3.6	-0.3	3.3	0.0	0.1	12.1	1.8	6.7	8.0
4	4.3	-7.2	3.8	3.3	0.9	27.4	13.6	4.6	0.0	17.2
5	0.7	0.1	0.0	1.6	0.0	0.1	9.3	2.6	3.0	3.6
6	2.2	0.9	0.0	20.6	0.0	0.4	33.9	3.2	7.6	8.5
7	20.9	-231.8	16.6	26.3	6.9	36.9	-58.1	8.7	-60.5	195.9
8	2.0	-6.5	3.1	6.0	3.2	5.7	2.7	2.7	12.4	15.7
9	-14.6	-38.0	9.2	0.9	3.5	12.0	-52.1	19.9	-6.4	31.6
10	23.6	22.3	12.5	14.6	3.4	12.2	169.1	18.9	38.0	49.3

2051 PM

UC1	1	2	3	4	5	6	7	8	9	10
1	-0.5	-1.6	0.0	0.9	0.2	0.4	0.1	-0.4	-0.8	1.1
2	-1.7	-3.3	0.0	0.1	0.8	0.6	-10.1	-1.0	-2.1	0.4
3	0.0	-0.8	0.0	1.4	0.0	0.0	2.2	0.2	0.5	1.3
4	0.3	-0.1	0.2	-0.1	0.3	3.6	-2.7	0.9	0.0	0.5
5	0.1	-0.2	0.0	0.4	0.0	0.0	3.5	0.2	0.1	0.2
6	0.3	0.4	0.0	1.8	0.0	0.0	3.9	0.9	2.7	1.2
7	1.0	-10.2	2.2	-4.3	1.8	2.6	-9.8	-0.5	-3.8	6.7
8	-0.1	-0.6	0.2	0.2	0.4	1.0	-0.1	0.1	0.1	1.1
9	-0.5	-1.4	0.3	0.0	0.0	0.7	-2.0	0.4	-1.0	0.7
10	1.1	0.6	1.4	0.6	0.2	0.5	5.4	1.8	0.9	1.5

UC2	1	2	3	4	5	6	7	8	9	10

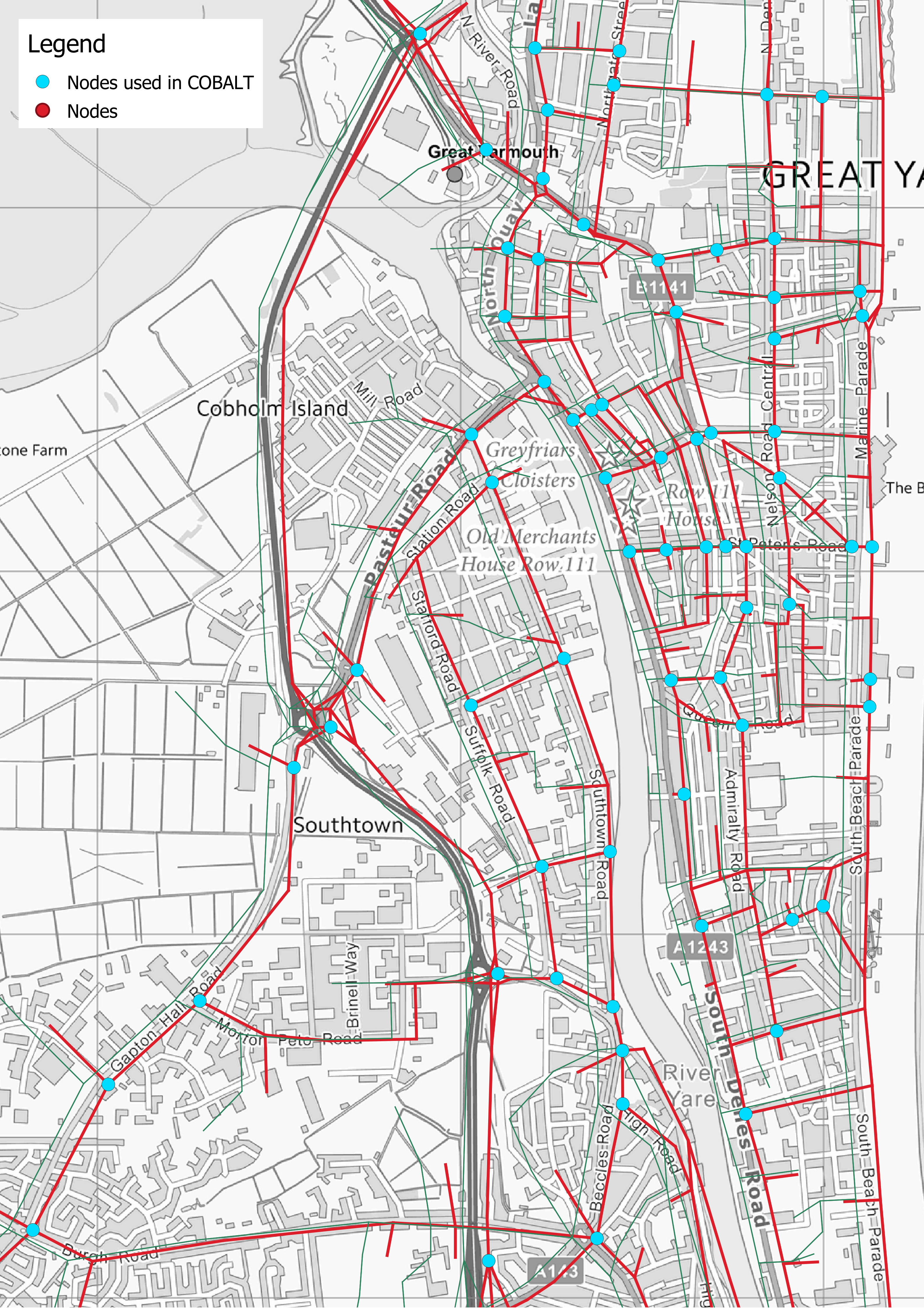
UC1	1	2	3	4	5	6	7	8	9	10
1	-2.6	-21.9	-2.8	23.9	1.4	0.0	20.4	-7.9	-12.3	14.2
2	-7.5	-10.6	-10.3	-5.4	-1.4	-1.3	-73.5	-8.3	-11.5	2.5
3	-2.0	-5.4	-0.2	1.2	0.0	0.2	-11.9	13.7	11.3	7.6
4	2.3	-3.1	0.0	0.3	0.7	9.2	11.2	1.5	-0.3	4.3
5	0.4	-0.9	0.0	0.0	0.0	0.1	0.3	3.3	1.6	1.7
6	-0.2	-1.1	0.2	0.7	0.1	0.1	-2.9	6.3	5.4	2.9
7	3.1	-78.0	-0.5	16.6	2.3	5.1	83.4	-4.8	-25.6	67.1
8	-1.6	-2.5	7.2	-0.1	2.0	3.4	-2.1	15.1	7.7	8.4
9	-3.2	-8.1	6.5	0.2	0.4	2.4	-14.0	9.5	-0.6	8.2
10	7.1	5.4	10.7	5.6	1.6	3.0	66.9	14.9	11.8	11.6

UC3	1	2	3	4	5	6	7	8	9	10
1	-8.6	-26.6	1.9	9.3	0.3	1.5	-8.8	1.8	-20.7	20.2
2	-22.6	-71.4	-1.2	-4.4	2.2	2.5	-149.5	-6.2	-33.9	17.0
3	3.0	-1.8	-0.3	3.4	0.0	-0.1	14.2	2.5	8.9	5.8
4	2.3	-3.7	1.2	0.5	1.0	33.2	18.6	3.7	-0.1	6.6
5	0.5	0.6	0.0	3.8	0.0	0.0	17.0	1.8	0.8	1.9
6	1.8	7.1	0.0	15.0	0.0	0.1	26.0	4.7	13.9	3.9
7	7.5	-186.8	12.1	14.6	8.1	20.6	-59.5	4.1	-86.3	138.6
8	1.4	-1.0	3.2	4.1	3.0	4.8	5.7	2.8	15.0	14.8
9	-7.0	-23.2	4.9	0.4	1.1	1.6	-44.8	13.9	-9.5	20.0
10	15.6	12.8	6.8	7.7	1.5	2.6	101.5	15.7	23.3	36.7

St. Johns House
Queen Street
Manchester
M2 5JB

wsp.com

Appendix C – COBA-LT Links and Junctions


Legend
Nodes used in COBALT
Nodes
Great Yarmouth
GREAT YA
Cobholm Island
Southtown
Greyfriars Cloisters
Row 111 House
Old Merchants House Row 111
Mill Road
Pasteur Road
Station Road
Stafford Road
Suffolk Road
Southtown Road
North Quay
N River Road
B1141
A1243
A143
South Denes Road
Admiralty Road
Nelson Road Central
Marine Parade
South Beach Parade
St Peter's Road
Queen's Road
Gapton Hall Road
Morton Peto Road
Brinell Way
Burgh Road
Beccles Road
High Road
River Yare
The B

Appendix D – Active Mode Appraisal

Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING

Technical Note: Active Mode Appraisal Methodology

1
AUGUST 2018

CONFIDENTIAL

Norfolk County **Council**

GREAT YARMOUTH THIRD RIVER CROSSING

Technical Note: Active Mode Appraisal Methodology

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70041951

OUR REF. NO. 1

DATE: AUGUST 2018

Norfolk County **Council**

GREAT YARMOUTH THIRD RIVER CROSSING

Technical Note: Active Mode Appraisal Methodology

WSP

St. Johns House
Queen Street
Manchester
M2 5JB

Phone: +44 161 602 8400

WSP.com

CONTENTS

APPENDICES

1

INTRODUCTION

1 INTRODUCTION

1.1 OVERVIEW

This technical note details the economic appraisal of the changes in terms of the impact on active modes, i.e. pedestrians and cycle users, resulting from the proposed third river crossing in Great Yarmouth. Included within this note are details on the approach used to appraise the scheme, the sources of data used and assumptions applied, as well as summarising the overall economic results.

Four key active mode indicators are considered as part of the appraisal:

- Physical Activity (Health) impacts;
- Absenteeism impacts;
- Journey Quality/Ambience impacts; and
- Journey Time impacts

The economic appraisal of the scheme has followed the guidance set out by the Department for Transport (DfT) and specifically follows the approach set out in the following Transport Analysis Guidance (TAG) documents:

- TAG Unit A1.1: Cost-Benefit Analysis (Nov 2014);
- TAG Unit A4.1: Social Impact Appraisal (Nov 2014); and
- TAG Unit A5.1: Active Mode Appraisal (Jan 2014).

1.2 TECHNICAL NOTE STRUCTURE

The remainder of this technical note is set out as follows:

Section 2 provides an overview of the scheme;

Section 3 provides an overview of the methodology adopted for calculating the active mode economic benefits for the scheme, including the approach to generating without scheme and with scheme demand;

Section 4 sets out the physical activity (health) impacts that are forecast to result from the scheme;

Section 5 describes the absenteeism impacts that are expected to be generated by the scheme;

Section 6 describes the journey quality/ambience impacts that are forecast to result from the scheme;

Section 7 details the Journey Time savings estimated from a new crossing;

Section 8 presents the overall active mode benefits over the appraisal period and details the high and low demand sensitivity testing.

2 OVERVIEW

2.1 GREAT YARMOUTH THIRD RIVER CROSSING SCHEME

The proposal is for a new (third) crossing over the River Yare, Great Yarmouth. The town itself is geographically constrained, bounded by the North Sea to the east and both the River Yare and the River Bure to the west. Currently there are only two road crossing points over the River Yare. The Haven Bridge crosses the River Yare along the A1243, linking in with the Strategic Road Network (SRN) to the south. The Breydon Bridge crosses the River Yare along the A12 forming a north-south route, providing a direct route to and from Norwich.

Great Yarmouth's town centre and its riverfront have, for many years been subject to industrial decline and under-utilisation, exacerbated by limited road access to the peninsula and the congestion which this causes.

Great Yarmouth is highlighted as a key growth location within the New Anglia LEP's Strategic Economic Plan and is a key area for regeneration. The proposed scheme will support regeneration by improving access to the industrial area south of the peninsula (including the Peel Ports), reducing impacts of severance and by relieving congestion in, and around the town centre. It is anticipated that the provision of a third crossing will encourage a greater uptake of active modes through improved infrastructure provision for these modes as well as shorter journey lengths for some trips. An additional route across the river together with a modal shift towards active modes will also help to reduce congestion in the town by reducing the number of vehicles on the roads.

Figure 1 shows the alignment of the proposed third river crossing, which is located south of the two existing bridges. The bridge features an off-road segregated pedestrian and cycle path on the northern side of the carriageway and pedestrian path on the southern side; at-grade crossings are also provided at the west and east junction.

Plate 1 - Scheme Proposal

3 METHODOLOGY

This active mode appraisal only focuses on the benefits for active modes associated with the package of sustainable travel, road safety and pedestrian/cycle improvements forming part of the proposal. As outlined in Section 1.1, the active mode appraisal is focused on four key indicators. Table 1 outlines these four indicators and identifies where the Third Crossing scheme is expected to have an impact.

Table 1 - Summary of elements of appraisal

Active Mode Indicator	Location Focus of Assessment	Active Mode Appraised	Explanation
Physical Activity (Health)	Third River Crossing, and A1243 Haven Bridge	Pedestrians & Cycle users	The provision of a new crossing with pedestrian and cycle infrastructure is anticipated to encourage greater cycle and pedestrian movements, with associated health benefits.
Absenteeism	Third River Crossing, and A1243 Haven Bridge	Pedestrians & Cycle users	
Journey Quality	Third River Crossing, and A1243 Haven Bridge	Pedestrians & Cycle users	Reduced traffic levels on the existing bridges can improve journey quality for existing routes. Also the provision of off carriageway segregated cycle and pedestrian paths will provide quality benefits for cycle users and pedestrians.
Journey Time	Third River Crossing New toucan crossings*	Pedestrians & Cycle users	The provision of a third river crossing in a can improve journey times by removing traffic from existing routes as well as improving accessibility and cycle speeds through reduced distances to travel and reduced journey times in this area. The replacement of a footbridge with at-grade Toucan crossing over Williams Adams Way will help to reduce journey length and distance whilst improving accessibility for all users.

** It should be noted that physical activity, absenteeism and journey quality benefits were only calculated for the proposed bridge crossing and not the proposed toucan crossings on William Adams Way to avoid the possibility of double counting. Only journey time benefits were calculated to quantify the benefit of replacing the footbridge with at-grade crossings, this presents a more conservative level of benefits but is considered a sufficiently robust method for this appraisal.*

3.1 CALCULATING 'WITHOUT SCHEME' AND 'WITH SCHEME' DEMAND

In order to quantify the impact of the scheme on active modes, demand estimates for pedestrians and cyclists have been calculated for Do-Nothing (Without Scheme) and Do Something (With Scheme) scenarios. Each of the active mode appraisal calculations requires an estimate of the walking and cycling demand, either in terms of the number of people, or the number of trips undertaken.

The demand estimates produced were based on the latest available count data (June 2016) on the existing Haven bridge as shown in Table 2. The survey counted the number of pedestrians and/or cyclists observed crossing at this location during a 12 hour (7am – 7pm) period. Surveys taken at the A12 Breydon Bridge were not assessed due to the nature of the road (50mph) with no facilities for walking or cycling.

Table 2 - Summary of pedestrian and cycle survey counts (June 2016)

Date	Location	Ped Count	Cycle Count
30/06/2016	Haven Bridge	4,742	1,056

Additional surveys were undertaken in February 2017 at four locations, listed in Table 3. This survey data was used to supplement the June 2016 count data, mainly for assessing the impact of replacing the footbridge on William Adams Way with a toucan crossing.

Table 3 - Summary of pedestrian and cycle survey counts (February 2017)

Date	Location	Ped Count	Cycle Count
21/02/2017	Suffolk Road/Queen Anne's Road/William Adams Way	466	159
21/02/2017	William Adams Way Footbridge	386	79
21/02/2017	South Denes Road	45	59
21/02/2017	William Adams Way/Beccles Road/Southtown Road	527	258

3.2 TEMPRO GROWTH FACTORS

The Department for Transport's (DfT) Trip End Model Presentation Program (TEMPro) takes account of local planning data including population, employment and car ownership, together with traffic growth factors to provide local traffic projection factors.

The growth factors obtained from TEMPro, detailed in Table 4, provide an uplift factor for estimated growth in walking and cycling numbers for the Great Yarmouth District. Factors were identified to enable the count years (2016 and 2017) to be uplifted to the expected opening year of 2023 and the average figures for the two modes were used to calculate the uplift in pedestrian and cycle numbers.

Table 4 - TEMPro uplift factors

Count Year	Opening Year	Walk			Cycle		
		Origin	Destination	Average	Origin	Destination	Average
2016	**2023**	1.0542	1.0538	1.0540	1.0438	1.0437	1.0438
2017	**2023**	1.0453	1.045	1.0451	1.037	1.037	1.037

(Uplifts are based on Geographical Area – Great Yarmouth; Purpose Definition - Walking and Cycling; Time Period - Average Day; Trip End Type - O/D)

3.3 USER BASE DEMAND

Demand for cycling across the River Yare has been calculated using count data for the A1243 Haven Bridge. The recorded number of cyclists crossing the bridge over a 12 hour period (7am-7pm) is detailed in Table 1-3. The count data included counting cyclists on-carriageway as well as off-carriageway.

A 'reference demand' figure for cycle user activity has been selected based on the 12 hour survey counts. The two-way count on Haven Bridge was 1,056 which was uplifted by a factor of 1.15 to give 24hr flow values, equal to 1,214

The 'reference demand' figure for pedestrian user activity has also been based on the 12 hour survey counts. The two-way count was 4,742 which was uplifted by a factor of 1.15 to give a 24hr flow value of 5,453.

The same method was employed for the survey counts taken at the four locations in February 2017 to capture the walking and cycling demand for the proposed toucan crossing. The counts were again uplifted by a factor of 1.15 giving a 24hr flow value of 91 cycle trips and 444 pedestrian trips.

3.4 CONVERTING TRIPS TO INDIVIDUALS

The number of trips in the 'without scheme' and 'with scheme' scenarios were estimated using the survey data as described above. However, a number of the active mode calculations require an estimate of the number of individuals, rather than trips.

In line with TAG Unit A5.1, where the number of individual users is unknown, the number of individual users is based on the assumption that 90% of trips are part of a return journey using the same route, to avoid double counting in the calculation of the number of individuals affected. The formula to calculate the number of individual users is as follows:

$$((No.of\ Trips\ * 90\%)/2) + (No.of\ Trips * 10\%)$$

3.5 WITHOUT SCHEME DEMAND (DO-NOTHING SCENARIO)

Average numbers of pedestrians and cyclists crossing Haven Bridge and the pedestrian footbridge on William Adams Way were derived from the survey data. Estimates of future numbers were calculated by multiplying the average trip numbers by the relevant TEMPro growth factor for an opening year of 2023 (as per Table 4). The number of individuals was calculated using the formula detailed in the paragraph above. This gave the following total trip and individual numbers:

- Cycle users on bridge: 1,268 trips and 697 individuals
- Pedestrians on bridge: 5,748 trips and 3,161 individuals
- Cycle users at William Adams Way crossing: 95 trips and 52 individuals
- Pedestrians at William Adams Way crossing: 468 trips and 257 individuals

3.6 WITH SCHEME DEMAND (DO-SOMETHING SCENARIO)

As highlighted above the do-nothing scenario includes an uplift in cyclist and pedestrian numbers using TEMPro growth factors. This provides a forecasted increase in trips by these modes using the existing bridges. However, through the provision of an additional crossing point it is considered that further uplifts in travel by these modes will occur. This is because in some circumstances the trip length will reduce and travel on foot or bicycle will become a more viable and attractive mode (Section 3.7 details the methodology for calculating this uplift).

It was assumed a proportion of the existing (and additional) pedestrians and cyclists would cross a third bridge in the proposed location if it was available. The proportion of existing pedestrians and cyclists diverting to the new bridge was assumed to be the same as the vehicular proportional change from Haven Bridge to the new crossing.

This method was adopted using the traffic model outputs which project that in 2023, 62% of AADT vehicular traffic would transfer over to the new crossing from the Haven Bridge. This figure was therefore applied to the proportion of pedestrians and cyclists that would divert from the existing Haven Bridge to use the new crossing.

3.7 ESTIMATION OF UPLIFTS RESULTING FROM A NEW CROSSING POINT OVER THE RIVER YARE

In order to estimate the uplift in demand that could result from the implementation of the scheme, a desktop research exercise was conducted to find appropriate comparative packages that had been implemented in other relevant locations. Whilst it was not possible to find a study which exactly resembled this scheme, the research identified a wide range in levels of increases in walking and cycling from provision of additional, new and improved active mode infrastructure outlined below:

3.7.1 *CYCLE SCHEMES*

The change in cycling flows across the bridge was calculated by estimating uplifts relating to the improved infrastructure by looking at the outcome of previous schemes.

- Cycle lane scheme on Lewes Road, Brighton showed a 14% uplift in cycling post implementation.
- A new pedestrian and cyclist bridge, Diglis Bridge in Worcester, showed an annual increase in cycle numbers passing the site from 31,000 to 465,000 (1400% increase).
- Post implementation of the London Greenway cycle routes an average increase in cycling of 18% was recorded.
- Evaluation of the Government's Sustainable Travel Towns project showed a 26% to 30% increase in cycling trips resulting from improved infrastructure
- Similarly, the Cycling Towns initiative evaluation indicated a 27% increase in cycling from the baseline cycling numbers and a 4% increase per annum.
- A public realm improvement in Darlington town centre, referred to in Manual for Streets 2, showed the number of cyclists to have increased by 30% post implementation of the scheme.
- Data relating to a Sustrans Cycle Route in Skellingthorpe, Lincoln showed a 25% increase in cycle numbers over a two year period (2012-14).
- Before and after counts in 2004 on a Cycle Street in Oss, Netherlands demonstrated a cycling increase of 11% and reduction in motor traffic of around 30%.
- A study of the implementation of cycle infrastructure in Copenhagen showed the construction of cycle tracks resulted in 18-20% increase in cycle/moped traffic and a decrease of car traffic on those roads, whereas introduction of lanes resulted in a 5-7% increase in cycling numbers.

It can therefore be seen implementation of cycle infrastructure can increase usage by a range of proportions. For this exercise it was considered a range of increases in cycling numbers of 5% to 30% would be appropriate to test the range of benefits.

3.7.2 *PEDESTRIAN SCHEMES*

The change in pedestrian flows across the bridge was calculated by estimating uplifts relating to the improved infrastructure by looking at the outcome of previous schemes.

- The evaluation of the Government's Sustainable Travel Towns project showed a 10% to 13% increase in walking trips as a result of improved pedestrian facilities.
- The Living Streets report "The Pedestrian Pound" stated that evaluations of pedestrian improvements in Coventry and Bristol showed a 25% increase in footfall on Saturdays and improved routes to and from Wanstead High Street increased footfall by 98%.

- Pedestrian and cycle improvements in Kingston showed a 12% increase in pedestrian usage after the scheme was implemented.

For this appraisal it was considered that a range of increases in pedestrian numbers of 5% to 15% would be appropriate to test the range of possible benefits resulting from the scheme.

In order to test the assumptions being made, different scenario tests are being applied. A 'Low' scenario tested a reduction in uplift in active mode users and conversely, a 'High' Scenario tested an increased uplift. Table 5 details a summary of the uplifts used to test the different scenarios for the scheme.

Table 5 - Summary of uplifts for scenario tests

Assumptions and Results	Scenario Tests		
	Core	Low	High
Overall Cycle user Uplift	17.5%	5%	30%
Overall Pedestrian Uplifts	10%	5%	15%

In addition to the uplifts referred to above, it was also assumed that the provision of a third crossing would reduce the journey length and/or time for some existing trips creating additional modal shift.

To calculate this, the 2011 census data was interrogated to assess the number of commuters travelling to or from the Lower Super Output Areas (LSOA) that fall within a 5km radius of the alignment of the scheme.

Actual walking and cycling distances were calculated for each LSOA pair on either side of the River Yare under current road network conditions (in the absence of the new crossing). The new bridge was then added to the road network layer and the distances were re-calculated. It was assumed that where the distance was shorter in the 'do-something' scenario, then the commuter would divert on to the new crossing.

The proportion of commuters for each mode of travel is available via the 2011 census data. This was used to calculate the expected number of commuters travelling by each mode. A 5% modal shift to active modes was applied to the number of people travelling by car, taxi and bus. This gave an estimated number of 78 new active mode users as a result of modal shift brought about by the new crossing opportunity. This number was then split on a 2:1 ratio of pedestrians to cyclists, based on average travel to work mode proportions for the area.

A 5% modal shift was considered appropriate based on a Sustrans appraisal of a new pedestrian footbridge at Canary Wharf. This report suggested a 5% increase in cycling trips and 11% increase in walking trips would be expected as a result of the provision of a new bridge.

4 PHYSICAL ACTIVITY IMPACTS (HEALTH)

4.1 OVERVIEW

TAG Unit A5.1 states that physical activity impacts typically form a significant proportion of benefits for active mode schemes. It is expected that the implementation of the scheme will result in increased levels of physical activity due to two key factors: the provision of improved cycle and pedestrian infrastructure and the reduction in traffic levels on parts of the existing network, namely Haven Bridge.

4.2 ASSUMPTIONS & METHODOLOGY

The method for calculating physical activity impacts is taken from 'Quantifying the health effects of cycling and walking' (World Health Organisation (WHO), 2007). The calculation seeks to forecast the physical activity impacts that may result from the package for both pedestrians and cycle users.

The assessment follows the guidance set out in TAG Unit A5.1 and the recent DfT publication, 'Investing in Cycling and Walking: The Economic Case for Action' (2015). As outlined in the following sections, the method requires estimates of the number of new pedestrians and cycle users as a result of the scheme; the time per day they will spend active; and mortality rates applicable to the group affected by the package. The assessment uses the latest mortality and relative risk parameters from the WHO Health Economic Assessment Tool (HEAT) updated guidance[1].

The physical activity impacts have been calculated using the assumptions set out in Table 6.

Table 6 - Physical activity assumptions

Variable	Value	Source
Number of new pedestrians (assuming 10% uplift of without scheme and modal shift of existing commuters)	368	Derived from count data and uplifts applied
Number of new cycle users (assuming 17.5% uplift of without scheme and modal shift of existing commuters)	148	
Proportion of increase in walking/cycling attributable to intervention	75%	Assumption of 75% as it is considered the new bridge is the main reason for a change.

[1] Walking and for Cycling. Methodology and User Guide. Economic Assessment of Transport Infrastructure and Policies. 2014 Update (WHO, 2014)

Mortality Rate for Pedestrians (Deaths per 100,000 Persons per Year)	434.10	WHO HEAT Mortality Database
Mortality Rate for Cycle users (Deaths per 100,000 Persons per Year)	248.97	
Average Time Spent Walking (mins)	13.2	Average walking trip length from National Travel Surveys 2013-2017 (1.1km) / DMRB 11.3.8 guidelines for average pedestrian walking speed (5kph) * 60
Average Time Spent Cycling (mins)	15.9	Average cycle trip length from National Travel Surveys 2013-2017 (5.3km) / DMRB 11.3.8 guidelines for average cycling speed (20 kph) * 60
HEAT Reference Case – Pedestrian Minutes Active (mins/day)	24	WHO HEAT Parameters
HEAT Reference Case – Pedestrian Relative Risk	0.11	
HEAT Reference Case – Cycle user Minutes Active (mins/day)	14.3	
HEAT Reference Case – Cycle user Relative Risk	0.10	
Value of a Statistical life	£1,640,134	DfT TAG

In order to calculate the physical activity impact for the package, the following calculations are undertaken:

- **Number of new users attributable to the intervention** – Number of new users * Proportion of walking/cycling attributable to intervention;
- **Expected deaths amongst new users** – New users attributable to intervention * (mortality rate / 100,000);

- **Do Something scenario relative risk**[2] – (Average time spent cycling / Reference case minutes active) * Reference case relative risk;
- **Lives saved in the Do Something scenario** – Expected deaths amongst new users * Do Something scenario relative risk;
- **Value per Year** – Lives saved in the Do Something scenario * Value of a statistical life

4.3 PHYSICAL ACTIVITY (HEALTH) IMPACT RESULTS

The forecast physical activity (health) impacts, based on the HEAT assessment are summarised in Table 7 for the Core Scenario for the opening year in 2010 prices.

Table 7 - Summary of physical activity (health) impacts (2010 prices)

Impact	Pedestrians	Cycle users	Total
Core Scenario: Physical Activity (Health) benefit per annum	£118,941	£50,455	£169,397

[2] To avoid inflated values at the upper end of the range, the risk reduction is capped: A maximum 45% risk reduction in the risk of mortality for cycling (corresponding to 450 minutes per week) and a maximum 30% risk reduction (corresponding to 458 minutes per week) for walking

5 ABSENTEEISM

5.1 OVERVIEW

TAG Unit A5.1 outlines that improved health from increased physical activity (including walking and cycling) can also lead to reductions in short term absence from work. As previously outlined, it is anticipated that the measures being implemented through the scheme will encourage an uplift in physical activity (through increased walking and cycling) as a result of the improved cycling and walking provision.

5.2 ASSUMPTIONS & METHODOLOGY

This section describes the assumptions and methodology used to assess the impact of the scheme on absenteeism levels. The calculation of impacts follows the guidance set out in TAG Units A4.1 and A5.1. The method requires estimates of the number of new commuting pedestrians and cycle users as a result of the package; the time per day they will spend active; and average absenteeism rates and labour costs.

The absenteeism impacts for the core scenarios have been calculated using the assumptions set out in Table 8.

Table 8 - Absenteeism impact assumptions

Variable	Value	Source
Number of new pedestrians (assuming 10% uplift of without scheme demand and calculation of modal change from existing commuters)	368	% uplift applied to study area wide demand estimate, derived from count data
Number of new cycle users (assuming 17.5% uplift of without scheme demand and calculation of modal change from existing commuters)	148	
Proportion of new cycle users that are commuters	50%	Assumption made in the absence of suitable data. Based on type of environment and likely trip purpose.
Proportion of new pedestrians that are commuters	50%	Assumption made in the absence of suitable data. Based on type of environment and likely trip purpose.
Average time spent cycling (mins)	23.3	Based on average of National Travel Surveys 2013 – 2017 and DMRB average speeds.
Average time spent walking (mins)	17	

Average annual absenteeism rate per person (days per year)	4.1	Office for National Statistics (ONS) - Sickness absence in the labour market: 2017
Expected reduction in absenteeism from increase physical activity	6%	World Health Organisation (WHO) - Health and Development through Physical Activity and Sport, 2003
Activity per day to achieve 6% reduction in absenteeism (minutes)	30	
Median Gross Annual Earnings for Full-time Employees (£)	£28,366	Office for National Statistics (ONS) - Annual Survey of Hours and Earnings, 2017 (East of England)
Salary on-cost multiplier	1.9	Based on UK sickness cost 2013 (PWC Study) and days lost to sickness in 2017
Proportion of increase in walking and cycling attributable to intervention	75%	Assumption of 75% given that actual level is unknown and new bridge is considered main reason for change.
Number of working days	220	Standard economic assumption

In order to calculate the absenteeism impact for the scheme, the following calculations are undertaken:

- **Reduction in sick days per affected individual** – Average annual absenteeism rate per person * Expected reduction in absenteeism from increased physical activity;
- **Estimated employment cost per day** – (Median Gross Annual Earnings for Full-time Employees (£) * Salary on-cost multiplier) / Number of working days;
- **Absenteeism benefit per affected individual** – Reduction in sick days per affected individual * Estimated employment cost per day;
- **Value of Reduction in Absenteeism per New Pedestrian/Cycle user per Annum** – (Absenteeism benefit per affected individual * Proportion of new pedestrians/cycle users that are commuters * Average time spent walking/cycling (mins) / Activity per day to achieve 6% reduction in absenteeism (minutes); and
- **Overall Absenteeism impact on Pedestrians / Cycle users** – Value of Reduction in Absenteeism per New Pedestrian/Cycle user per Annum * Number of new pedestrians/cycle users) * Proportion of increase in walking/cycling attributable to intervention.

5.3 ABSENTEEISM IMPACT RESULTS

The forecast absenteeism impacts are detailed in Table 9 and show an opening year benefit in 2010 prices for the Core Scenario.

Table 9 - Summary of absenteeism impacts (2010 prices)

Impact	Pedestrians	Cycle users	Total
Core Scenario: Absenteeism benefit per annum	£4,668	£2,580	£7,249

6 JOURNEY QUALITY/AMBIENCE IMPACTS

6.1 OVERVIEW

TAG Unit A5.1 states that journey quality is an important consideration in scheme appraisal for pedestrians and cycle users. It includes fear of potential accidents and therefore the majority of concerns are about safety (e.g. segregated cycle tracks greatly improve journey quality over cycling on a road with traffic). It is also fair to assume that a lower level of vehicular traffic will create a more pleasant environment for cycle users and pedestrians.

This section provides an overview of the journey quality benefits that are forecast to result from the scheme. Given that the journey quality/ambience impact experienced by pedestrians and cycle users vary, the impacts for each mode have been reported separately.

6.2 METHODOLOGY

The calculation of benefits follows the guidance set out in TAG Unit A5.1 and uses the data contained within the TAG Databook to quantify the impact of the Great Yarmouth Third River Crossing on pedestrian and cycle users. The approach is based on assigning a 'quality value' to each trip made by existing and new users. It is important to note that journey quality benefits are subject to the 'rule of half'. Current users of a route will experience the full benefit of any improvements to quality whereas the benefits to new users are halved.

Table 10 and Table 11 outline the published research figures as a guide to the potential maxima for an improvement, as included within the TAG Databook. The values in the table give an approximate monetary benefit of the introduction of a pedestrian and/or cycling scheme and include not only infrastructural changes, but facilities as well. These monetary values include all aspects of quality, including environmental quality, comfort, convenience and perceived improvements to safety.

Table 10 - Values of aspects in pedestrian environment (2010 prices and values)

Scheme type	Value (p/km)	Source
Street lighting	3.7	Heuman (2005)
Kerb level	2.6	
Crowding	1.9	
Pavement evenness	0.9	
Information panels	0.9	
Benches	0.5	
Directional signage	0.5	

Table 11 - Values of journey ambience of different types of cycle facility relative to no facilities (2010 prices and values)

Scheme Type	Value (p/min)	Source
Off-road segregated cycle track	7.03	Hopkinson & Wardman (1996)
On-road segregated cycle lane	2.99	Hopkinson & Wardman (1996)
On-road non-segregated cycle lane	2.97	Wardman et al. (1997)
Wider lane	1.81	Hopkinson & Wardman (1996)
Shared bus lane	0.77	Hopkinson & Wardman (1996)

6.3 CYCLE USER IMPACT ASSUMPTIONS

The number of new and existing cycle users is required to calculate the journey quality benefits. This was calculated by estimating proportions of the new and existing users that would use the existing Haven Bridge and the proposed third crossing.

As previously outlined, an increase in cycle trip numbers has been forecasted using the TEMPRO growth factors, together with an estimated uplift resulting from the implementation of the scheme. It was assumed that a proportion (62%) of the new and existing users would use the new crossing point and this figure was factored in to the calculations for journey quality benefits using the figures in Table 12. As described in Section 3.6, the 62% reflects the proportion of total vehicular traffic estimated to use the new crossing from the traffic modelling exercise. Given the users are expected to divert from the existing bridges, they are considered to be existing users rather than new users for the purposes of the calculations. The number of new users was derived by calculating the proportion of uplift, i.e. 17.5%, in cycle trips of the total increase in cycle trips.

With no cycling facilities being provided on the existing bridges, it has been assumed that the scheme measures will result in benefits for cycle users through the provision of an off-road segregated cycle lane from an on-road non-segregated cycle lane. The improvement is considered to warrant a quality value of 4.06p/min. This was calculated using the values in Table 11 and based on an assumption that an off-road segregated lane is worth 7.03p/min and a non-segregated on-road lane is worth 2.97p/min. The upgrade from non-segregated on-road to an off-road segregated lane is then calculated by the difference between their values (4.06p/min).

Additionally, through the provision of a new crossing location, the volume of traffic using the existing crossing points is expected to reduce and therefore can improve the ambience of both the new and existing bridges. The traffic modelling work forecasted that the flows on the Haven Bridge would reduce by 50%. A bespoke value for the benefit of reduced traffic was calculated using an average of the cycle benefit inputs, i.e. off-road segregated track, on-road segregated cycle lane and on-road non-segregated cycle lane. This gave a value of 4.33p/min.

The number of new users was derived by assuming the same proportion of cycle users as traffic (i.e. 62%) would use the new bridge and 17.5% of these (i.e. the assumed uplift) are new users as a result of the provision of the bridge.

The number of existing cycle users was derived by subtracting the number of new users from the assumed number of cycling trips on the new bridge i.e. the 62% of cycle trips in the do something scenario.

The number of trips on all three bridges expected to benefit from a reduction in traffic is the number of new cyclists derived from the uplifts as explained previously.

The journey quality/ambience impacts for cycle users have been calculated using the assumptions set out in Table 12.

Table 12 - Journey quality/ambience impacts for cycle users

Variable	Value	Source
Number of existing users – rerouting to use third crossing	781	Based on uplifts and traffic modelling
Number of new users	166	Based on Census analysis
Number of users – Haven Bridge and third crossing	1,537	Based on uplifts and traffic modelling
Average Cycle Trip Length (km)	5.3	National Travel Survey 2017 - Table NTS0303 (average of 2013-2017)
Average Cycling Speed (kph) (DS)	20.0	DMRB 11.3.8 - Pedestrian, Cyclist, Equestrian and Community Effects
Average Cycle Time (mins) (DS)	15.9	(Avg. Trip length / Avg. Speed)
Scheme length (km)	0.40	Drawing Measurement
Toucan Crossing William Adams Way length (km)	0.0115	Drawing Measurement
Scheme Improvement Value for off-road segregated path (pence/min)	7.03	Derived from TAG Databook
Bespoke value for reduced traffic on existing bridges and new toucan crossing on William Adams Way	4.33	Derived and adapted from TAG Databook - Average of Off-Road, On-Road Segregated & On-Road Non-segregated
Annualisation factor	365	7 days * 52 weeks

In order to calculate the journey quality/ambience impact for cycle users, the following calculations are undertaken:

Time Spent Cycling on New Crossing $- (Average\ Cycle\ Time\ /\ Average\ Trip\ Length) * Scheme\ length$

Total Improvement Value (Assuming Cycle users use Route for Half Their Journey - $(Improvement\ Value * Time\ Spent\ Cycling)$

Existing User Benefit - $Total\ Improvement\ Value * No.of\ Existing\ Users$

New Users Benefit - $Total\ Improvement\ Value * No.of\ New\ Users) * 0.5$

Total Benefit - $(Existing\ Users\ Benefit + New\ Users\ Benefit) * Annualisation\ Factor$

6.4 PEDESTRIAN IMPACT ASSUMPTIONS

The proposed third crossing is expected to improve the quality of the route for pedestrians by offering an alternative route on a modern bridge with appropriate pedestrian facilities as well as an improved environment resulting from overall reductions in vehicular traffic flow over the existing bridges. The traffic modelling work forecasted that flows on the Haven Bridge would reduce by approximately 50%.

A segregated off-road footway/cycle track is to be provided on the northern side of the scheme. A specific value for these improvements is not included in the TAG data book, however, a bespoke value based on the crowding value and pavement evenness multiplied by the average walking trip length was used to estimate the level of benefit afforded. Additionally, to account for the potential variation in the value, a rule of half has been applied to the calculated value providing a final value of 1.64p per journey made on the new crossing and 2.64p per journey made on the new toucan crossing on William Adams Way.

Similarly, there is no specific value for a reduction of vehicles on the road adjacent to the pedestrian routes. Therefore, a bespoke improvement value has been calculated based on the crowding values and the average walking trip length. This is considered appropriate considering the type of benefits anticipated. As per the segregated path value, to account for the potential variation in the value, a rule of half has been applied to the calculated value providing a final value of 1.12p per journey. As a check against this value, the ambience values included within Transport for London's Business Case Development Manual were reviewed. The value for 'light traffic, easy to cross' generates a higher but comparable value per journey.

The journey quality/ambience impacts for pedestrians have been calculated using the assumptions set out in Table 13.

Table 13 - Journey quality / ambience impact assumptions for pedestrians

Variable	Value	Source

Number of existing pedestrian trips on Haven Bridge (Do Minimum)	5,748	Based on survey data and Tempro uplifts.
Number of existing pedestrian trips on new crossing (Do Something)	3,556	Based on uplifts and traffic modelling
Number of new pedestrian trips on new crossing (Do Something)	395	Based on Census 'Travel to Work' analysis
Number of pedestrian trips on Haven Bridge (Do Something)	6,417	Based on uplifts and traffic modelling
Segregated path benefit (p/journey)	1.54	Bespoke Value derived from TAG Databook
Overall Improvement Value on existing bridges (p/journey)	1.05	Bespoke Value derived from TAG Databook
Overall Improvement Value on new toucan crossing Williams Adams Way (p/journey)	2.42	Based on average of TAG Databook values for pedestrian facilities
Annualisation Factor	365	7 Days * 52 Weeks

In order to calculate the journey quality/ambience impact for pedestrians, the following calculations are undertaken:

Existing User Benefit - $Total\ Improvement\ Value * No.of Existing\ Users$

New Users Benefit - $Total\ Improvement\ Value * No.\ of\ New\ Users) * 0.5$

Total Benefit - $(Existing\ Users\ Benefit + New\ Users\ Benefit) * Annualisation\ Factor$

6.5 JOURNEY QUALITY/AMBIENCE RESULTS

The forecast journey quality/ambience impacts are detailed in Table 14 and show the opening year benefit in 2010 prices.

Table 14 - Summary of journey quality / ambience impacts (2010 prices)

Impact	Pedestrians	Cycle users	Total
Core Scenario: Journey Quality/Ambience benefit per annum	£49,894	£41,183	£91,077

7 JOURNEY TIME

7.1 OVERVIEW

This section provides an overview of the journey time benefits that are forecast to result from the scheme.

The provision of a segregated off-road cycleway/footway and reduction in traffic will provide a safe and convenient route for cycle users across both the new third crossing and existing Haven Bridge. The new infrastructure may allow cycle users to travel faster compared to the existing conditions due to less impediments/congestion on the existing routes. Journey times for cycle users may therefore be reduced, particularly for those starting or ending their trips in areas adjacent to or south of the new crossing, including Gorleston, as those journeys will be significantly shorter.

Similarly, the provision of a new crossing in the proposed location may also bring about journey time improvements for pedestrians in these areas due to a reduction in distance to be travelled.

It is difficult to quantify the number of pedestrians and cyclists that would benefit from a reduction in journey time, however, a calculation using census data was undertaken. Pedestrian and cycle journey time calculations have been undertaken for journeys related to commuters travelling to and from the census LSOAs within a 5km radius of the proposed third crossing location. These areas were selected as it is assumed that a significant proportion of people travelling to/from these areas would benefit from a new crossing in the proposed location. Although this is not comprehensive for all potential pedestrian and cycle users of the new bridge, it provides an indication, albeit a conservative estimate, of benefits that could be achieved. Therefore, it could be considered the level of benefit calculated may be an underestimation and greater benefits may be possible.

7.2 METHODOLOGY AND ASSUMPTIONS

The calculation of journey time benefits follows the guidance set out in TAG Unit A5.1 and uses the data contained within the TAG Databook to quantify the impact of the Great Yarmouth Third River Crossing improvements.

To calculate journey time improvements, the number of users benefitting from the new bridge at the proposed location needs to be estimated. Census data relating to method and locations of travel to work were interrogated to establish existing travel patterns. A calculation of the pedestrian and cyclist numbers, based on census travel to work data, was undertaken to estimate users of active modes on both the proposed third crossing as well as the resulting existing and new active mode users on the existing crossings. The analysis of census data for commuting trips cross referenced the location of usual residence and place of work together with the method of travel to work. The calculation that was undertaken is summarised below:

i. The total number of commuters residing in LSOAs, within a 5km distance of the site, (i.e. the origin) on one side of the river, travelling to the workplace in LSOAs within a 5km distance of the site (i.e. the destination) on the opposite side of the river were obtained from 2011 census data.

ii. The proportions of modes of travel to work for each LSOA was also obtained from Census 2011 data.

iii. Using the figures in (i and ii) the number of commuters for each mode of travel can be calculated.

iv. The travel distances from a centroid of each 'origin' LSOA to the centroid of the corresponding 'destination' LSOA was measured for a Do-Minimum scenario (without the scheme) and the Do-Something scenario (with the scheme) using GIS. Where the distance was calculated to be shorter in the Do-Something scenario, it was assumed the commuter would use the new bridge.

v. The number of commuting pedestrians and cyclists that would benefit from the shorter travel distances were then totalled.

vi. Journey Time Savings could then be calculated using the average walk and cycle speeds (5km/h and 20km/h respectively) and the differences in distances travelled. Average journey time savings for pedestrians and cyclists were then derived based on all the time savings calculated.

The calculation above provided the number of existing active mode users that would use the new bridge at the proposed location. This was converted to trips using the reverse of the formula previously described in section 3.4. It is also considered that as a result of providing a new bridge, there are other people that will benefit from reduced journey lengths as a result of the new crossing, such as leisure trips for example. However, without data relating to all origin and destination movements in this area it is difficult to quantify. An estimate was derived using the uplifts previously mentioned for pedestrian and cyclist numbers, i.e. 17.5% uplift for cyclists and 10% uplift for pedestrians. The values derived from the application of these uplifts were used to represent the 'new' cyclists and pedestrians.

To calculate the level of benefits, the value of non-working time per person by commuting trip person (derived from the TAG Databook) is multiplied by the time saved and the number of users, existing and new. An annualisation factor is subsequently applied.

Table 15 details the assumptions and values used in formulating the level of benefits that could be derived by provision of the scheme.

Table 15 - Journey time assumptions

Variable	Value	Source
Existing Number of Cyclists diverting to new bridge (trips)	212	Commuters from census data.
Core: Number of New Cyclists (new bridge)	37	Derived from census commuter data and assumed uplifts.
Existing Number of pedestrians diverting to new bridge (trips)	585	Based on survey data and Tempro growth factors
Core: Number of new pedestrians (trips)	59	Derived from census commuter data and assumed uplifts.
Proportion of commuting journeys	100%	The data was travel to work data so all trips were commuting journeys.
Average cycling speed (kph)	20	DMRB 11.3.8 - Pedestrian, Cyclist, Equestrian and Community Effects

Average walking speed (kph)	5	Based on DMRB 11.3.8 - Pedestrian, Cyclist, Equestrian and Community Effects
Value of non-working Time per person by 'commuter' trip purpose	6.81	TAG Databook - Table A1.3.1 - Value of Time per Person (2010 prices and values)
Value of non-working Time per person by 'other' trip purpose	6.04	TAG Databook - Table A1.3.1 - Value of Time per Person (2010 prices and values)
Average pedestrian journey time savings over bridge (hr)	0.112	Based on 2011 Census Travel to work data and journey length measurements
Average pedestrian journey time savings over new toucan crossing (hr)	0.015	Based on Actual Pedestrian Survey Counts and journey length measurements
Average cyclist journey time savings over bridge (hr)	0.017	Based on 2011 Census Travel to work data and journey length measurements
Average cyclist journey time savings over new toucan crossing (hr)	0.012	Based on Actual Pedestrian Survey Counts and journey length measurements
Annualisation factor	365	7 days * 52 weeks

7.3 JOURNEY TIME RESULTS

As described above, it was not possible to identify routes for all existing trips by active modes and therefore only an indication of the level of benefits relating to commuters is provided, given the availability of data. The estimate of journey time savings for the bridge was calculated using known commuting patterns based on census data to the LSOAs within a 5km radius of the new proposed scheme location. It is likely there will be other commuters and users of the scheme that would benefit from a third crossing in terms of a reduction in journey time, however, it is considered that it is not possible to robustly quantify this and as such, these are not included in the benefits forecasted.

Journey time savings were also calculated for a new proposed toucan crossing on Williams Adams Way (replacing the existing footbridge). This was calculated using actual 12hr pedestrian count data (February 2017) and journey length measurements (included within Table 16).

The forecast journey time impacts are presented in Table 16 showing the opening year benefit in 2010 prices.

Table 16 - Journey time assumptions

Impact	Pedestrians	Cycle users	Total
Core Scenario: Journey Time benefit per annum	£278,220	£18,028	£296,248

8 ACTIVE MODE BENEFITS OVER 30YR APPRAISAL PERIOD (CORE SCENARIO)

8.1 OVERVIEW

The active mode appraisal has been conducted over a 30 year appraisal period, in line with TAG. The opening year benefits for each active mode impact are summarised for the Core Scenario in Table 17 and the 30 year appraisal results in Table 18.

Table 17 - Summary of opening year active mode impacts core scenario (2010 prices)

Impact	Pedestrians	Cycle users	Total
Physical Activity (Health)	£118,941	£50,455	£169,397
Absenteeism	£4,668	£2,572	£7,240
Journey Quality/Ambience	£49,894	£41,183	£91,077
Journey Time	£278,220	£18,028	£296,248
Total	**£451,724**	**£112,238**	**£563,962**

8.2 ASSUMPTIONS

As outlined above, a 30 year appraisal period has been assumed for the active mode benefits with an opening year of 2023. In line with TAG, the benefits have been discounted and reported in present values using the schedule of discount rates provided in the TAG Databook. As the appraisal has taken place in 2017, a discount rate of 3.50% per year has been applied until 2045, with a rate of 3.00% thereafter.

Again, in line with TAG, the values have included real growth in line with forecast GDP/capita.

8.3 OVERALL RESULTS

Table 18 summarises the PVB for each of the active mode impacts outlined in the preceding sections of the report, for the Core Scenario, over the 30 year appraisal period. Appendix A provides a full summary of the discounted benefits.

Table 18 - Summary of active mode impacts over 30 year appraisal period (2010 prices and values)

Impact	Pedestrians	Cycle users	Total
Physical Activity (Health)	£2,152,089	£912,918	£3,065,007
Absenteeism	£84,466	£46,541	£131,007
Journey Quality/Ambience	£902,767	£745,151	£1,647,918

Journey Time	£5,034,019	£326,197	£5,360,216
Total	**£8,173,341**	**£2,030,807**	**£10,204,148**

8.4 SENSITIVITY TESTING

As recommended in TAG Unit A5.1, the potential differences in uplift for pedestrians and cycle users as a result of the scheme have been considered.

8.5 CORE, HIGH AND LOW SCENARIOS

In order to sensitivity test the various assumptions and estimates used as part of the calculations, Core, High and Low Scenarios were tested.

The Core Scenario includes the main assumptions and estimates on the without scheme scenario. However, in order to test that the assumptions are appropriate, different levels of uplift were tested with reduced levels of uplift of pedestrians and cyclists being tested in the Low Scenario and greater levels of uplift in the High Scenario. Table 19 summarises the proportions used in the sensitivity tests and resulting benefits.

Table 19 - Low and high uplift sensitivity test results (rounded to nearest £1)

Assumptions and Results	Scenario Tests		
	Core	Low	High
Pedestrian Uplifts	10%	5%	15%
Cycle user Uplift	17.5%	5%	30%
Pedestrians Benefits	£8,173,341	£7,067,017	£9,483,385
Cycle users Benefits	£2,030,807	£1,399,730	£2,655,034
Total Benefits	**£10,204,148**	**£8,466,747**	**£12,138,419**

Appendix A

BENEFITS OVER 30 YEARS APPRAISAL PERIOD

Year	Discount Factor	GDP per Capita Growth Factor	Absenteeism PVB	Physical Activity PVB	Journey Quality PVB	Journey Time PVB
2010	1.000	1.000				
2011	1.035	1.006				
2012	1.071	1.014				
2013	1.109	1.029				
2014	1.148	1.052				
2015	1.188	1.068				
2016	1.229	1.080				
2017	1.272	1.093				
2018	1.317	1.102				
2019	1.363	1.110				
2020	1.411	1.117				
2021	1.460	1.126				
2022	1.511	1.137				
2023	1.564	1.150	£4,630	£108,313	£58,235	£189,422
2024	1.619	1.165	£5,210	£121,886	£65,533	£213,160
2025	1.675	1.181	£5,105	£119,439	£64,217	£208,881
2026	1.734	1.200	£5,009	£117,183	£63,004	£204,935
2027	1.795	1.219	£4,919	£115,095	£61,882	£201,283
2028	1.857	1.241	£4,837	£113,158	£60,840	£197,896
2029	1.923	1.263	£4,757	£111,305	£59,844	£194,655
2030	1.990	1.287	£4,684	£109,584	£58,918	£191,645
2031	2.059	1.312	£4,611	£107,884	£58,004	£188,671
2032	2.132	1.336	£4,539	£106,200	£57,099	£185,728
2033	2.206	1.361	£4,468	£104,527	£56,200	£182,802
2034	2.283	1.387	£4,398	£102,891	£55,320	£179,940
2035	2.363	1.413	£4,330	£101,310	£54,470	£177,175
2036	2.446	1.441	£4,266	£99,812	£53,665	£174,556
2037	2.532	1.470	£4,204	£98,349	£52,878	£171,997
2038	2.620	1.499	£4,142	£96,910	£52,104	£169,480

2039	2.712	1.528	£4,081	£95,477	£51,334	£166,974
2040	2.807	1.558	£4,020	£94,043	£50,563	£164,467
2041	2.905	1.589	£3,960	£92,636	£49,806	£162,005
2042	3.007	1.620	£3,900	£91,250	£49,061	£159,581
2043	3.112	1.651	£3,841	£89,873	£48,321	£157,174
2044	3.221	1.683	£3,783	£88,498	£47,581	£154,769
2045	3.334	1.715	£3,724	£87,135	£46,849	£152,386
2046	2.898	1.747	£4,365	£102,128	£54,909	£178,605
2047	2.985	1.780	£4,318	£101,018	£54,313	£176,664
2048	3.075	1.813	£4,270	£99,910	£53,717	£174,726
2049	3.167	1.847	£4,224	£98,817	£53,129	£172,815
2050	3.262	1.882	£4,178	£97,756	£52,559	£170,960
2051	3.360	1.920	£4,137	£96,786	£52,037	£169,263
2052	3.461	1.958	£4,096	£95,834	£51,526	£167,599
Sum	**£131,007**	**£3,065,007**	**£1,647,918**	**£5,360,216**		
					Overall Total	**£10,204,148**

St. Johns House
Queen Street
Manchester
M2 5JB

wsp.com

Appendix E – Social and Distributional Impacts

Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING

Social and Distributional Impacts Report

001
AUGUST 2018

CONFIDENTIAL

Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING

Social and Distributional Impacts Report

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 62240375

OUR REF. NO. 001

DATE: AUGUST 2018

Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING

Social and Distributional Impacts Report

WSP

St. Johns House,
Queen Street, Manchester
M1

Phone: +44 161 602 8400

WSP.com

CONTENTS

TABLES

PLATES

ANNEXES

1 INTRODUCTION

1.1 PURPOSE OF THE REPORT

This report has been prepared as supporting information for the Great Yarmouth Third River Crossing (GYTRC) to be submitted to the Department for Transport (DfT).

The purpose of Social and Distributional Impact (SDI) Analysis is to attempt to identify groups that gain benefits and those that are likely to experience disbenefits of a transport intervention with particular reference to the impact upon equality through identifying the effects upon groups that are disadvantaged both financially and socially.

The report sets out the methodology and outputs of the SDI analysis for the appraisal of the GYTRC and presents a full appraisal undertaken for the identified Distributional (DI) indicators in accordance with WebTAG Units A4.1[1] and A4.2[2]. The report is structured by providing a scheme background before detailing a three-step approach for each indicator:

- Step 1 – Screening Process:
  - Identification of likely impacts for each indicator.
- Step 2 – Assessment:
  - Confirmation of the area impacted by the transport intervention (impact area)
  - Identification of social groups in the impact area; and
  - Identification of amenities in the impact area.
- Step 3 – Appraisal of Impacts:
  - Core analysis of the impacts; and
  - Full appraisal of DIs and input into AST

1.2 SCHEME BACKGROUND

Great Yarmouth currently suffers from high levels of congestion from local, regional and strategic traffic, particularly around Haven Bridge, due to a lack of a direct crossing to the southern part of the peninsula. The Haven Bridge currently experiences moderately high and inappropriate access and egress of Heavy Goods Vehicles (HGV's) travelling to the Peel Ports and Outer Harbour causing delays and making journey times unreliable. The mixture of port-related and local traffic makes it more difficult for people to access the town centre, seafront, and leisure facilities and presents a limitation on future growth in the area.

---

[1] WebTAG: TAG unit A4-1 social impact appraisal, December 2017

[2] WebTAG: TAG unit A4-2 distributional impact appraisal, December 2015

The lack of a direct river crossing makes Great Yarmouth seem remote, and discourages inward investment. Bus users, cyclists and pedestrians have long, indirect journeys into the peninsula, which discourages commuting to work by more sustainable modes.

The scheme will provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern parts of Great Yarmouth. Specifically, it will provide a connection between the Strategic Road Network (A47) and the South Denes Business Park, Enterprise Zone, Great Yarmouth Energy Park and the Outer Harbour, all of which are located on the South Denes peninsula (Plate 1).

Plate 1 - Great Yarmouth Third River Crossing Location Plan

The Great Yarmouth Enterprise Zone has the potential to create 5,000 new jobs by 2025, and there are plans for 2,000 new homes and 20-30 hectares of employment development. A new river crossing is needed to accommodate the traffic generated by this planned growth, to improve connectivity to the strategic road network, and to avoid making existing problems worse. Without a new crossing, the full potential for growth in the Enterprise Zone and LDO area, including the port and outer harbour, may not be fully realised.

GYTRC is recognised by Norfolk County Council, Norfolk and Suffolk Local Transport Body, New Anglia LEP and the A47 Alliance as a “strategic priority for unlocking future economic growth in the area”. It is considered to be necessary to alleviate the existing problems on the highway network and to support the delivery of national and local policy agendas identified for Great Yarmouth.

1.3 SCOPE OF SOCIAL AND DISTRIBUTIONAL IMPACTS

The analysis of distributional impacts is mandatory in the appraisal process and is a key component of the Appraisal Summary Table (AST). The Distributional Impacts Appraisal compares the distribution of benefits arising from a transport intervention against the distributions of different social groups to assess the extent to which benefits are experienced by those groups and compared nationally.

Distributional impacts consider the benefits and disbenefits that transport interventions have across different social groups. For example, people with access to a car may experience less benefits to those without a car for an intervention that improves local public transport services. It is important to consider vulnerable groups and that they are not disadvantaged further by receiving a disproportionately low share of the benefits provided the intervention, or a disproportionately high share of the disbenefits.

Within WebTAG unit A4.2, there are eight transport benefit indicators that are assessed as part of the Distributional Impacts Appraisal:

- User benefits;
- Noise;
- Air quality;
- Accidents;
- Security;
- Severance;
- Accessibility; and
- Personal affordability.

The appraisal of SDI focuses on eight specific impacts, as detailed within Table 1.

Table 1 - The Eight Social and Distributional Impacts

TAG Unit	Summary of Importance
User Benefits (TAG Unit A4.2.2)	It is important to gain an understanding of the distribution of user benefits by social group and by area. This analysis assists in understanding how user benefits accrue to different groups in society and across a geographic area. Analysing a wider area outside of the immediate vicinity of the intervention is vital as user benefits are often generated significantly beyond the immediate area of the scheme. Note that SDI analysis is only applicable for individuals and not in-work trips experienced by businesses.
Noise (TAG Unit A4.2.3)	It is important to understand the distributional effects of changes to noise generated by the transport intervention – both in terms of improvements and deterioration. Changes in noise levels resulting from the intervention will be experienced to varying extents in different areas and by different groups of

TAG Unit	Summary of Importance
	people. It is therefore important to understand the noise-related social and distributional impacts of a scheme
Air Quality (TAG Unit A4.2.4)	Changes in emission levels resulting from the transport intervention will vary by location and social group. It is therefore important to understand the distribution of air quality changes – both in terms of improvements and deteriorations.
Accidents (TAG Unit A4.2.5)	Transport schemes can have significant impacts on safety and accidents and as these issues can have varying impacts on different areas and social groups, it is important to understand the specific impacts of an individual scheme.
Severance (TAG Unit A4.2.6)	Transport interventions can result in changes to levels of severance within the transport network through influencing traffic flows and providing new infrastructure. As severance issues impact on different social groups and areas to differing extents, it is important to analyse how individual scheme will alter levels of severance.
Security (TAG Unit A4.2.7)	Transport schemes can have impacts on personal security (both real and perceived) and these benefits can differ according to area and social group. It is therefore, important to gain an understanding of the social and distributional impacts of the transport intervention from the personal security perspective.
Accessibility (TAG Unit A4.2.8)	Access to services often presents significant difficulties to certain social groups and those living remotely. Transport interventions can have an impact of the ability of people to access services they require.
Personal Affordability (TAG Unit A4.2.9)	Changes in costs (both increases and reductions) need to be assessed in terms of understanding the social and distributional effects. Any changes in transport costs due to changes to the transport network could impact on the lower income groups.

Table 2 sets out the groups of people to be identified in the analysis for each of the indicators listed above.

Table 2 - Social Groups and SDI Indicators

Dataset / Social Group	User Benefits	Noise	Air Quality	Accidents	Severance	Security	Accessibility	Personal Affordability
Income Distribution	✓	✓	✓				✓	✓
Children (proportion of population aged under 16)		✓	✓	✓	✓	✓	✓	
Young Adults (proportion of population aged 16-25				✓			✓	
Older People (proportion of population aged over 70)		✓		✓	✓	✓	✓	
Proportion of population with a disability					✓	✓	✓	
Proportion of population of Black and Minority Ethnic (BME) origin						✓	✓	
Proportion of households without access to a car					✓		✓	
Carers (proportion of households with dependent children)							✓	

Table 3 sets out the general scoring method of distributional impacts for identified social groups.

Table 3 - General System for Grading of Distributional Impacts for each of the Identified Social Groups

Impact	Assessment
Beneficial and the population impacted is significantly greater than the proportion of the group in the total population	Large Beneficial ✓✓✓
Beneficial and the population impacted is broadly in line with the proportion of the group in the total population	Moderate Beneficial ✓✓
Beneficial and the population impacted is smaller than the proportion of the group in the total population	Slight Beneficial ✓
There are no significant benefits or disbenefits experienced by the group for the specified impact	Neutral
Adverse and the population impacted is smaller than the proportion of the group in the total population	Slight Adverse

Impact	Assessment
	×
Adverse and the population impacted is broadly in line with the proportion of the group in the total population	Moderate Adverse ××
Adverse and the population impacted is significantly greater than the proportion of the group in the total population	Large Adverse ×××

1.4 INITIAL SCREENING

An initial screening assessment has been undertaken to consider the likely positive and negative impacts of the eight DI indicators listed in Table 4.

The findings from the initial screening are presented in the proforma (Appendix B) which identifies which indicators should be appraised in more detail and provides recommendations, where appropriate for further analysis. The screening proforma is summarised in Table 4 below.

Table 4 - Summary of Proforma

SDI Indicator	Likely SDI Impact	Recommendation
User Benefits	Yes	Proceed to Step 2
Noise	Yes	Proceed to Step 2
Air Quality	Yes	Proceed to Step 2
Accidents	Yes	Proceed to Step 2
Security	No	No further assessment required
Severance	Yes	Proceed to Step 2
Accessibility	No	No further assessment required
Affordability	Yes	Proceed to Step 2

Following the initial screening process, and prior to undertaking the actual SDI Appraisal, WebTAG Unit A4.2 states that a full screening should be progressed. This is provided for each SDI indicator in the following sections.

2 USER BENEFITS

2.1 INTRODUCTION

User benefits of transport schemes are experienced by different groups of people in different areas. Although it is not possible to attribute social impacts to user benefits, the analysis of distributional impacts (DI) is more attainable.

2.2 SCREENING (STEP 1)

The proposed scheme is a transport intervention that has been developed for the purpose of generating benefits to users. A user benefit DI analysis should be undertaken, in line with TAG Unit 4.2, where user benefit analysis has been used in the scheme appraisal.

An initial screening proforma was undertaken which assessed the user benefits using the DfT's Transport User Benefit Appraisal (TUBA) software, where they have been quantified in conjunction with a spatially disaggregate transport model.

TUBA calculates user benefits from the differences in travel times, vehicles operating costs (VOCs) and user charges between the Do-Minimum and Do-Something scenarios. The outputs can then be used to spatially identify a benefit per head of the population as a result of the scheme and assess the areas that will have the most significant impacts in relation to income distribution for people living within the impact area.

2.3 ASSESSMENT – AREAS OF IMPACT (STEP 2A)

The impact area for user benefits is defined as the core modelled area within the SATURN transport model, defined by the Great Yarmouth borough (Plate 2). The transport model zones were used to define the SDI study area as this would provide a defined area where impacts could be quantified. The area is considered large enough to capture the biggest impacts expected due to the scheme. Areas where impacts are quite likely but are expected to be relatively small such as the city of Norwich and wider Norfolk were all included within 'rest of England and Wales' due to inaccuracies associated with data aggregation at this geographical level.

Plate 2 - Core Modelled Area

2.4 ASSESSMENT – IDENTIFICATION OF SOCIAL GROUPS IN IMPACT AREA (STEP 2B)

It is important to understand the distribution of user income within the impact area. To achieve this, the income domain from the Index for Multiple Deprivation (IMD) 2015 has been mapped at Lower Super Output Area (LSOA) level throughout the scheme area.

Initially, the user benefit analysis was conducted on the core modelled impact area. However, the resolution of the majority of the model zones within the impact area were found to be either smaller or larger than the LSOAs or their respective boundaries did not share a high degree of commonality (i.e overlapping). It was therefore recommended to convert the model data from model zone level to LSOA level. The zones were initially split based on geographical area but were then further disaggregated based on the proportion of population of each respective LSOA. This was found to be the most robust method to capture changes in population density and to meet the requirements set out in TAG Unit 4.2. The end result provided user benefits assigned to each individual LSOA as shown in Plate 3, allowing the appraisal to focus on the impact across income deprivation quintiles.

2.5 APPRAISAL OF IMPACTS (STEP 3)

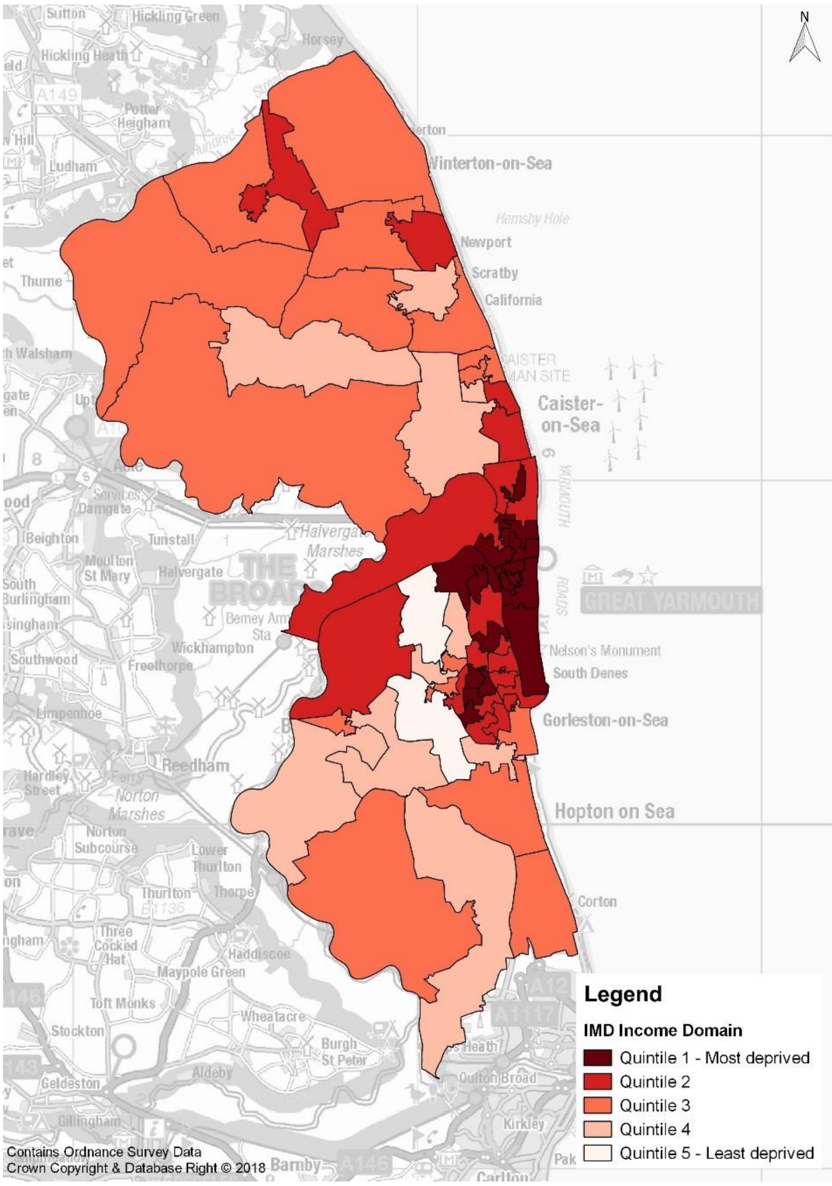
Table 5 shows the distribution of user benefits across the population within the scheme area by national income deprivation quintile. Around 85% of the benefits of the scheme are experienced by the population within the impact area. Further to this, approximately 46% of the benefits within the impact area are accrued by people within the lowest 20% of the IMD income domain. This translates to around 39% when including the rest of England and Wales. Over a quarter of the impact area scheme user benefits (28%) were accrued by people within the second income quintile (20<40%). Only 5% of people within the impact area are receiving benefits from the scheme within the highest 20% income domain. No disbenefits were observed for any area.

Table 5 - Distribution of User Benefit Costs by Income Deprivation Quintile

	IMD Income Domain					
	0%<20%	**20%<40%**	**40%<60%**	**60%<80%**	**80%<100%**	**Rest of England and Wales**
Total user benefits of LSOA's within impact area (£M)	44,966	27,022	7,553	13,412	4,755	16,592
Share of user benefits within impact area	46%	28%	8%	14%	5%	-
Share of user benefits within Modelled Area (Inc. rest of England and Wales)	39%	24%	7%	12%	4%	15%
Population	28,243	29,666	24,882	14,808	3,686	55.98m
Share of population in the impact area	28%	29%	25%	15%	4%	-
Assessment	✓✓✓	✓✓	✓	✓✓	✓✓	

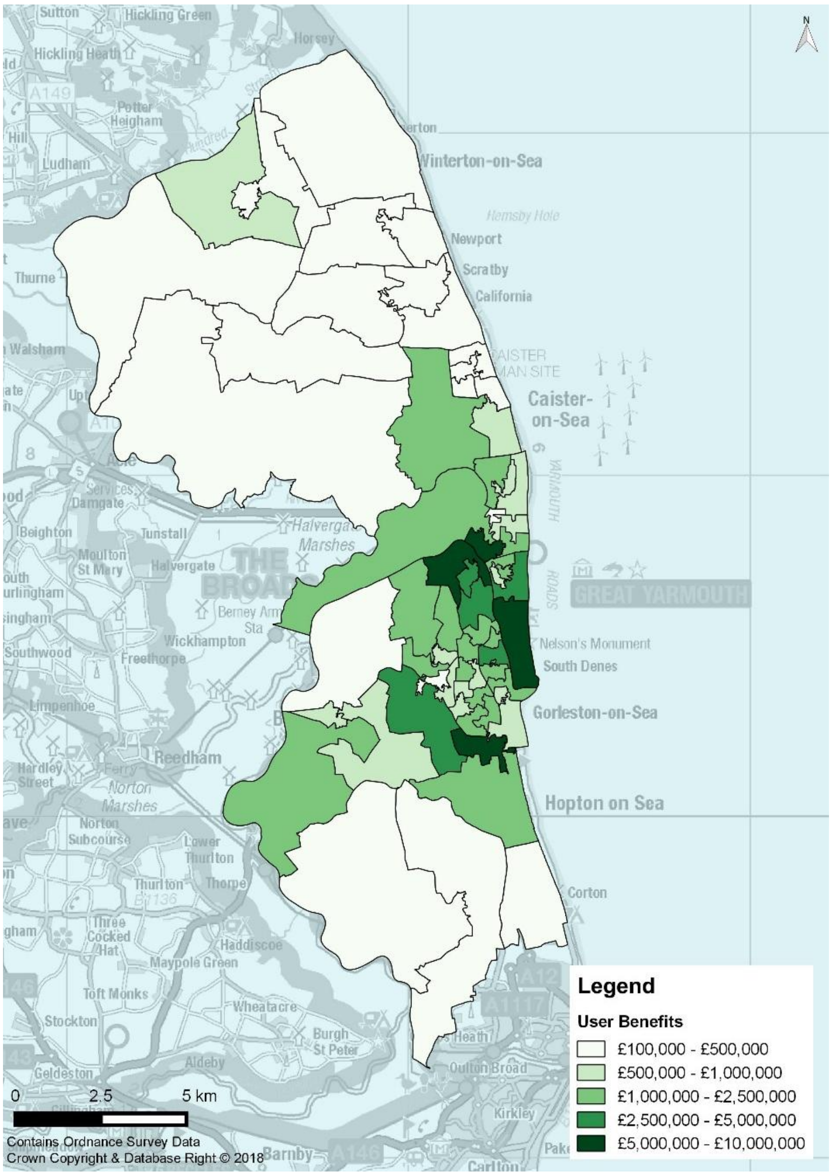
Plate 3 presents a visual representation of the income domain quintiles and how user benefits are distributed throughout the impact area at LSOA level.

Plate 3 - IMD Income Domain



Similarly, Plate 4 shows where the monetary benefits are being accrued within the impact area by LSOA level.

Plate 4 - User Benefits disaggregated at LSOA level



The TUBA outputs have also been assessed and disaggregated across the resident population of Great Yarmouth to identify benefits for each individual LSOA. Plate 4 spatially demonstrates the calculated user benefits per LSOA within the impact area. Every LSOA experiences a benefit with the largest benefits being accrued on the Peninsula and around the town centre therefore the DI appraisal of user benefits has been assessed as **Large Beneficial.**

3 NOISE

3.1 INTRODUCTION

Noise impacts are likely to occur where an intervention results in changes to traffic flows or speeds or where the physical gap between people and traffic is altered. Changes in traffic volume on existing roads or new routes may cause either of the threshold values for noise to be exceeded. A 25% increase in traffic flow is equivalent to a +1dB change in noise, whereas a 20% decrease in traffic flow is equivalent to a -1dB change in noise, as cited in the DMRB[3].

3.2 SCREENING (STEP 1)

As the scheme will result in both changes to traffic flows and road alignment, it is necessary to carry out distributional analysis for noise. Impacts on the existing network through the redistribution of traffic will also lead to changes in noise levels which require assessment.

The data shows that as a result of GYTRC, there will likely be an impact on noise within areas of the Great Yarmouth district. There are a number of receptors located within the scheme area where the most significant noise quality impacts are likely to occur. Further to this, there is a significant proportion of those aged under 16 living close to the scheme that are particularly sensitive to changes in air and noise quality.

3.3 ASSESSMENT – AREAS OF IMPACT (STEP 2A)

A defined impact area has been identified to accurately capture the changes in noise levels (>1dB(A)) within the vicinity of the scheme along the existing transport corridors. This is currently set to 1km around the scheme boundary with an inner study area of 250m. The study shows that there are approximately 4616 households within 1km, and 970 households within 250m of the scheme.

3.4 ASSESSMENT - IDENTIFICATION OF SOCIAL GROUPS IN IMPACT AREA (STEP 2B)

WebTAG guidance states that attention should be paid to the impact of noise on children and older people as key at-risk groups. Plate 5 shows that there is a high proportion of children under 16 within the impact area, including close to links where traffic flows are expected to increase by 25% or more.

The assessment of noise impacts against IMD income domain quintiles was also undertaken in line with TAG Unit 4.2. Plate 8 shows that approximately half of the proposed scheme alignment runs through areas within the 20% most income deprived within England, whilst the other half runs through areas in the second most deprived quintile (20-40%).

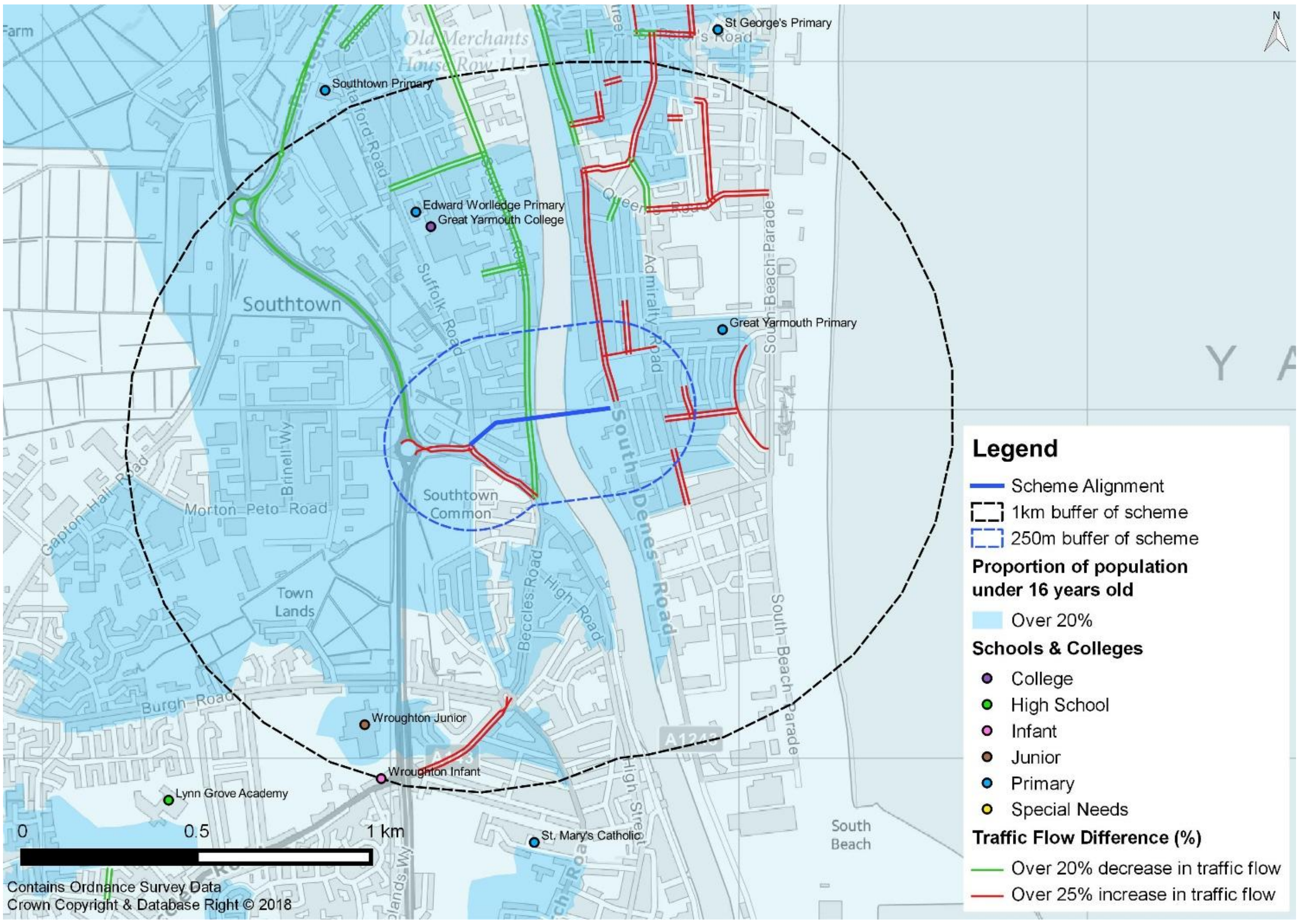
[3] Design Manual for Roads and Bridges (DMRB) Volume 11 Environmental Assessment, Section 3, Part 7

3.5 ASSESSMENT – AMENITIES IN THE IMPACT AREA (STEP 2C)

With children being a key at-risk social group, it is therefore necessary as part of the DI assessment to examine the impact of noise and air quality on schools in the area. Plate 5 shows that there are no schools located within 250m of the scheme, however, within 1km of the scheme, there are three primary schools, one junior school and one college.

Although the quantitative change in noise is unknown in the areas where these schools are located, it is observed that Great Yarmouth Primary could potentially experience an adverse noise impact due to significant increased traffic flows (over +25%) on nearby Barrack Road and Harbord Crescent. In addition, Wroughton Junior School and Wroughton Infant School could also experience an adverse impact due to significant increased flow on Beccles Road. Conversely, Edward Worlledge Primary and Great Yarmouth College are likely to experience benefits due to the reduced traffic flows forecasted on Southtown Road, Gordon Road (over -20%).

Plate 5 - Schools within Impact Area and Traffic Flow Change



Areas experiencing significant changes in traffic flows give indication as to where there would be anticipated measurable change in noise and air quality levels.

Plate 5 highlights the road links showing potentially significant change in traffic flow (+25% and -20%). It can be seen that amongst a number of smaller links on the local road network, some key strategic links are predicted to experience an increase of over 25% in traffic flow within 1km of the scheme are the following:

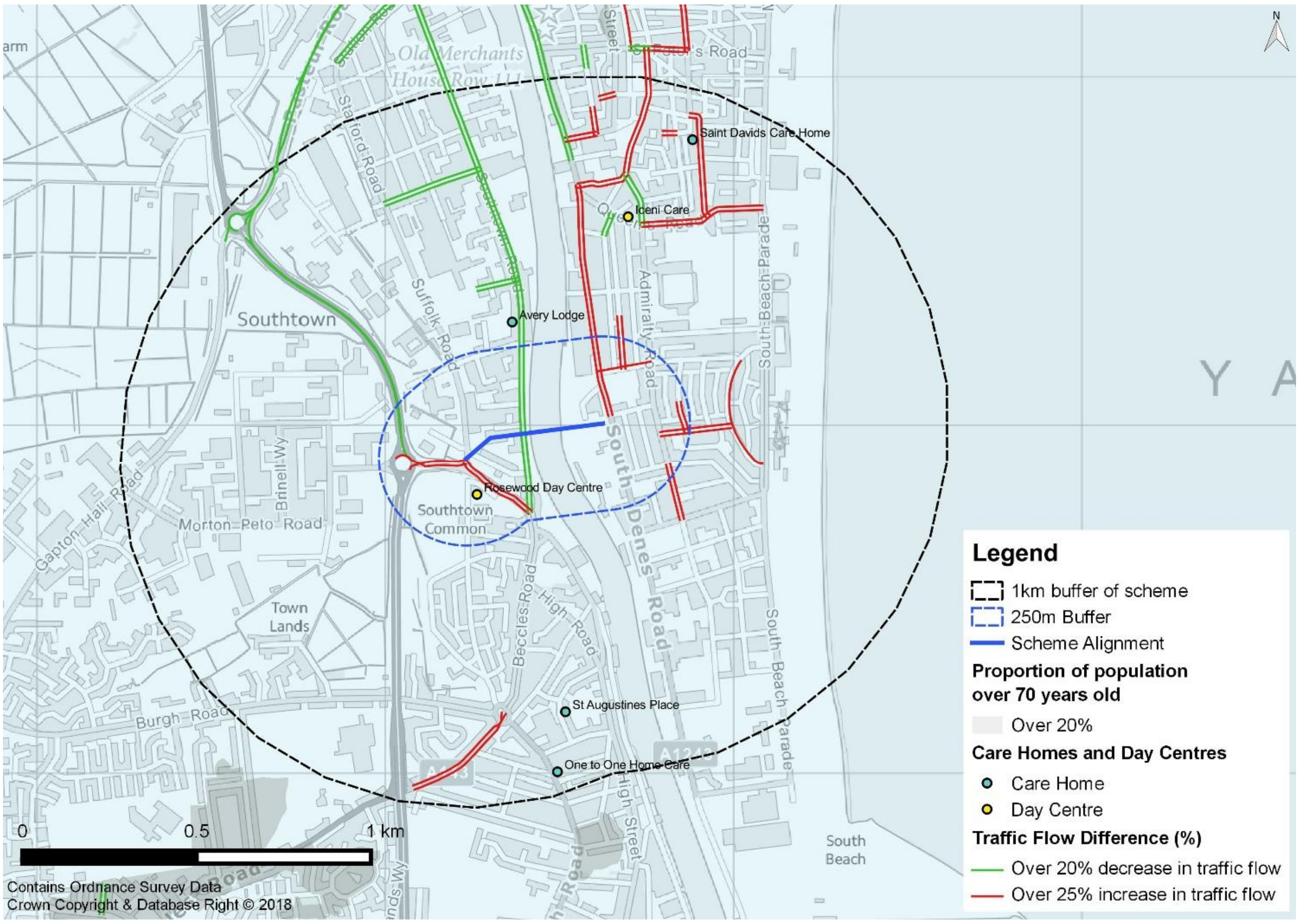
- William Adams Way between Harfrey's roundabout and Southtown Road;
- A143 Beccles Road between Burgh Road and the A47; and
- A1243 Southgates Road between Sutton Road and Mariners' Road.

The following links are expected to experience over a 20% decrease in traffic flow:

- A47 between Harfrey's roundabout and Pasteur Road/Gapton Hall Road roundabout;
- Southtown Road between William Adams Way and Pasteur Road; and
- A1243 South Quay between Charles Street and Pasteur Road.

Plate 6 shows the location of care homes and day centres within the impact area. It can be seen that a number of these receptors are located on links where flows are expected to increase by 25% or more. These include the Rosewood Day Centre and Saint Davids Care Home where a significant increase in traffic volume and associated noise are predicted along William Adams Way and Nelson Road South respectively.

Plate 6 - Care Homes and Day Centres within Impact Area and Traffic Flow Change



3.6 APPRAISAL OF IMPACT (STEP 3)

There are no Defra Noise Important Areas (NIAs) within 250m of the scheme, however, sections of the A47 Harfrey's roundabout and the Victoria Road roundabout have been identified as NIAs which are all associated with high levels of road traffic noise. In addition, sections of the A149 to the north of Great Yarmouth are also classified as NIAs.

The introduction of a third crossing and any potential mitigation measures which could be incorporated within the scheme design will not be of direct benefit to receptors in those areas. However, there is the potential for vehicle flows to be significantly reduced on some routes as a result of the scheme, which could be of benefit to groups that are located close to existing roads where traffic flows are expected to decrease.

Currently, receptors located close to the A47 experience high levels of noise, as illustrated in Plate 7 which shows the road traffic noise levels derived from a strategic noise mapping exercise undertaken by Defra in 2012 to meet the requirements of the Environmental Noise Directive and the Environmental Noise Regulations 2006.

Traffic flows along the A47 have been predicted to decrease significantly by over 20%. It is therefore likely that these receptors will experience some benefits as a result of the scheme. On the other hand, receptors close to Beccles Road are likely to experience adverse impacts due to traffic flows increasing (over 25%) on links that already have relatively high noise levels.

Plate 7 - Noise Level (2012)

Noise modelling is currently being undertaken and results are not expected until January 2019. Without model results, it is assumed that schools and other sensitive receptors within close proximity to affected roads (≥1 dB in the short-term; and ≥3 dB in the long-term) may experience an adverse impact.

In the absence of noise modelling, traffic flow changes demonstrate that receptors located north of the impact area on the western side of the River Yare are likely to benefit from reduced noise as a result of reduced traffic flows. Receptors situated south of the impact area and on the peninsula are more likely to experience adverse impacts from increased traffic flows on the strategic highway network.

Overall, taking into account that there are a significant amount of children under 16 and people living in the most deprived income quintile within areas that will likely experience increases in noise, the scheme has been appraised as having a **Slight Adverse** impact on noise DI's. This will be updated once the modelling results are available.

4 AIR QUALITY

Similarly, to noise, interventions that are likely to result in changes to traffic flows on both the local and strategic road network will impact on air quality, particularly slow moving traffic.

IMD 2015 income domain population has been used to analyse areas likely to be affected. Vulnerable groups have been identified using 2011 census data, in this case locations of where children under 16 years of age make up a significant proportion of the population were analysed along with the locations of schools. The assessment focuses on nitrogen dioxide (NO_2) impacts and also examines the change in particulate matter (PM_{10}) associated with traffic flow changes as a result of the scheme.

4.1 SCREENING (STEP 1)

There are a number of receptors located within the scheme area where significant air quality impacts are likely to occur. Further to this, there is a significant proportion of those aged under 16 living close to the scheme that are particularly sensitive to changes in air and noise quality.

4.2 ASSESSMENT – AREAS OF IMPACT (STEP 2A)

As specified in WebTAG unit A3.4, the assessment area has been defined from the air quality assessment and focuses on a 200m boundary of the scheme. Changes in traffic flow from the traffic model have been used as a proxy for establishing changes to air quality based on the following scoping criteria set out in the DMRB[4].

- Road alignment will change by 5m or more, or
- Daily traffic flows will change by 1,000 annual average daily traffic (AADT) or more, or
- HDV (Heavy Duty Vehicle) flows will change by 200 AADT or more, or
- Daily average speed will change by 10 km/hr or more, or
- Peak hour speed will change by 20 km/hr or more.

A number of key links that meet the above criteria have been identified and are shown in Table 6.

[4] Design Manual for Roads and Bridges (DMRB) Volume 11 Environmental Assessment, Section 3, Part 1

Table 6 - Links that meet criteria for full Air Quality appraisal

Road	Section	Impact
A1243 Southgates Road	Swanston's Road to Queen's Road	Negative
A1243 South Quay	Queen's Road to Bridge Road	Positive
Barrack Road	Southgates Road to Admiralty Road	Negative
Mariners' Road	South Quay to Blackfriars' Road	Negative
Blackfriars Road	Mariners' Road to Alma Road	Negative
Sutton Road	South Denes Rd to Admiralty Road	Negative
Queen's Road	Admiralty Road to Nelson Road South	Negative
Nelson Road South	Queen's Road to Albert Square	Negative
Southtown Road	William Adams Way to Pasteur Road	Positive
Beccles Road	Harfrey's roundabout to A143 Beccles Road/ A47 junction	Negative
Pasteur Road	Bridge Road to A47	Positive
Gapton Hall Road	A47 to Burgh Road	Positive
B1370 Church Road	Garnham Road to Trafalgar Road East	Negative
A47	Pasteur Road to A143 Beccles Road	Positive

4.3 ASSESSMENT - IDENTIFICATION OF SOCIAL GROUPS IN IMPACT AREA (STEP 2B)

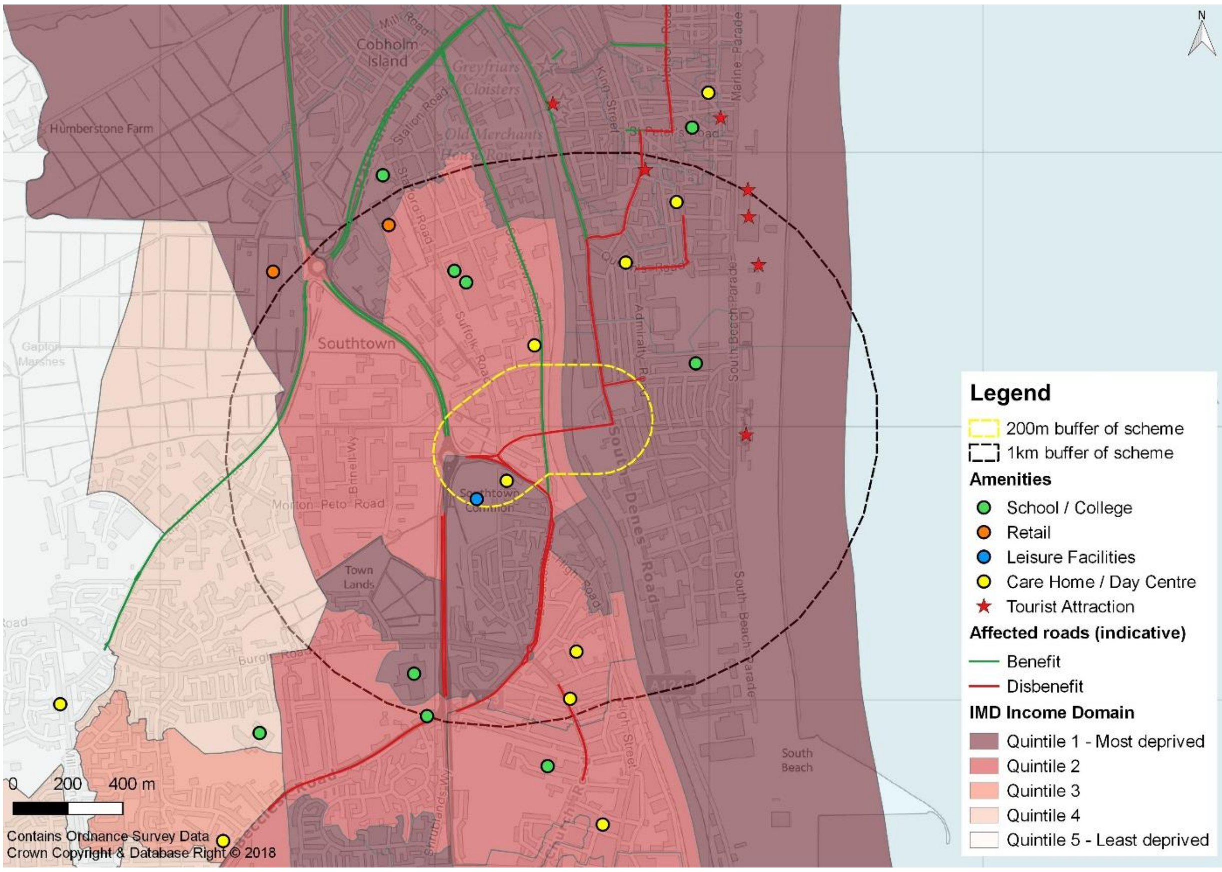
WebTAG guidance states that the most vulnerable group affected by poor air quality are children (under 16) as a key at-risk group. Plate 5 in the previous section shows that there is a high proportion of children under 16 within the impact area.

The assessment of air quality impacts against the IMD income domain was also undertaken in line with WebTAG Unit A4.2. Plate 8 shows that the proposed scheme alignment intersects areas within the 20% most income deprived and second most deprived quintiles (20-40%) nationwide.

4.4 ASSESSMENT – AMENITIES IN THE IMPACT AREA (STEP 2C)

With children being a key at-risk social group, it is therefore necessary as part of the SDI assessment to examine the impact of noise and air quality on schools in the area. There are no schools located within 200m of the scheme, however, within 1km of the scheme, there are three primary schools, one junior school and one college as shown in Plate 8. It is observed that Great Yarmouth Primary and both Wroughton Junior School and Wroughton Infant School are likely to experience an adverse noise impact due to significant increased traffic flows (over 20%) on Barkis Road and Beccles Road respectively. Conversely, Edward Worlledge Primary and Great Yarmouth College are likely to experience beneficial impacts due to the reduced traffic flows on Southtown Road, Gordon Road (over 20%) and Suffolk Road (over 10%).

Plate 8 - Amenities within the impact area and IMD income domain



Air quality modelling is currently being undertaken and results are not expected until January 2019. Therefore, the full distributional analysis which assesses air quality impacts for individual receptors based on the five IMD income quintiles cannot be undertaken at this stage.

In the absence of air quality modelling and to facilitate a worst case high level assessment, it is assumed that receptors (i.e schools) within 200m of roads that are predicted to experience a negative impact based on changes in traffic flow, speed and composition may be impacted negatively in terms of air quality.

The appraisal for air quality has considered the likely population affected by potential changes to NO_2 and PM_{10} based on the DMRB air quality scoping criteria as discussed in section 4.2 of this report. A number of links within the impact area meet these criteria and are in close proximity to sensitive receptors including schools and concentrations of vulnerable groups, including children aged under 16. As a worst case assessment for the most vulnerable groups closest to roads meeting the DMRB criteria, it is recognised that there are likely to be **Moderate Adverse** impacts, however there are also likely to be less adverse and in some instances beneficial impacts for other social groups.

5 ACCIDENTS

Changes in accident rates are often attributed to the integration of transport schemes which result in changes in traffic flows. Most accidents related to transport occur on the road network where there is a strong link between both vulnerable groups and deprivation. Further to this, it is noted that a child from a more deprived area is more likely to be involved in a fatal road accident than a child from a higher social class.

Any intervention that results in increases to traffic levels and speeds or reduces physical separation between people and traffic can give rise to increases in accidents. The approach for the DI appraisal of accidents uses data from the accident assessment as well as STATS 19 data from the DfT's Road Casualties online database for July 2013 to May 2018.

The approach identifies the screening process (Step 1) before identifying the accident locations (Step 2a). Step 2b assesses any impacts on vulnerable groups while Step 2c identifies any amenities within the impact area that are likely to be used by these vulnerable groups.

A full appraisal is carried out in Step 3 to determine the impacts.

5.1 SCREENING (STEP 1)

The scheme is expected to impact on vehicle flow, speed and HDV use in addition to a shift in the number of pedestrians and cyclists (+/- 10%) using the local road network. The scheme also includes changes to road alignments around the landings of the bridge on either side of the river and therefore a full distributional accident assessment is appropriate.

5.2 ASSESSMENT – AREAS OF IMPACT (STEP 2A)

The impact area has been defined from the COBA-LT analysis and includes key modelled network links within 1km of the scheme that will be directly affected.

Accident rates from the COBA-LT output file for the 2023 and 2038 assessment years were analysed to identify all links within the impact area with a change in accident rate of +/- 10% (Plate 9). All links that changed by 10% or more were displayed within GIS along with the observed accident locations categorised by severity (2013-2018).

5.3 ASSESSMENT - IDENTIFICATION OF VULNERABLE GROUPS IN IMPACT AREA (STEP 2B)

Within the impact area, there are a number of vulnerable groups including children and older people. In addition, vulnerable users including pedestrians, cyclists and motorcyclists are assessed along with young male drivers and those living within the IMD most 5% deprived areas.

Notably, there are significantly high concentrations of children under 16 living within proximity of Beccles Road (as shown in Plate 5) where accidents are predicted to significantly increase due to increased flow as traffic reassigns across the network. Beccles Road is also within an area where there are high levels of deprivation as can be seen in Plate 8 in the previous section.

5.4 ASSESSMENT – AMENITIES IN THE IMPACT AREA (STEP 2C)

The concentration of vulnerable groups is not only dependant on the resident population but also on local amenities within the impact area that may attract visitors from vulnerable groups.

A number of amenities have been identified within 1km of the scheme including 2 primary schools, 1 junior school, 1 infant school, 1 college, 2 places of worship in addition to numerous hotels and tourist attractions.

5.5 APPRAISAL OF IMPACT (STEP 3)

The distributional impact appraisal of accidents uses STATS 19 data from the DfT's Road Casualties online database for the five-year period between July 2013 and May 2018. As discussed in Step 2a, accident locations have been plotted on a map by severity alongside the links that experience a -/+10% change in accident rates based on the COBA-LT analysis (Plate 9).

Although Beccles Road, Church Road and South Denes Road (north of the scheme) are forecast to experience an increase in the number of accidents between the two assessment years, the accident rate (accidents per million vehicle kilometres) is expected to decrease on all links assessed over the 60 year appraisal period.

Plate 9 - Links with +/-10% Change in Accident Rates and STATS19 Data 2013-2018 by Severity

Analysis has been undertaken to identify vulnerable groups that might be affected within the impact area.

Table 7 shows the proportion of casualties for each vulnerable group within the impact area and across the nation as a whole between 2013 and 2018, based on STATS 19 data.

Table 7 - Proportion of Casualties for each Vulnerable Group

Vulnerable Group	% Casualties Impact Area (2013-2018)	% Accidents (2016 National Average)	Assessment
Children (under 16 years old)	15%	9%	Slight Adverse
Young People (16-29)	47%	33%	Slight Adverse
Older People (66+)	3%	7%	Neutral
Other Ages	35%	51%	Neutral
Total	100%	100%	Slight Adverse

Within the impact area, children account for a greater proportion of casualties than the average across Great Britain. It is therefore anticipated that any changes in accident rates within the area could be considered to have a greater impact on children than others road users. Similarly, young people (16-29) account for a significantly greater proportion of casualties within the impact area than the national average.

The proposed scheme will result in traffic being removed from local roads, particularly in areas with vulnerable groups. This is reflected in the COBA-LT accident analysis reported in the Business Case that shows a reduction in slight (62) serious (1.3) and fatal (0.6) injury accidents.

New pedestrian and cyclist crossing facilities incorporated as part of the scheme design within the impact area will further help towards achieving lower accident rates.

A detailed analysis of forecast traffic flow data demonstrates that the proposed scheme will remove traffic from some local roads in areas with vulnerable groups. This is reflected in the COBA-LT accident analysis reported in the Business Case that shows a reduction in slight (62) serious (1.3) and fatal (0.6) injury accidents. However, when cross referenced with Plate 11, Plate 12 and Plate 13 in the following section which show the distribution of vulnerable groups, it can be seen that there are still high proportions of vulnerable groups in areas where both accident rates and traffic flows are forecast to significantly increase, particularly around Beccles Road.

Similarly, Table 8 shows the proportion of casualties for each road user type within the impact area and across the nation as a whole. It can be seen that during the period between July 2013 and May 2018 the number of recorded pedestrian casualties within the impact area was higher than the national average. Conversely, however, there were less recorded cyclist and driver casualties during this same period.

Table 8 - Proportion of Casualties for each Road User Type

User Type	Total (Impact Area)	% Casualties Impact Area (2011-2015)	% Accidents (2016 National Average)
Pedestrian	22	14.7%	13%
Cyclist	13	8.7%	10.2%
Driver (car, motorcycle, goods vehicle, bus)	80	53.3%	54.2%
Passenger (car, motorcycle, goods vehicle, bus)	35	23.3%	22.1%
Total	**150**	**100%**	**100%**

Table 9 assigns observed accidents within the impact area to links and junctions where the number of accidents are forecast to increase or decrease by at least 10% (between the two assessment years). Key vulnerable users and groups are focused on in line with WebTAG unit A4.2.

Table 9 - Observed accidents and links/junctions were accident occurrence is predicted to increase

	User Type	Links/junctions with 10% increase in accidents	Neutral links/junctions (between -10% and 10% change)	Links/junctions with 10% decrease in accidents	Assessment
Vulnerable Users	Pedestrian	4	11	5	Slight Beneficial
	Cyclist	4	6	3	Slight Adverse
	Motorcylists	1	4	1	Neutral
	Male Drivers Aged 16-25	7	9	2	Moderate Adverse
Vulnerable Groups	Under 16	5	16	8	Moderate Beneficial
	Aged 70+	2	1	1	Moderate Adverse
Severity	Fatal	0	1	0	Neutral
	Serious	6	9	3	Moderate Adverse

	User Type	Links/junctions with 10% increase in accidents	Neutral links/junctions (between -10% and 10% change)	Links/junctions with 10% decrease in accidents	Assessment
	Slight	18	55	24	Slight Beneficial

Analysis of the accidents data demonstrates that there are slightly more links and junctions within the impact area that are forecast to experience an increase in accidents than are forecast to decrease. These links also have higher a number of casualties from vulnerable users and groups. For these reasons, the scheme has been assessed as **Slight Adverse.**

6 SEVERANCE

The severance impacts of a transport scheme are often an unintended consequence and are a measure of the scheme's impact on residents' access to local community facilities and services. An assessment is required of for non-motorised users, particularly pedestrians, as stated in TAG Unit A4.2.

6.1 SCREENING

Severance impacts were assessed by considering the detailed drawings of the scheme and forecast changes in vehicle flow. As the scheme provides new road across over the River Yare, one of Great Yarmouth's largest physical barriers, it is expected that the 'severance' of communities would be reduced. The scheme's design incorporates a new pedestrian footway along with a dedicated off-carriageway cycle lane.

There are some roads within the impact area that would experience potential changes in severance as a result of increases or decreases in traffic volumes. Therefore, it is appropriate to examine these areas further to understand the severance impacts on vulnerable groups.

6.2 ASSESSMENT – AREAS OF IMPACT (STEP 2A)

The impact area has been defined through the severance analysis, described in the social impacts appraisal section in TAG Unit A4.1. A 1km buffer was applied around the scheme alignment within the impact area. Within this 1km buffer, changes in severance as a result of changes to road alignments, road closures, infrastructure and vehicle flow were assessed. Although there are links outside of the 1km buffer that experience significant changes in the above, the assessment only focuses on the local area where the most concentrated impacts are anticipated.

6.3 ASSESSMENT - IDENTIFICATION OF SOCIAL GROUPS IN IMPACT AREA (STEP 2B)

Vulnerable groups are particularly sensitive to the effects of severance. Within these vulnerable groups are children, older people, people with disabilities and households with no access to a car. Table 10 shows the proportion of these vulnerable groups within the scheme area along with regional and national comparisons.

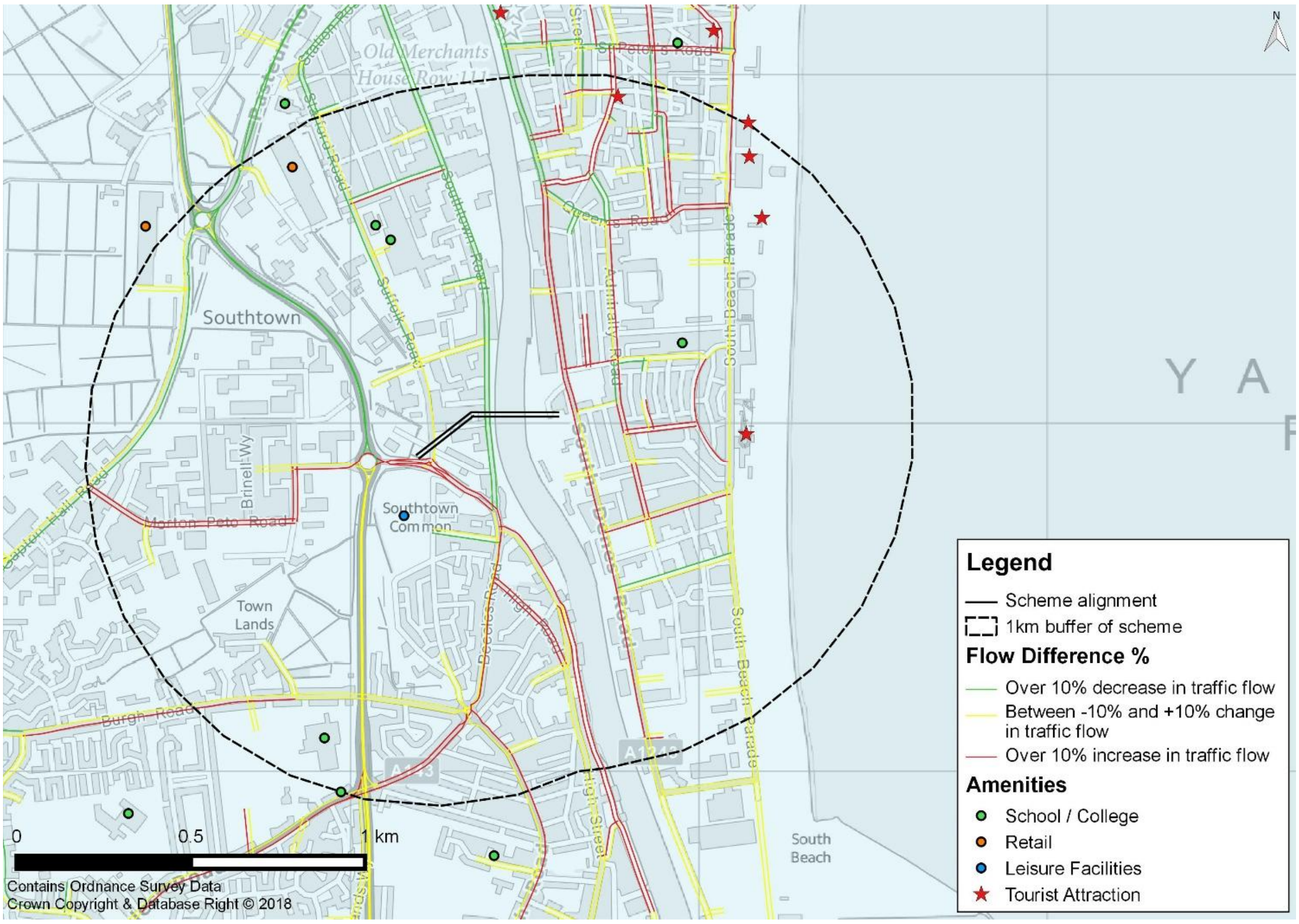
Table 10 – Vulnerable Groups

Vulnerable Group	% Impact Area	% Norfolk	% England
Older People (Aged 70+)	9.2%	15.4%	7.7%
Children (Aged Under 16)	22.7%	16.9%	18.9%
No Car Households	16.8%	18.8%	25.8%
Residents with long-term health problems or disabilities	20.2%	20.1%	7.8%

6.4 ASSESSMENT – AMENITIES IN THE IMPACT AREA (STEP 2C)

The severance impact area contains a number of local amenities (Plate 10) that are likely to generate trips from the wider area in addition to local residents. These include 2 Primary schools, 1 Junior school, 1 Infant school, 1 College and various hotels and shops. Also within the impact area is the Gapton Hall Retail Park, Southtown Common Recreation Ground, the Sea Life Centre, Pleasure Beach and a number of different attractions along the sea front which are likely to attract high numbers of children.

Plate 10 - Amenities within Impact Area and Traffic Flow Changes

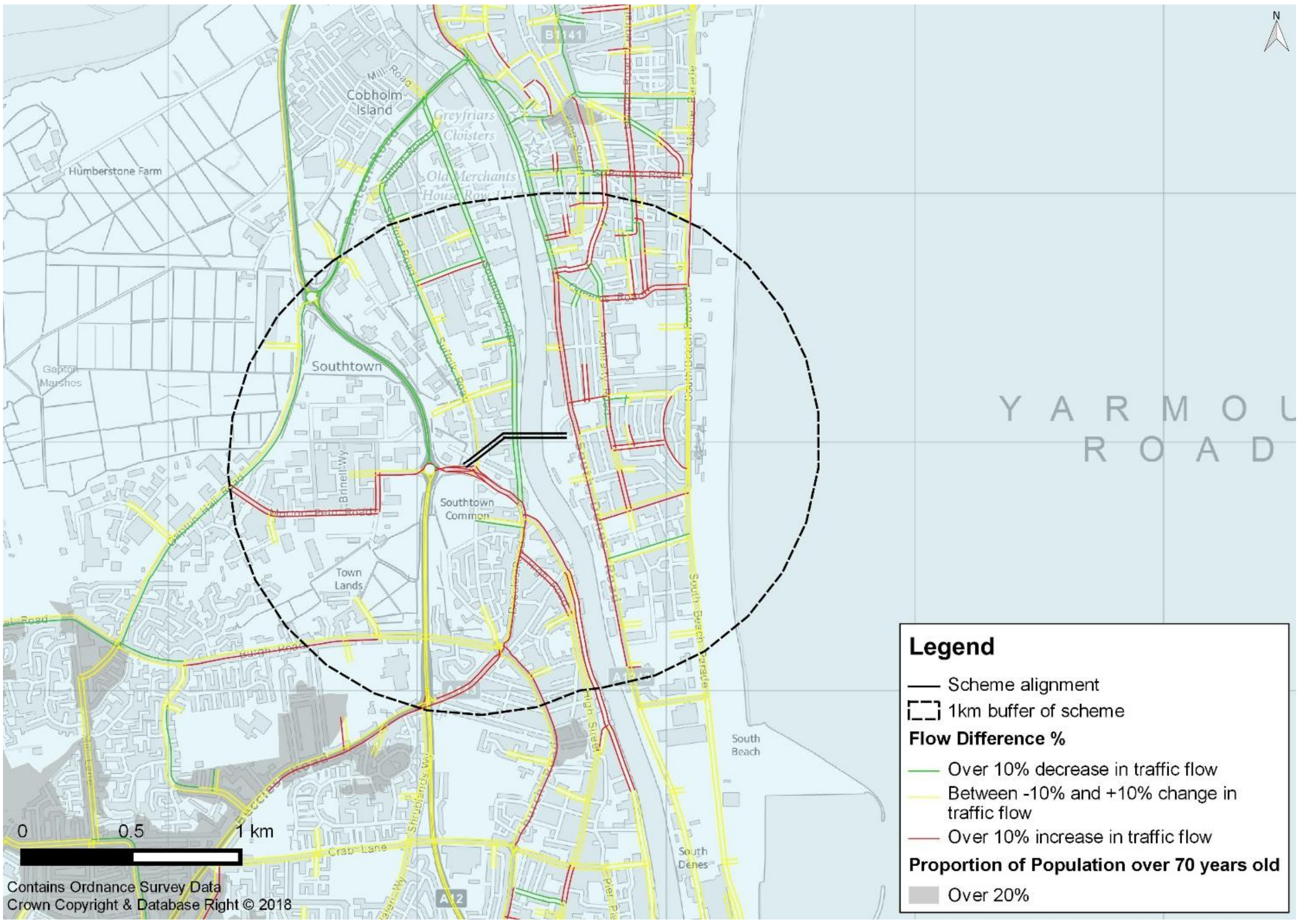


6.5 APPRAISAL OF IMPACT (STEP 3)

The assessment for severance includes locations within 1km of the scheme where the road network experiences significant changes (>10%) in traffic flows where there are concentrations of vulnerable groups. Changes in vehicle flow have the potential to impact on people's ability to access schools and other amenities in addition to affecting the permeability of roads.

During the severance assessment, the populations of vulnerable groups at output area level have been examined to identify any areas where there are high concentrations in close proximity to links where vehicle flows are expected to significantly increase of decrease as shown in Plates 11-14.

Plate 11 - Distribution of Traffic Flow Changes against Concentrations of Older People (Aged over 70)



It can be seen that in some areas, the redistribution of traffic across the highway network leads to an increase in directional traffic flows in areas with high concentrations of vulnerable groups. Those links close to the scheme alignment include Beccles Road, Church Road, South Denes Road and Burgh Road amongst other smaller links.

Plate 12 - Distribution of Traffic Flow Changes against Concentrations of People with a Disability

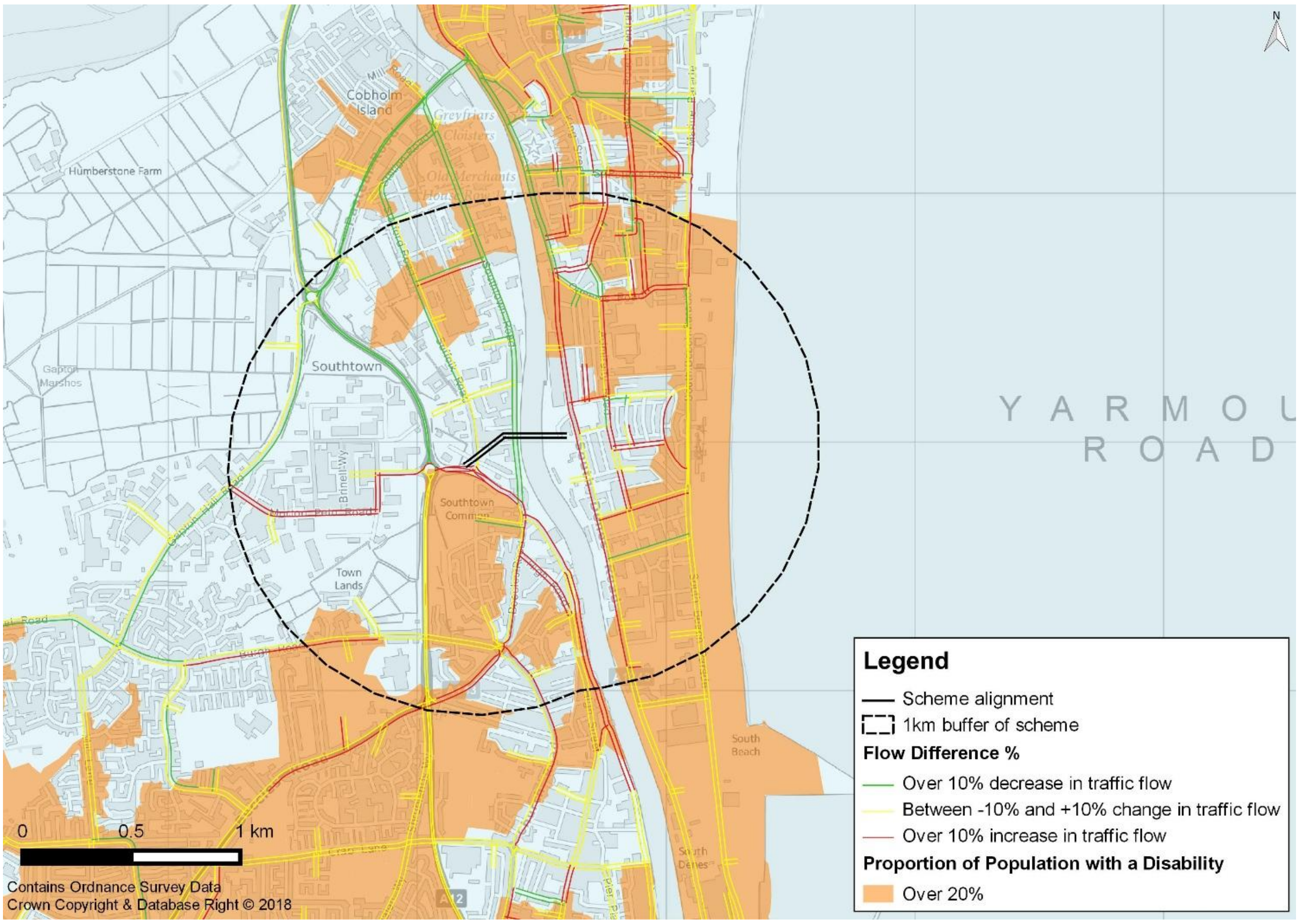


Plate 13 - Distribution of Traffic Flow Changes against Concentrations of Children (Aged under 16)

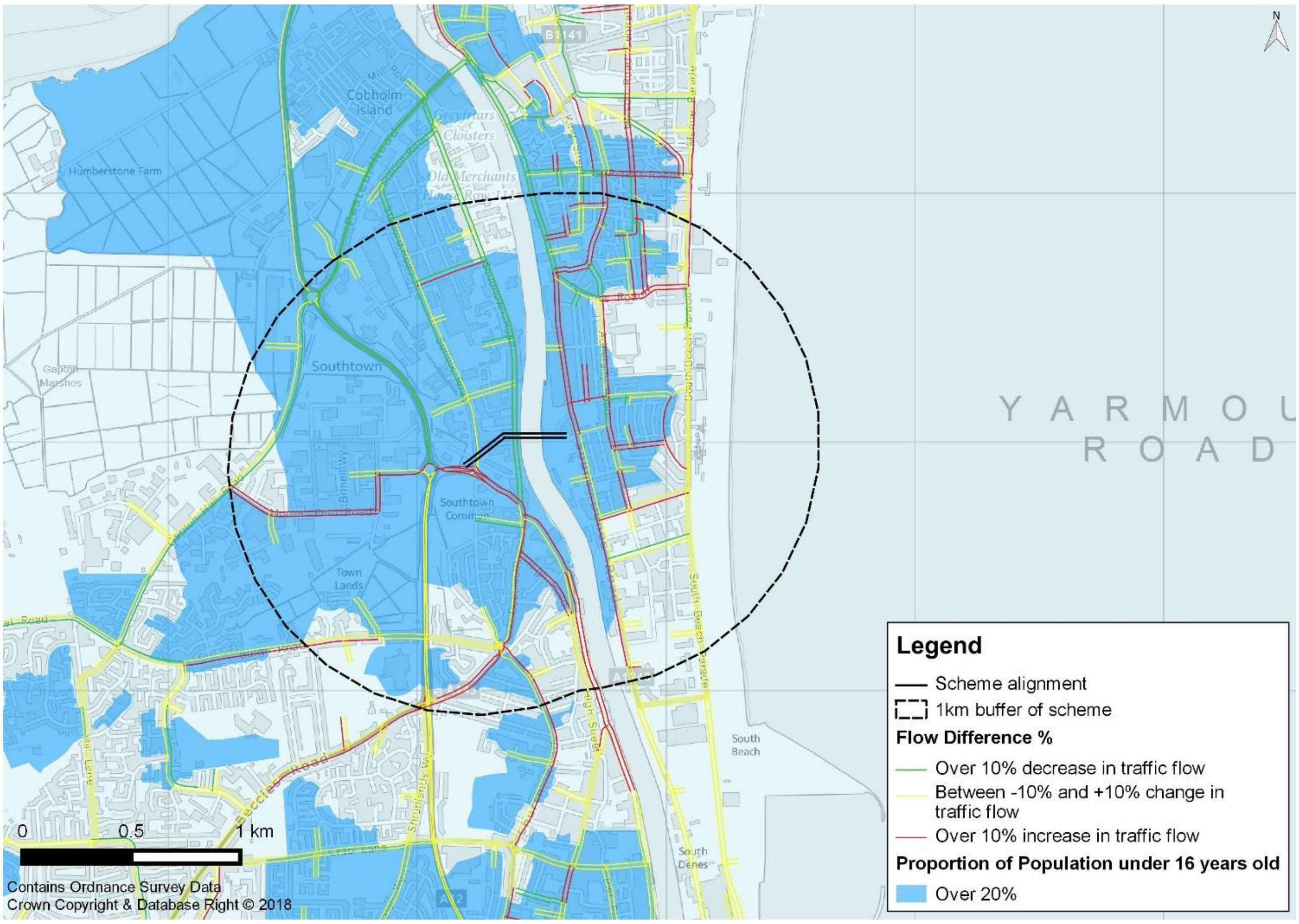
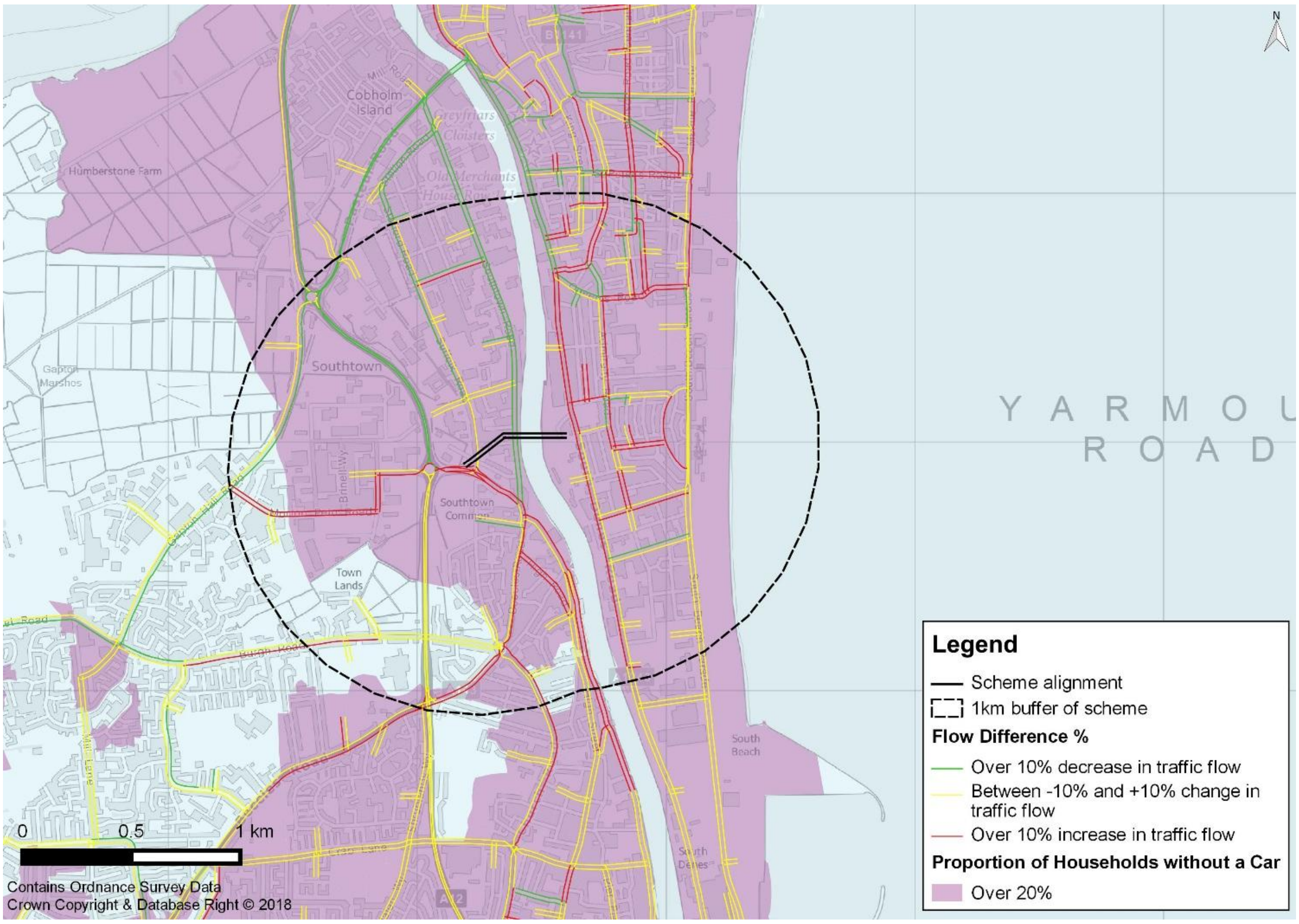


Plate 14 - Distribution of Traffic Flow Changes against Concentrations No Car Households



Plates 11 to 14 show that there are significant increased traffic flows on the local road network in areas where there are concentrations of vulnerable groups. As a result, there is a potential impact on these groups' ability to access key amenities and services.

As can be seen in Plate 14, there are many areas where households without a car make up over 20% of the population in proximity to the links likely to be affected by increased traffic flows, and may therefore experience increased severance.

Conversely, there are a number of links that show a reduction in traffic flow, including the A47, Southtown Road, Pasteur Road and Gapton Hall Road which may provide benefits to the community (including vulnerable users) through reduced severance caused by traffic.

Plate 15 shows some of the key pedestrian crossing points on links within 1km of the scheme alignment that are anticipated to experience a 10% change in traffic flow as a result of the scheme. A 400m buffer was applied to each respective crossing point to capture the proportion of vulnerable groups living within a reasonable walking distance in order to assess the potential impact of severance directly caused by increased traffic flows. The severance worksheet in Appendix C details the number of people in vulnerable groups likely to be affected by severance at each crossing location, as a result of the scheme at these particular sites. This was subsequently used to appraise severance DI's.

Plate 15 - Key Pedestrian Crossing Locations

It should be considered that regardless of vehicle flow changes associated with the redistribution of traffic across the highway network, the provision of a new crossing between two previously poorly connected parts of Great Yarmouth will have a significant positive impact on community severance by offering an alternative central crossing, providing access to the town centre and other key amenities and facilities.

As part of the scheme, there are additional pedestrian facilities being provided on the crossing itself and on William Adams Way (site 1) which aim to reduce the impact on pedestrian movement. Table 11 provides a summary of the severance assessment for vulnerable groups within the impact area.

Table 11 - Benefit Assessment

Impact	Children	Older People	People with a Disability	Older People
Slight Adverse				
Moderate Adverse				
Large Adverse				

Impact	Children	Older People	People with a Disability	Older People
Neutral				
Slight Beneficial	✓	✓	✓	✓
Moderate Beneficial				
Large Beneficial				

Although a number of links are expected to see a significant change in traffic flow which will result in both benefits and disbenefits to certain vulnerable groups, the overall DI assessment on severance is considered to be **Slight Beneficial** due to the positive impact outweighing the negative impact.

7 PERSONAL AFFORDABILITY

In line with WebTAG, the personal affordability impacts of the scheme have been considered throughout the appraisal process. Changes in transport costs have the potential to disproportionately affect areas where there are few or no travel alternatives, particularly in areas where income levels preclude car ownership. As a result, impact on travel to work, education and affordable food for example can be expected. These impacts are likely to be exacerbated in areas with low income, low car ownership and a high elderly population.

7.1 SCREENING (STEP 1)

The only element assessed for the affordability impact appraisal was fuel and non-fuel operating costs (TUBA benefit) as shown in Table 12. A full appraisal of fuel and non-fuel costs are need due to the anticipated changes in journey speeds, congestion and rerouting as a result of the scheme.

Table 12 - Screening of personal affordability impact appraisal

Mode	Cost Change	Cost Change Expected	Change Captured in TUBA	Impact
Car	Car fuel and non-fuel cost	Yes	Yes	Changes due to congestion relief and rerouting
	Road user charges	No	No	
	Public parking charges	No	No	
	Other car charge/costs	No	No	
Public Transport	Bus fares	No	No	
	Rail fares	No	No	
	Rapid transit fares	No	No	
	Mode shift between public transport modes due to change in supply	No	No	
	Concessionary fares	No	No	
	Other public transport charges/costs	No	No	
Non-motorised modes	Walking costs	No	No	
	Cycling costs	No	No	

7.2 ASSESSMENT – AREAS OF IMPACT (STEP 2A)

The impact area for the personal affordability distributional appraisal follows the boundary of the strategic traffic model, as identified in the user benefits analysis. This impact area outlines the area in which passengers' cost of travel is being directly affected by the scheme.

7.3 ASSESSMENT – IDENTIFICATION OF SOCIAL GROUPS IN THE IMPACT AREA (STEP 2B)

In line with WebTAG methodology, the primary group of interest is people on low incomes. To ensure consistency, the same method for the user benefit appraisal was adopted whereby five quintiles were identified using the IMD income domain at LSOA level throughout the scheme area.

7.4 APPRAISAL OF IMPACT (STEP 3)

Overall, across the study area, there would be a benefit of £9.4 million in car fuel and non-fuel costs over the 60 year appraisal period (2010 prices). Table 13 provides a distributional assessment of fuel and non-fuel costs across the five IMD income domains, in line with WebTAG Unit 4.2. The assessment for each group is based on whether the intervention generates an overall benefit or disbenefit and the share of the benefit / disbenefit that a group receives in relation to its proportion of the population. The scoring is the same as that in the user benefit analysis and uses the method of comparing the proportion of benefits/ disbenefits realised by a specific group to the proportion of the population made up by that group (+/-5%).

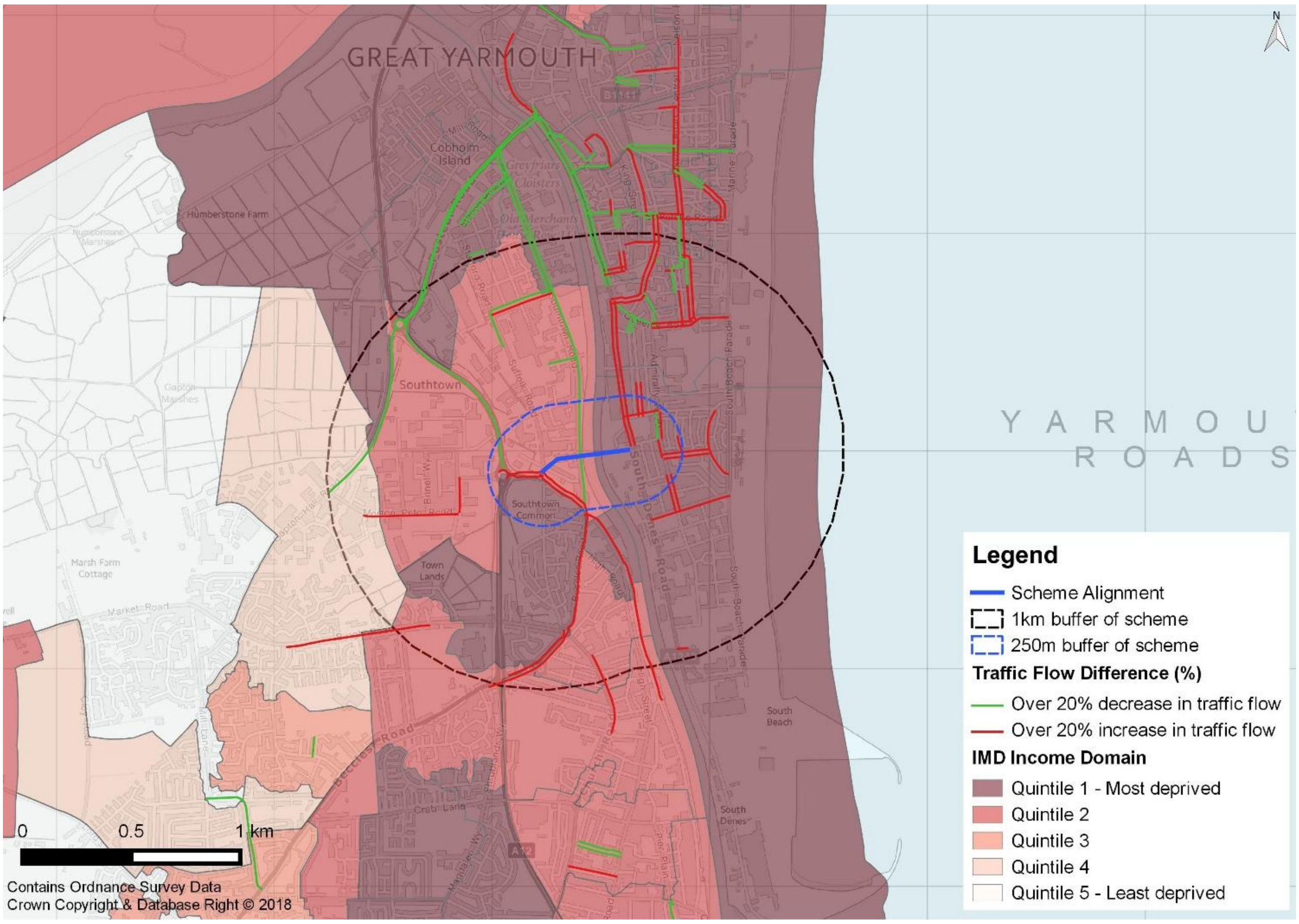
Table 13 - Distribution of Personal Affordability Benefits by Income Deprivation Quintile

	IMD Income Domain					Rest of England and Wales
	0%<20%	20%<40%	40%<60%	60%<80%	80%<100%	
Total population	28,243	29,666	24,882	14,808	3,686	55.98m
Proportion of population in impact area	28%	29%	25%	15%	4%	-
Overall benefits	£4,703,192	£2,149,431	£559,779	£1,067,953	£400,568	£465,558
Distribution of benefits in impact area	53%	24%	6%	12%	5%	-
Assessment	✓✓✓	✓✓	✓	✓✓	✓✓	

It can be seen from the above table that the two lowest income groups experience the largest share of the benefits, 53% and 24% respectively. No disbenefits were observed across all groups and therefore the personal affordability DI impacts are appraised as **Large Beneficial.**

ANNEX A – TRAFFIC FLOW CHANGE AND IMD QUINTILES

Plate A1 - Traffic flow changes (+/-20%) and IMD income domain



ANNEX B – SCREENING PROFORMA

Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
User benefits	The TUBA user benefit analysis software or an equivalent process has been used in the appraisal; and/or the value of user benefits Transport Economic Efficiency (TEE) table is non-zero.	Yes	Total benefit of £115m over the 60 year appraisal period. Benefits to motorised users in relation to journey time benefits as assessed using TUBA where they have been quantified in conjunction with a spatially disaggregate transport model.	Yes. Analysis needs to be undertaken to determine the spread of user benefits amongst income deprivation quintiles.
Noise	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or %HDV content. Also note comment in TAG Unit A3.	Yes	Desktop study and noise measurement surveys undertaken. Modelling currently being undertaken (expected in October 2018). There will be some positive noise improvements where traffic is taken off the road local road network.	Yes. Need to examine the noise assessments to ascertain the distribution of noise

Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
			Adverse impacts are also expected in some areas where traffic reroutes. Sensitive receptors i.e schools may be affected by increases in noise in these locations.	impacts across income groups and children in the area. Assessment of sensitive receptors also required.
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or %HDV content: • Change in 24 hour AADT of 1000 vehicles or more • Change in 24 hour AADT of HDV of 200 HDV vehicles or more • Change in daily average speed of 10kph or more • Change in peak hour speed of 20kph or	Yes	There will be some benefits to air quality through reduced road traffic flow, speed and composition. Conversely, in areas where traffic flows are expected to increase due to rerouting, negative impacts are likely to be experienced. Negative impacts may also be experienced during construction and operational phases.	Yes. Need to examine the outputs from the air quality assessments to ascertain the distribution of impacts cross income groups and children in the impact area. This will involve using Indices of Deprivation 2010 and census 2011 data.

Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
	more • Change in road alignment of 5m or more			
Accidents	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.	Yes	The new crossing will result in a reduction vehicle kms travelled on the highway network within Great Yarmouth and therefore reduce the number of accidents. However, increased traffic flows in the vicinity of the crossing could result in an increase in collisions locally.	Yes. Analysis should be undertaken for defined areas of deprivation and for defined vulnerable groups and users.

Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.	No	New bridges will enhance the security of urban locations by providing additional footfall, CCTV, emergency contact points and improved lighting. While there is a general improvement in security of the area, bridges can also attract crime. The scheme is therefore envisaged to have a neutral impact on security.	No
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, %HGV content.	Yes	In general, a new bridge will reduce severance by offering an alternative river crossing at a central location within the town. However, increased traffic flows may lead to some adverse impacts to vulnerable groups in close proximity to the scheme.	Yes. Further work is required to assess locations of vulnerable users and key crossing locations within proximity of the scheme.

Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
Accessibility	Changes in routings or timings of current public transport services, any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g. demolition & re-location of a school).	No	Changes in routings and timings of current public transport services are anticipated within the impact area, however these are unlikely to be known until closer to the scheme opening date.	No
Affordability	In cases where the following charges would occur; Parking charges (including where changes in the allocation of free or reduced fee spaces may occur); Car fuel and non-fuel operating costs (where, for example, rerouting or changes in journey speeds and congestion occur resulting in changes in costs); Road user charges (including discounts and exemptions for different groups of travellers); Public transport fare changes (where, for	Yes	Car fuel and non-fuel cost benefits are expected as a result of rerouting, changes in journey speeds and congestion relief and have been assessed in TUBA.	Yes. Analysis needs to be undertaken to determine the spread of car fuel and non-fuel cost benefits amongst income deprivation quintiles.

Distributional Impact Appraisal Screening Proforma

Indicator	(a) Appraisal output criteria	(b) Potential impact (yes / no, positive/negative if known)	(c) Qualitative Comments	(d) Proceed to Step 2
	example premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); or Public transport concession availability (where, for example concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority[1]).			

ANNEX C – TAG WORKSHEETS

User Benefits Worksheet

	IMD Income Domains £m					Rest of England and Wales
	Most deprived areas 🡐			🡒 Least deprived areas		
	0%<20%	20%<40%	40%<60%	60%<80%	80%<100 %	
Total user benefits of LSOA's within impact area (£M)	44,966	27,022	7,553	13,412	4,755	16,592
Share of user benefits within impact area	46%	28%	8%	14%	5%	-
Share of user benefits within Modelled Area (Inc. rest of England and Wales)	39%	24%	7%	12%	4%	15%
Population	28,243	29,666	24,882	14,808	3,686	-
Share of population in the impact area	28%	29%	25%	15%	4%	-
Assessment	✓✓✓	✓✓	✓	✓✓	✓✓	

Key to individual assessment of each income quintile	
Beneficial and 5% greater (or more) than the proportion of the group in the total population	*Large Beneficial*
Beneficial and in line (+/-5%) with the proportion of the group in the total population	*Moderate Beneficial*
Beneficial and 5% smaller (or less) than the proportion of the group in the total population	*Slight Beneficial*
There are no user benefits or dis-benefits experienced by the group	*Neutral*

User Benefits Worksheet

	IMD Income Domains £m					Rest of England and Wales
	Most deprived areas ← → Least deprived areas					
	0%<20%	20%<40%	40%<60%	60%<80%	80%<100 %	
A dis-benefit which is 5% smaller (or less) than the proportion of the group in the total population					*Slight Adverse*	
A dis-benefit which is in line (+/-5%) with the proportion of the group in the total population					*Moderate Adverse*	
A dis-benefit which is 5% greater (or more) than the proportion of the group in the total population					*Large Adverse*	

Personal Affordability Worksheet

	IMD Income Domains £m					Rest of England and Wales
	Most deprived areas ← → Least deprived areas					
	0%<20%	20%<40%	40%<60%	60%<80%	80%<100 %	
Total population	28,243	29,666	24,882	14,808	3,686	55.98m
Proportion of population in impact area	28%	29%	25%	15%	4%	-
Overall benefits	£4,703,192	£2,149,431	£559,779	£1,067,953	£400,568	£465,558
Distribution of benefits in impact area	53%	24%	6%	12%	5%	-
Assessment	✓✓✓	✓✓	✓	✓✓	✓✓	

Key to individual assessment of each income quintile	
Beneficial and 5% greater (or more) than the proportion of the group in the total population	*Large Beneficial*
Beneficial and in line (+/-5%) with the proportion of the group in the total population	*Moderate Beneficial*
Beneficial and 5% smaller (or less) than the proportion of the group in the total population	*Slight Beneficial*
There are no user benefits or dis-benefits experienced by the group	*Neutral*
A dis-benefit which is 5% smaller (or less) than the proportion of the group in the total population	*Slight Adverse*
A dis-benefit which is in line (+/-5%) with the proportion of the group in the total population	*Moderate Adverse*
A dis-benefit which is 5% greater (or more) than the proportion of the group in the total population	*Large Adverse*

Accidents Worksheet

	Existing Casualty Rate for Vulnerable Users		
	Defined Vulnerable Casualty Group:		Motorcyclists, Cyclists and Pedestrians
	Low (more than 30% of average rate for class of road)	**Medium** (<30% lower to <30% higher than average rate for class of road)	**High** (more than 30% higher than average rate for class of road)
1. Change in physical layout that could impact on defined vulnerable group			
Significant improvement	Moderate Beneficial	Moderate Beneficial	Large Beneficial
Slight improvement	Slight Beneficial	Slight Beneficial	Moderate Beneficial
Neutral	Neutral	Neutral	Neutral
Slight worsening	Slight Adverse	Slight Adverse	Moderate Adverse
Significant worsening	Moderate Adverse	Moderate Adverse	Large Adverse
2. Change in traffic flow OR speed			
Significant reduction (>15% decrease)	Moderate Beneficial	Moderate Beneficial	Large Beneficial

Accidents Worksheet

	Existing Casualty Rate for Vulnerable Users		
	Defined Vulnerable Casualty Group:		Motorcyclists, Cyclists and Pedestrians
	Low (more than 30% of average rate for class of road)	**Medium** (<30% lower to <30% higher than average rate for class of road)	**High** (more than 30% higher than average rate for class of road)
Slight reduction (>5%, <15% decrease)	Slight Beneficial	Slight Beneficial	Moderate Beneficial
Neutral (<5% increase or decrease)	Neutral	Neutral	Neutral
Slight increase (>5%, <10% increase)	Slight Adverse	Slight Adverse	Moderate Adverse
Significant increase (>10% increase)	Moderate Adverse	Moderate Adverse	Large Adverse

3. Change in numbers of pedestrians, cyclists and motorcyclists

Likely to increase due to new pedestrian and cyclist provision on Williams Adams Way, Suffolk Road and the crossing itself.

Accidents Worksheet

	Existing Casualty Rate for Vulnerable Users		
	Defined Vulnerable Casualty Group:		Motorcyclists, Cyclists and Pedestrians
	Low (more than 30% of average rate for class of road)	**Medium** (<30% lower to <30% higher than average rate for class of road)	**High** (more than 30% higher than average rate for class of road)

Overall assessment for link, based on criteria 1, 2 and 3 above

Slight adverse. There are slightly more links and junctions within the impact area that are forecast to experience an increase in accidents than are forecast to decrease. These links also have higher a number of casualties from vulnerable users and groups

Qualitative Commentary

Some links and junctions which have experienced accidents in the past five years are forecast for further increases in accident occurrence from the COBA-LT analysis, which is likely to exacerbate accident impacts. However, some key links and junctions, particularly to the north of the impact area are expected to see a significant decrease in accidents as a result of the scheme

Accidents Worksheet

	Existing Casualty Rate for Vulnerable Users		
	Defined Vulnerable Casualty Group:		Motorcyclists, Cyclists and Pedestrians
	Low (more than 30% of average rate for class of road)	**Medium** (<30% lower to <30% higher than average rate for class of road)	**High** (more than 30% higher than average rate for class of road)

Severance Worksheet

	All social groups			No-car households			Young people			Older people			People with disabilities		
	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of households affected	Overall effect [A]*[B]	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]
Site 1: William Adams Way	3	818	2454	3	134	402	2	129	258	3	74	222	3	174	522
Site 2: South Denes Road	0	1639	0	0	750	0	0	240	0	-1	158	-158	-1	364	-364
Site 3: Southtown Road	2	1370	2740	2	186	372	2	227	454	2	92	184	2	245	490
Site 4: Burgh Road	-1	1155	-1155	-1	273	-273	-1	145	-145	-1	177	-177	-1	243	-243
Site 5: Suffolk Road	2	806	1612	2	90	180	1	123	123	2	64	128	2	145	290
Site 6: Morton Peto Road	-1	513	-513	-1	151	-151	-1	72	-72	-1	44	-44	-1	75	-75

Severance Worksheet

	All social groups			No-car households			Young people			Older people			People with disabilities		
	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of households affected	Overall effect [A]*[B]	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]	Change in severance [A]	No of people affected [B]	Overall effect [A]*[B]
Total			**5138**			**530**			**618**			**155**			**620**

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements (example below)
	0-20%	20-40%	40-60%	60-80%	80-100%		
User benefits	✓✓✓	✓✓	✓	✓✓	✓✓	No	There are significant overall net user benefits from the scheme with residents in the most deprived quintile experiencing the largest share of the benefits. No disbenefits were observed.
Noise	TBC	TBC	TBC	TBC	TBC	TBC	Modelling is still being undertaken. Links and junctions where changes in noise levels as a result of altered traffic flow, speed and composition have been assessed but a full distributional analysis cannot yet be undertaken. There are a significant number of children under 16 and people living in the most deprived income quintile within areas that will likely experience increases in noise. There are a number of receptors including schools within close proximity of links that are expected to significantly increase in noise (>1dB)

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements (example below)
	0-20%	20-40%	40-60%	60-80%	80-100%		
Air quality	TBC	TBC	TBC	TBC	TBC	TBC	Modelling is still being undertaken. Links and junctions where changes in air quality as a result of altered traffic flow, speed and composition have been assessed but a full distributional analysis cannot yet be undertaken. There are a significant number of children under 16 and people living in the most deprived income quintile within areas that will likely experience increases in noise. There are a number of receptors including schools within close proximity (<200m) of affected links where air quality is expected to deteriorate as a result of the scheme.
Affordability	✓✓✓	✓✓	✓	✓✓	✓✓	No	There are significant car fuel and non-fuel benefits from the scheme with residents in the most deprived quintile experiencing the largest share of the benefits. No disbenefits were observed.

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements (example below)
	0-20%	20-40%	40-60%	60-80%	80-100%		
Accessibility	N/A	N/A	N/A	N/A	N/A	N/A	N/A

AST entry

Impact	Social groups						User groups				Qualitative statement (including any impact on residential population AND identified amenities)
	Children & young people	Older people	Carers	Women	Disabled	BME	Pedestrians	Cyclists	Motor-cyclists	Young male drivers	

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements (example below)
	0-20%	20-40%	40-60%	60-80%	80-100%		
Noise	×	Neutral					There are a significant number of children under 16 and people living in the most deprived income quintile within areas that will likely experience increases in noise. There are a number of schools within proximity of links that are expected to experience an increase in noise

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					**Are the impacts distributed evenly?**	**Key impacts - Qualitative statements (example below)**				
	0-20%	20-40%	40-60%	60-80%	80-100%						
Air Quality	×										A number of links within the impact area that expected to deteriorate in air quality are in close proximity to sensitive receptors including schools and concentrations of children aged under 16

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements (example below)				
	0-20%	20-40%	40-60%	60-80%	80-100%						
Accidents	✓✓	××					✓	×	Neutral	×	There are a higher number of observed accidents involving young children and pedestrians on links where accident occurrence is expected to decrease rather than increase. Conversely, there are a higher number of observed accidents involving older people, cyclists and young male drivers on links where accident occurrence is expected

Distributional Impact Appraisal Matrix and AST Entry

	Distributional impact of income deprivation					Are the impacts distributed evenly?	Key impacts - Qualitative statements (example below)				
	0-20%	20-40%	40-60%	60-80%	80-100%						
											to increase rather than decrease
Security	N/A	N/A		N/A	N/A	N/A					N/A

Severance	✓	✓	✓		✓						The provision of a new crossing between two previously poorly connected parts of Great Yarmouth will have a significant positive impact on community severance by offering an alternative central crossing, providing access to the town centre and other key amenities and facilities. Although a number of links are expected to see a significant change in traffic flow which will result in both benefits and disbenefits to certain vulnerable groups, the overall DI assessment on severance is considered to be Slight Beneficial due to the positive impact outweighing the

											negative impact.
Accessibility	N/A	N/A	N/A	N/A	N/A	N/A					N/A

St. Johns House,
Queen Street, Manchester
M1

wsp.com

Appendix F – Wider Impacts Benefits – Core Scenario

TECHNICAL NOTE

Project:	Great Yarmouth Third River Crossing	Date:	30/11/2018
		TN Ref:	N/A
Subject:	Wider Impact Benefits – Core Scenario		

1 INTRODUCTION

1.1.1 This technical note details the appraisal process and results for the wider impacts assessment of the Great Yarmouth Third River Crossing (GYTRC). The proposed scheme will provide a third crossing over the River Yare, creating a new, more direct link between the western and eastern parts of Great Yarmouth. Specifically, it will provide a connection between the Strategic Road Network (A47) and the South Denes Business Park, Enterprise Zone, Great Yarmouth Energy Park and the Outer Harbour, all of which are located on the South Denes peninsula.

1.1.2 The location of the proposed third river crossing is provided in Plate 1 below.

Plate 1 - GYTRC Scheme Location

2 WIDER IMPACTS IN TRANSPORT APPRAISAL

2.1.1 WebTAG Unit A2.1 advises that all benefits of a transport scheme may not be realised through analysis of user benefits if there are ‘distortions’ or market failures that mean the economy is not functioning efficiently. These benefits are defined as ‘wider impacts’ and will arise as the impact of transport improvements are transmitted into the wider economy. These impacts can be large and form an important element of the overall appraisal of a transport scheme. The types of Wider Impacts DfT includes in transport appraisals are:

WI1 – Agglomeration

"Agglomeration" refers to the concentration of economic activity over an area, also known as the 'effective density'. Transport schemes can alter the accessibility of firms in an area to other firms and workers, thereby affecting the level of agglomeration. Businesses derive benefits from being located close to one another through greater business interaction; more efficient/effective labour market interaction and knowledge/technology spill overs.

WI2 – Output change in imperfectly competitive markets

A reduction in transport costs (to business and/or freight) allows firms to profitably increase output of the goods or services that require use of transport in their production. A transport intervention that leads to increased output of goods and services will deliver a welfare gain as consumers' willingness to pay for the increased output will exceed the cost of producing it.

WI3a – Tax revenues arising from labour supply impacts

Transport costs are likely to affect the incentives for an individual to work. In deciding whether or not to work, an individual will weigh the costs associated with work, including travel costs, against the wage of the job. A change in transport costs alters the net financial return to individuals from employment. This is likely to affect the number of people choosing to work and as a result, the overall amount of labour supplied in the economy.

WI3b – Tax revenues arising from moves to more or less productive jobs

Transport schemes are likely to affect the overall costs and benefits to an individual from working in different locations and the benefits to business of operating and employing people in different locations. As a result, transport schemes are likely to have an impact on the overall productivity of employment as productivity varies by location. WebTAG guidance advises that the assessment of benefits from the move to more or less productive jobs should only be calculated for projects where a Land Use Transport Interaction (LUTI) model has been developed as this must be used to model changes in employment location between areas. For the purpose of this note, the 'move to more or less productive jobs' is therefore not assessed.

3 METHODOLOGY

3.1 INTRODUCTION

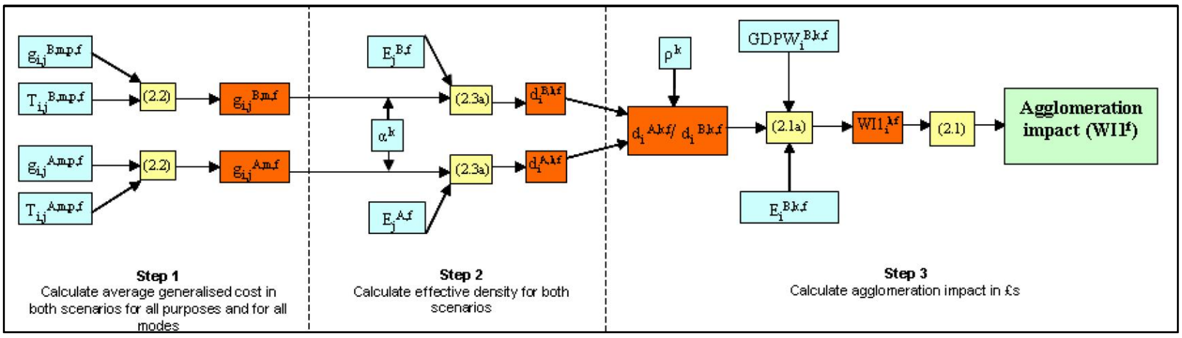
3.1.1 The Wider Impacts for the scheme have been calculated using WSP's Wider Impacts in Transport Appraisal (WITA) emulation tool. The emulation tool, a macro-embedded spreadsheet that applies the methodology set out in WebTAG A2.1 has previously been accepted for use by Highways England, Transport for the North and the DfT for assessment of wider impact benefits for the Trans-Pennine Tunnel and the M60 North West Quadrant. The WITA tool assesses all three types of Wider Impacts discussed above.

3.1.2 The following section discusses the inputs required to run the WITA tool and the definitions used for the assessment of Great Yarmouth Third River Crossing.

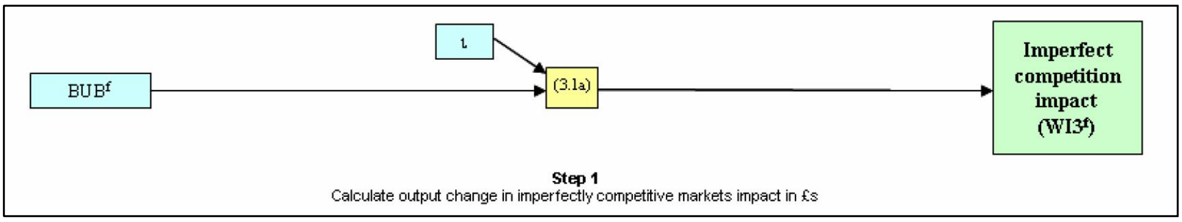
3.2 WIDER BENEFIT IMPACT FORMULATION

3.2.1 WSP's WITA tool adopts the principles and formulation as stated in the TAG A2.1, Appendix D, with each element of the wider impact assessment is calculated using the formulae as follows:

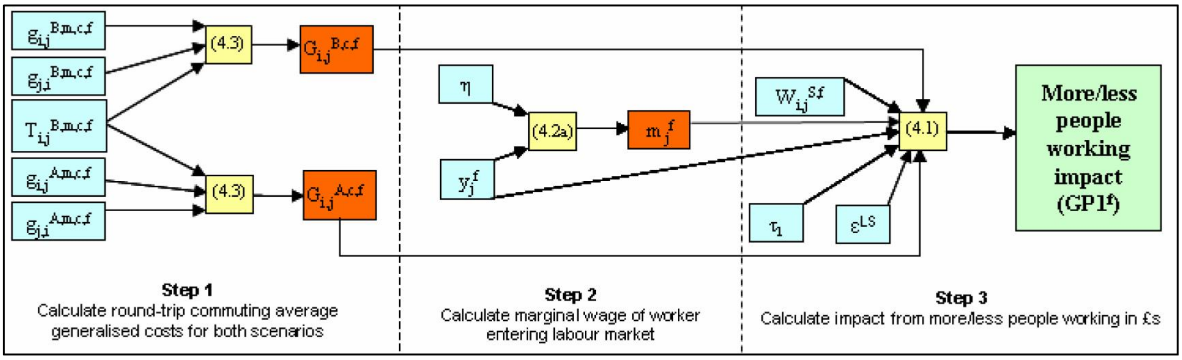
3.2.2 Agglomeration Impacts:



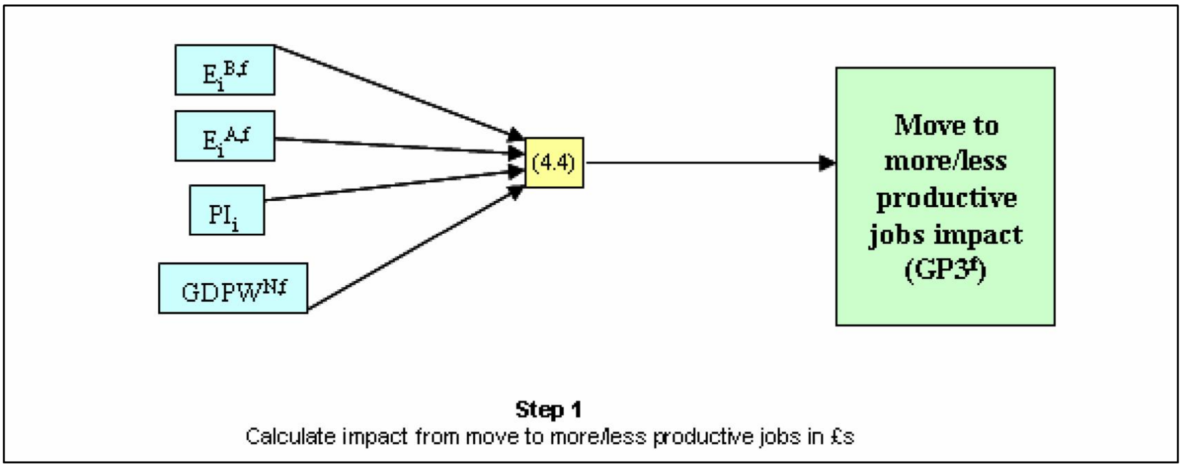
3.2.3 Imperfect Competition Impacts:



3.2.4 Labour Supply Impact:



3.2.5 Move to More/Less Productive Jobs:



3.2.6 Detail of the formulae used to calculate wider impacts benefits are provided in Appendix D of TAG Unit A2.1.

3.3 GENERALISED COST CALCULATIONS

3.3.1 Generalised costs derived from the transport models play a key role in calculation of wider impact benefits, particularly for agglomeration impacts and labour supply impacts. Generalised costs used in calculation of wider impact benefits, as stated from the TAG A2.1, should be in unit of pounds and in 2010 prices and by WITA zone system. Since transport models provide travelled time and travelled distance information at transport model zone systems, it is necessary to convert travelled time and distance to generalised costs in monetary terms in 2010 prices. Detailed calculation of generalised costs from the transport model zones to WITA zone system are explained below:

3.3.2 First, generalised costs for each journey purpose, each modelled year, Do-Minimum /Do-Something and by time periods separately are calculated in accordance with the TAG A1.3 guidance, as below:

$$g_{i,j}^{S,m,p,f,t} = VoT_{Total}^{S,m,p,f,t} * Time_{i,j}^{S,m,p,f,t} + VoC_{i,j}^{S,m,p,f,t} * Dist_{i,j}^{S,m,p,f,t} + Charge_{i,j}^{S,m,p,f,t}$$

Where:

- $\boldsymbol{Time_{i,j}^{S,m,p,f,t}}$, $\boldsymbol{Dist_{i,j}^{S,m,p,f,t}}$, $\boldsymbol{Charge_{i,j}^{S,m,p,f,t}}$ are travel time (in hours), travel distance (in km) and charge (in pounds) from origin (i) to destination (j) from the transport models for scenario (S), mode (m), purpose (p), forecast year (f) and time period (t) respectively.
- $\boldsymbol{VoT_{Total}^{S,m,p,f,t}} = \boldsymbol{VoT_{Driver}^{S,m,p,f,t}} + \boldsymbol{Occupancy} * \boldsymbol{VoT_{Passenger}^{S,m,p,f,t}}$ is the total value of time per vehicular trip. If demand is by person trips then $\boldsymbol{VoT_{Total}^{S,m,p,f,t}}$ is either $\boldsymbol{VoT_{Driver}^{S,m,p,f,t}}$ ***or*** $\boldsymbol{VoT_{Passenger}^{S,m,p,f,t}}$where relevant.
- $\boldsymbol{VoC_{i,j}^{S,m,p,f,t}} = \boldsymbol{Fuel\ VoC_{i,j}^{S,m,p,f,t}} + \boldsymbol{NonFuel\ VoC_{i,j}^{S,m,p,f,t}}$ is Vehicle Operating Costs, calculated in accordance with the WebTAG A1.3 guidance.

3.3.3 The generalised costs are then converted to daily costs, all purposes by weighted averaging over travel purpose (p), time period (t) with number of corresponding trips for each type, and aggregated to WITA zone levels for each forecast year (f), scenario (S) and mode (m) separately:

$$G_{i,j}^{S,m,f} = \frac{\sum_{p,t} g_{i,j}^{S,m,p,f,t} * T_{i,j}^{S,m,p,f,t} * Dur^t}{\sum_{p,t} T_{i,j}^{S,m,p,f,t} * Dur^t}$$

Where:

- $\boldsymbol{Dur^t}$ is the duration (annualisation factor) for each time period (t);
- $\boldsymbol{g_{i,j}^{S,m,p,f,t}}$, $\boldsymbol{T_{i,j}^{S,m,p,f,t}}$ is the generalised cost and corresponding trips for each OD pair, by scenario (S), mode (m), purpose (p), forecast year (f) and time period (t).

3.3.4 For Labour supply impacts, it is required that the round-trip commuting generalised cost of travel is calculated, using the formula:

$$G_{i,j}^{S,c,f} = \frac{\sum_m (g_{i,j}^{S,m,c,f,t} + g_{j,i}^{S,m,c,f,t}) * T_{i,j}^{S,m,c,f,t} * Dur^t}{\sum_m T_{i,j}^{S,m,c,f,t} * Dur^t}$$

3.3.5 The generalised costs from the formulae above are then used to calculate agglomeration impacts and labour supply impacts respectively, following the equations stated in the Appendix D of the WebTAG A2.1.

3.3.6 For intra-zonal trips, the assignment model does not output costs since intra-zonal trips are not assigned. However, it is important that intra-zonal travel costs are included in the wider impact assessment to ensure a full picture of how transport impacts on journey accessibility across the full area affected. To estimate intra-zonal trip costs, half of the minimum inter-zonal costs for that zone are used. This follows guidance on intra-zonal trip costs as stated in Appendix A of WebTAG Unit M2.

3.4 PROFILING OVER APPRAISAL PERIOD

3.4.1 Since it is not possible to model every individual year over an appraisal period, the Wider impact benefits for the non-modelled years are either interpolated or extrapolated from the modelled years as follows:

- For non-modelled years between the modelled years, wider impact benefits are interpolated using the lower bound and upper bounds' modelled years; and
- For non-modelled years after the last modelled year, the calculation of wider impact benefits uses the benefits produced from the last modelled year and growth by the GDP growth rates to the end of the appraisal period.

4 WIDER IMPACT ASSESSMENT FOR GYTRC

4.1 ECONOMIC DATA

4.1.1 The economic and employment data were obtained from the latest WebTAG Wider Impacts dataset v2.5, released in July 2013. This data is available by Local Authority Districts (LAD) from 2006 to 2076 in five-year intervals. The forecasts presented in the dataset have been developed by DfT specifically for the estimation of Wider Impacts to fit the sectoral definitions used in the estimation of agglomeration elasticities and decay parameters. These forecasts are only used for estimating wider impacts.

4.1.2 The values for the relevant LADs between 2016 and 2041 are presented in Appendix A.

4.1.3 The assessment also requires the following information from the WebTAG data book:

- Value of Time (VoT) for business users
- Forecast growth in VoT
- Discount rates
- Vehicle occupancies
- Proportion of travel in work and non-work time
- Fuel Costs and VAT rates
- Vehicle operating cost parameters

4.1.4 Values from the above were obtained from the WebTAG data book (v1.9.1 released in December 2017) to be consistent with the economic data that was used for TUBA benefits.

4.2 DEFINITION OF ASSESSMENT AREA

4.2.1 WITA uses economic data at a Local Authority District (LAD) level and model data at a model zone level. In order to run the assessment, a WITA zone system must be defined to link the two other zone systems together.

For GYTRC, the assessment area includes all of Norfolk, with a WITA zone for each of the eight LADs. The WITA zoning system is shown in Plate 2

4.2.2 **Table 1** and summarised in

4.2.3 Table **1**.

4.2.4 The area definition has been constructed so that Sector 1 represents the fully simulated area of the model. WebTAG Unit A2.1 (para 6.1.5) warns against considering too small an area as it is likely to exaggerate the impact of the scheme appraised. Sectors 2-8 have therefore been included in the analysis so that the sectors in the wider impact appraisal cover the area over which wider benefits are expected.

4.2.5 The network within the simulation area (Sector 1) has been calibrated and validated using observed counts and journey time data which provides a sufficient level of confidence in the generalised costs for this area. Further details are given in the Local Model Validation Report (LMVR) addendum 2018.

4.2.6 Sectors 2-8 cover the buffer area of the model, where the network is represented in a more aggregate level to provide accessibility from external zones to the simulation area (Sector 1). The model has not been calibrated and validated to the same level in the buffer area and the generalised costs derived for these sectors may be less accurate. However, these costs are used to provide a baseline of travel costs from surrounding areas to the study area.

Plate 2 - WITA Area Definition

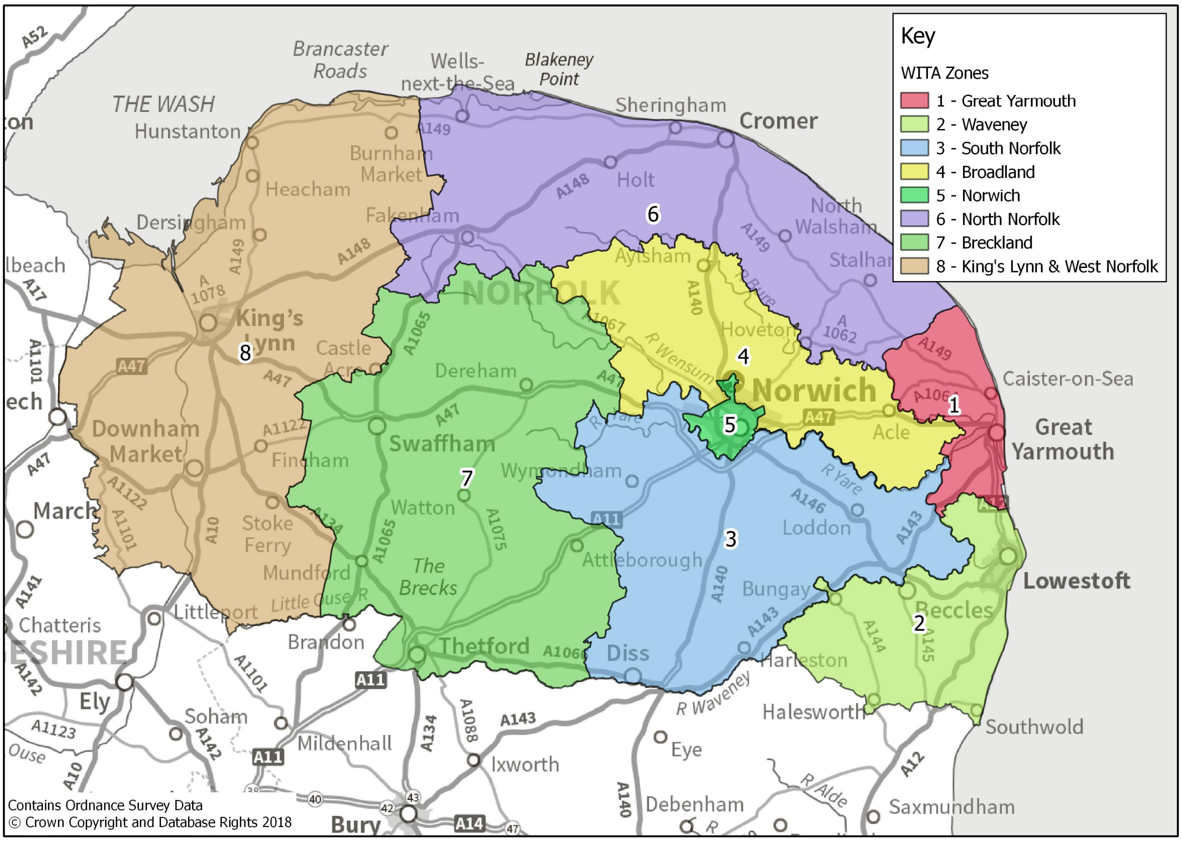


Table 1 - WITA Area Definition

WITA Zone	Local Authority District	Number of Model Zones in WITA Zone
1	Great Yarmouth	125
2	Waveney	8
3	South Norfolk	43
4	Broadland	38
5	Norwich	1

6	North Norfolk	4
7	Breckland	3
8	King's Lynn & West Norfolk	5

4.3 MODELLED TIME PERIODS & ANNUALISATION FACTORS

4.3.1 For consistency, WITA calculation adopts the same scheme data, modelled periods and annualisation factors that were used for TUBA calculation.

4.3.2 Scheme data for WITA has been obtained from the core scenario variable demand forecasts for the three modelled years: 2023, 2038 and 2051. The horizon year has been defined as 2082, 60 years after the scheme opening year.

4.3.3 The model has three time periods as follows:

- AM peak (0800-09:00)
- Inter-Peak (10:00-15:30 Average hour)
- PM peak (16:30-17:30)

4.3.4 Annualisation factors have been used to expand these modelled time periods to represent a full year, as detailed in Table 2. Note that the Inter-Peak model has been used as a donor model for the weekend time period.

Table 2 - Annualisation Factors

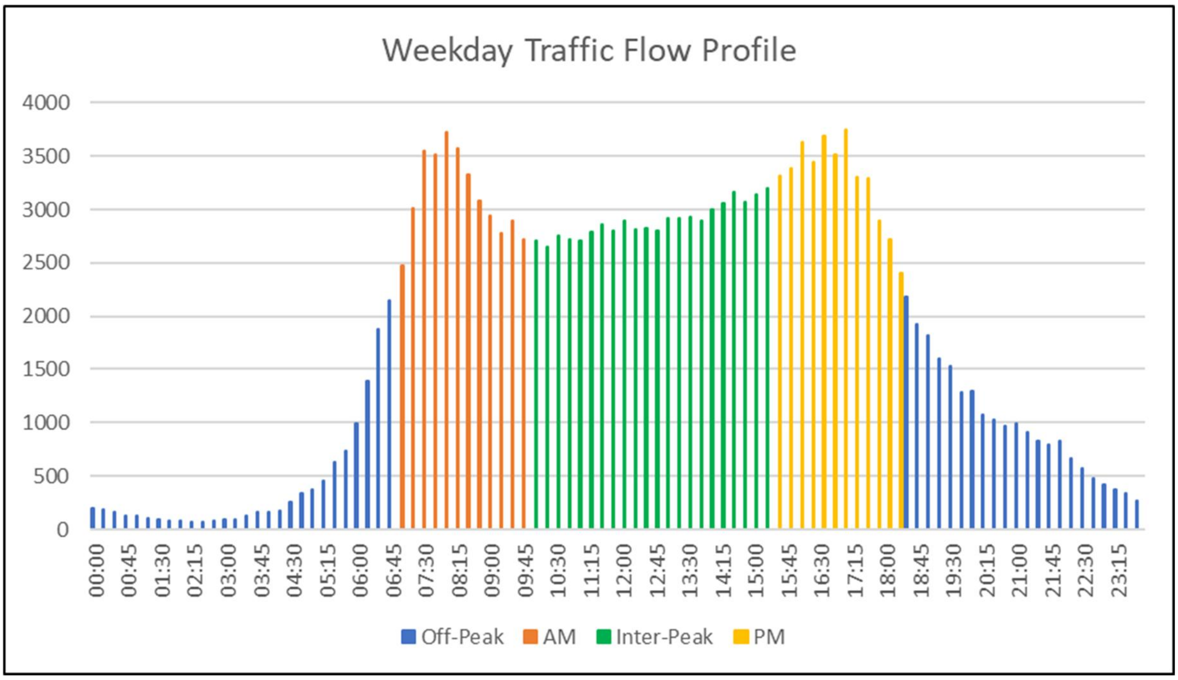
Time Period	Annualisation Factor
AM	1.51 x 253 = 383
Inter-Peak	7.23 x 253 = 1828
PM	2.2 x 253 = 556
Weekend	8.05 x 52 = 418

4.3.5 WebTAG Unit A2.1 (paragraph 3.3.1) states that transport models are required to estimate generalised travel costs for input into the wider impacts assessment. These costs are input as 24-hour average costs and as a result, using only the modelled time periods above would likely overestimate the benefits from the scheme.

4.3.6 To accurately produce the 24-hour average costs for WITA calculation, off-peak travel costs and demand would be required to be included in the calculation.

4.3.7 Since no explicit off-peak model has been developed, the average Inter-Peak matrix has been used to create a proxy demand matrix for average Off-Peak (18:00-07:00) demand which has been assigned to the network using a fixed assignment and included in the WITA assessment. A factor of 0.23219 was used to convert the Inter-Peak matrices into proxy Off-Peak matrices. This factor was derived by comparing local observed traffic flows to calculate a ratio of average Inter-Peak to average Off-Peak traffic. This is a common approach when an off-peak model is not available. The traffic profile for the observed flows used in this calculation is shown in **Plate 3**.

Plate 3 - ATC Traffic Flow Profile



Source: Automatic Traffic Counts (ATCs) from 9 locations in Great Yarmouth

4.3.8 To expand this average hour Off-Peak matrix to represent a full year, an annualisation factor for the Off-Peak time period has also been applied. This value is detailed in Table 3.

Table 3 - Off-Peak Annualisation Factor

Time Period	Annualisation Factor
Off-Peak	12 x 253 = 3036

4.4 USER CLASSES & MODES

4.4.1 WITA benefits are only calculated for commute and business trips so all 'other' trips have been excluded.

4.4.2 It should be noted that TAG guidance recommends that the results from freight trips are not included in the core assessment of wider impacts as it is not well known how changes in generalised costs for freight trips affect changes in destination choice, time of day or mode (WebTAG Unit A2.4 paragraph 5.1.4).

4.4.3 WITA requires average costs of all travel modes to represent travel costs of the economy (WebTAG Unit A2.4 paragraph 3.2.1), therefore ideally this would require travel costs for highway, PT and slow modes to be included in the calculation.

4.4.4 This assessment has included three modes: Car, Public Transport (Rail/Bus) and Slow Modes (Walking/Cycling).

4.5 DERIVATION OF PT AND SLOW MODE DEMAND

4.5.1 As there were no explicit PT and slow mode models developed, a method of creating a proxy demand and costs for each relevant mode was carried out, as below:

- trip-end databases were extracted from NTEM (TEMPRO) at MSOA level for car, PT (bus+rail) and slow mode (walk+cycle).

- Calculate a factor to convert car trip-ends to PT and Slow mode trip-ends respectively
- Apply the factors to car demand matrices to derive proxy demand matrices for PT and slow mode

4.6 COST INPUTS

4.6.1 To run WITA, generalised cost data is required for all users and modes for a full set of OD pairs.

4.6.2 The SATURN highway model has been used to extract the average travel time and travel distance between each Origin-Destination pair for car trips. Intra-zonal trip costs have been calculated as half the minimum inter-zonal trip cost for each zone, following guidance given in Appendix A of WebTAG Unit M2.

4.6.3 To determine a formula for estimating public transport costs, evidence was collated on bus fares in Great Yarmouth and surrounding areas. This evidence showed that that a standard service within Great Yarmouth of around 4km would charge £1.50 for a single trip. After deflation to 2010 prices, the following calculation was used to derive public transport travel costs for input into the calculation of wider impact benefits:

$$Public\ Transport\ Cost\ = £1 + 10p\ per\ kilometre\ travelled.$$

4.6.4 For the travel time of public transport modes, the time has been taken from the highway model with a factor of 1.2 applied to account for public transport trips taking longer than car trips and an additional 30 minutes added to account for access and egress time (time taken to get to and from the bus stop/train station).

4.6.5 Slow mode (walking and cycling) travel times have been defined using the highway model network with a travel speed of 5kph.

4.7 PRODUCTION ATTRACTION MATRICES

4.7.1 The WITA assessment requires 24-hour commute Production-Attraction (PA) matrices to be input for each modelled year for the Do Something scenario. The PA matrices should be a representation of all workers living in each zone and working in each zone.

4.7.2 PA matrices for car trips were extracted directly from the Variable Demand Model (VDM). For public transport and slow mode trips, the PA demand for commuting trips were produced by applying adjustment factors to car PA demand that was derived from TEMPro data at MSOA level at 24-hour level for each relevant PT and slow mode.

5 RESULTS

5.1 INITIAL WITA ASSESSMENT

5.1.1 To aid in understanding the impacts of the different elements used in the wider impacts assessment, the WITA assessment for GYTRC has been carried out for the following tests, with each iteration including additional elements:

- The first WITA run consisted of a highway only assessment using the annualisation factors from TUBA which included four time periods: AM, Inter-Peak, PM and Weekend.
- The second WITA run also comprised of a highway only assessment but this iteration included the four time periods above as well as the Off-Peak model data.

- The third assessment added in public transport data alongside the highway model information along with the five time periods of the previous run (AM, Inter-Peak, PM, Weekend and Off-Peak).
- The final run of WITA included public transport, slow modes and highway data for all five time periods (AM, Inter-Peak, PM, Weekend and Off-Peak).

5.1.2 The results of these assessments by wider impact are detailed in Table 4 for the full 60-year appraisal period.

Table 4 - WITA Results Summary, 60 Year Appraisal Period

Wider Impact	Test 1: 4 Time Periods	Test 2: 5 Time Periods	Test 3: 5 Time Periods + PT	Test 4: 5 Time Periods + PT + Slow Modes
Agglomeration	120,203	116,017	87,923	85,961
Output changes in imperfectly competitive markets	1,499	1,499	1,499	1,499
Tax revenues arising from labour supply impacts	1,535	1,380	4,462	5,669
Total	**123,236**	**118,896**	**93,884**	**93,129**

All values are in £000s, expressed in 2010 market prices and values

5.1.3 It can be seen that each step in the process makes adjustments to the wider impacts produced by the scheme. This is the case for all except the change in imperfectly competitive markets benefits which remain the same throughout as they are calculated as 10% of Business User benefits from TUBA.

5.1.4 For the first test, changes in costs between Do Minimum and Do Something are only considered for the AM, Inter-Peak, PM and weekend. This results in an overall value of £123.2m with £120.2m of the benefits from agglomeration, equivalent to 55% of TUBA User Benefits (£219.3m).

5.1.5 In the 2nd test, the changes in cost between Do Minimum and Do Something in the Off-Peak are now considered. In the Off-Peak, the scheme has a smaller impact on traffic than in the peak hours due to less congestion which causes a moderate reduction in benefits of £4.3m when the Off-Peak period is included in the assessment. This occurs as the change in average costs over 24-hours between Do Minimum and Do Something is reduced through the addition of the Off-Peak. The overall benefits for the test 2 are £118.9m, of which £116m are from agglomeration which equates to 53% of the TUBA User Benefits.

5.1.6 A similar pattern occurs through the addition of public transport trips to the assessment. Public transport trips (particularly rail) are less impacted by changes to the highway network than car trips so the change in costs is less significant between the Do Minimum and Do Something scenarios for public transport trips. Adding in the public transport trips therefore reduces the total difference in costs between the with and without scheme scenarios and reduces the overall benefits to £93.9m. Of these benefits, £87.9m are from agglomeration benefits which is equivalent to 40% of TUBA User Benefits.

5.1.7 The final input into the assessment was the addition of 'slow mode' (walking and cycling) trips. The inclusion of these trips provided another slight reduction in benefits as costs of slow mode trips are not affected by changes to the highway network as significantly as car trips. This assessment resulted in total benefits of £93.1m, of which £86m are from agglomeration which is equates to 39% of TUBA User Benefits.

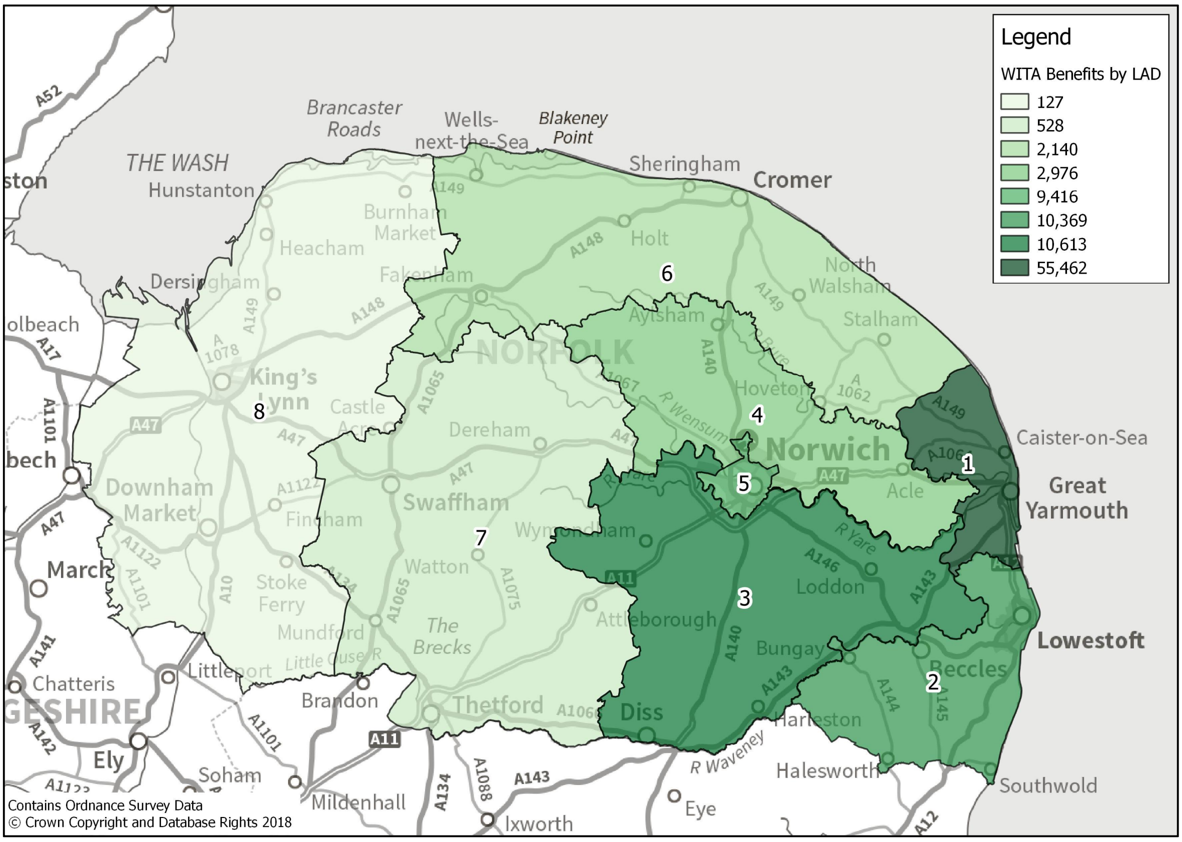
5.1.8 The initial wider impact results show an overall benefit of £93.1m which takes into account scheme impacts over all time periods, across three modes of transport and a suitable geographical area. **Table 5** and **Plate 4** present the wider impact benefits of the scheme at Local Authority District (LAD) level. This summary shows that the scheme has significant wider impact benefits for Great Yarmouth which receives £55.5m in benefits. Districts to the south (Waveney and South Norfolk) and Norwich receive a considerable amount of wider impact benefits, around £10m each, with the rest of the benefits distributed between the other nearby districts.

Table 5 - WITA Benefits Summary (without Output change in imperfectly competitive market)

LAD	Agglomeration impacts	Labour Supply Impacts	Total
1. Great Yarmouth	50,906	4,555	55,462
2. Waveney	9,868	501	10,369
3. South Norfolk	10,493	120	10,613
4. Broadland	2,826	150	2,976
5. Norwich	9,174	242	9,416
6. North Norfolk	2,067	73	2,140
7. Breckland	513	15	528
8. King's Lynn & West Norfolk	115	12	127
Total	**85,961**	**5,669**	**91,631**

All values are in £000s, expressed in 2010 market prices and values (total values not including benefits from output change in imperfectly competitive markets)

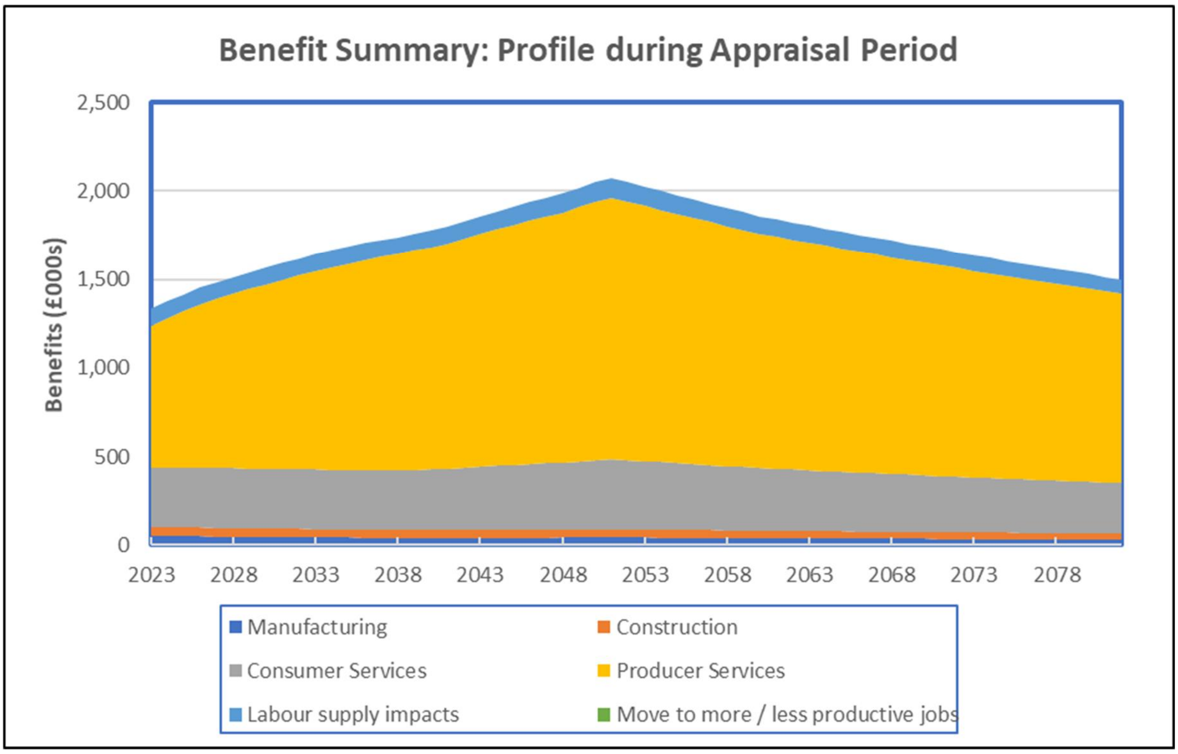
Plate 4 - WITA Benefits by LAD



All values are in £000s, expressed in 2010 market prices and values (total values not including benefits from output change in imperfectly competitive markets)

5.1.9 The 60-year benefit profile for the final WITA run is shown in **Plate 5**.

Plate 5 - WITA Benefits Profile - Highway, Public Transport and Slow Modes, 5 Time Periods



5.2 FURTHER ANALYSIS

5.2.1 It is noted that the travel costs derived from the traffic model for the calculation of wider impact benefits were used to produce travel costs across the wider network and the calculation of the wider impact benefits were based on all employment within each local authority regardless of whether or not any employment is affected by the proposed scheme.

5.2.2 To capture the more accurately the wider benefits for only trips that are affected by the scheme, additional analysis has been undertaken using 2011 Census Journey to Work data at a local authority level to establish the proportion of work related trips in each district that start or end in Great Yarmouth.

5.2.3 The total number of people travelling to or from each district for work was calculated along with the number of people that either live or work in each district that work or live in Great Yarmouth. These values were then used to calculate the proportion of commute trips for each district that have an origin or destination in Great Yarmouth. The results of this analysis are shown in Table 6.

Table 6 - Journey to Work Data Summary

District	Total Commute Trips To/From District	Commute Trips To/ From Great Yarmouth	Percentage of Trips with O/D in Great Yarmouth
Breckland	61,297	388	0.6%
Broadland	68,553	3,001	4.4%
Great Yarmouth	42,526	42,526	100.0%
King's Lynn and West Norfolk	64,596	463	0.7%
North Norfolk	40,556	1,591	3.9%
Norwich	101,766	2,879	2.8%
South Norfolk	69,986	1,696	2.4%
Waveney	47,818	6,929	14.5%

5.2.7 The proportions developed in this analysis have been used to scale the agglomeration part of the wider impact benefits, found through WSP WITA tool, to reflect the proportion of commute trips from each local authority that would reasonably be affected by the Great Yarmouth Third River Crossing scheme. Using this method, the adjusted wider impact benefits for the scheme are presented in Table 7.

Table 7 - Wider Impact Benefits Summary with Commute Trip Proportion Adjustment ***(without Output change in imperfectly competitive market)***

LAD	Agglomeration impacts	Labour Supply Impacts	Total
1. Great Yarmouth	50,906	4,555	55,461
2. Waveney	1,430	501	1,931
3. South Norfolk	254	120	374
4. Broadland	124	150	274
5. Norwich	260	242	502
6. North Norfolk	81	73	154
7. Breckland	3	15	18
8. King's Lynn & West Norfolk	1	12	13
Total	**53,059**	**5,669**	**58,727**

All values are in £000s, expressed in 2010 market prices and values (total values not including benefits from output change in imperfectly competitive markets)

5.2.8 It is noted that the labour supply impacts remain unchanged as the PA commuting data that was used for the calculation has been derived directly from the traffic model therefore already taking into account the commuting trips that are affected by the scheme.

5.2.9 With the addition of benefits due to output change in imperfectly competitive markets, the adjusted total wider impact benefits for the scheme are £58.7m. The adjusted agglomeration benefits account for £53.1m of this total, which is equivalent to 25% of TUBA user benefits.

6 SUMMARY

6.1.1 The Wider Impacts for the scheme have been calculated using WSP's Wider Impacts in Transport Appraisal (WITA) emulation tool. The emulation tool is a macro-embedded spreadsheet that applies the methodology set out in WebTAG A2.1.

6.1.2 The initial wider impact results show an overall benefit of £93.1m which takes into account scheme impacts over all time periods, across three modes of transport and a suitable geographical area.

6.1.3 Further analysis incorporated Census Journey to Work data to ensure that only trips with either an origin or destination within Great Yarmouth district were included in the final analysis. This reflects the proportion of commute trips from each local authority that would reasonably be affected by the Great Yarmouth Third River Crossing scheme.

6.1.4 With the addition of benefits due to output change in imperfectly competitive markets, the adjusted total wider impact benefits for the scheme are £58.7m. The adjusted agglomeration benefits account for £53.1m of this total, which is equivalent to 25% of TUBA user benefits

ANNEX A

EMPLOYMENT IN EACH SECTOR BY LOCAL AUTHORITY

LAD	LAD Name	Sector	2016	2021	2026	2031	2036	2041
33UB	Breckland	Construction	5,174	4,844	4,531	4,152	3,806	3,471
33UB	Breckland	Consumer services	14,100	14,118	14,099	13,935	13,810	13,660
33UB	Breckland	Manufacturing	9,722	9,067	8,390	7,654	7,032	6,467
33UB	Breckland	Producer services	6,991	7,543	8,136	8,609	9,064	9,572
33UC	Broadland	Construction	6,500	6,053	5,619	5,094	4,597	4,136
33UC	Broadland	Consumer services	13,887	13,973	13,959	13,761	13,584	13,401
33UC	Broadland	Manufacturing	7,525	6,981	6,411	5,787	5,233	4,747
33UC	Broadland	Producer services	5,724	6,181	6,619	6,936	7,246	7,597
33UD	Great Yarmouth	Construction	1,953	1,784	1,636	1,475	1,325	1,186
33UD	Great Yarmouth	Consumer services	14,342	14,215	14,114	13,886	13,715	13,605
33UD	Great Yarmouth	Manufacturing	3,137	2,854	2,590	2,324	2,093	1,889
33UD	Great Yarmouth	Producer services	5,620	5,913	6,250	6,466	6,679	6,958
33UE	King's Lynn and West Norfolk	Construction	5,732	5,310	4,921	4,482	4,065	3,669
33UE	King's Lynn and West Norfolk	Consumer services	17,219	17,190	17,110	16,854	16,645	16,486
33UE	King's Lynn and West Norfolk	Manufacturing	9,120	8,417	7,717	6,997	6,359	5,788
33UE	King's Lynn and West Norfolk	Producer services	6,890	7,388	7,869	8,231	8,579	9,027
33UF	North Norfolk	Construction	3,539	3,268	3,007	2,732	2,472	2,216
33UF	North Norfolk	Consumer services	13,813	13,936	14,054	13,990	14,012	13,992
33UF	North Norfolk	Manufacturing	4,860	4,470	4,069	3,680	3,337	3,016
33UF	North Norfolk	Producer services	4,482	4,766	5,014	5,196	5,353	5,584
33UG	Norwich	Construction	4,326	3,911	3,521	3,117	2,763	2,451
33UG	Norwich	Consumer services	28,493	28,320	27,962	27,348	27,023	26,822
33UG	Norwich	Manufacturing	8,473	7,630	6,796	5,989	5,320	4,759
33UG	Norwich	Producer services	32,757	35,082	37,303	39,377	41,910	44,387
33UH	South Norfolk	Construction	8,999	8,498	8,057	7,579	7,093	6,548

LAD	LAD Name	Sector	2016	2021	2026	2031	2036	2041
33UH	South Norfolk	Consumer services	15,641	15,907	16,250	16,434	16,705	16,977
33UH	South Norfolk	Manufacturing	6,448	6,065	5,688	5,327	4,997	4,651
33UH	South Norfolk	Producer services	10,122	11,018	11,998	12,871	13,751	14,702
42UH	Waveney	Construction	3,583	3,245	2,935	2,618	2,334	2,061
42UH	Waveney	Consumer services	14,241	13,997	13,782	13,396	13,123	12,844
42UH	Waveney	Manufacturing	7,487	6,755	6,043	5,368	4,795	4,270
42UH	Waveney	Producer services	7,148	7,448	7,767	7,966	8,181	8,427

GDP PER WORKER BY LOCAL AUTHORITY

LAD	LAD Name	Sector	2016	2021	2026	2031	2036	2041	2046	2051	2056
33UB	Breckland	Construction	36,333	40,581	44,209	48,696	53,783	59,320	65,494	72,311	79,837
33UB	Breckland	Consumer services	43,674	49,495	55,011	61,689	69,063	77,006	85,021	93,870	103,640
33UB	Breckland	Manufacturing	72,885	80,068	87,502	96,954	106,847	117,410	129,630	143,122	158,018
33UB	Breckland	Producer services	57,687	66,857	76,375	87,441	99,390	112,084	123,750	136,630	150,851
33UC	Broadland	Construction	36,109	40,258	43,777	48,134	53,086	58,483	64,570	71,290	78,710
33UC	Broadland	Consumer services	44,669	50,366	56,187	63,326	71,143	79,514	87,790	96,927	107,016
33UC	Broadland	Manufacturing	70,871	79,350	87,853	97,517	107,931	118,917	131,294	144,959	160,046
33UC	Broadland	Producer services	70,283	81,276	93,952	108,729	124,823	141,859	156,623	172,925	190,923
33UD	Great Yarmouth	Construction	36,242	40,484	44,120	48,614	53,707	59,250	65,417	72,225	79,743
33UD	Great Yarmouth	Consumer services	36,605	41,793	46,952	53,159	60,126	67,729	74,778	82,561	91,154
33UD	Great Yarmouth	Manufacturing	63,168	69,820	76,532	84,151	92,618	101,538	112,107	123,775	136,657
33UD	Great Yarmouth	Producer services	57,014	66,894	77,317	89,402	102,493	116,413	128,529	141,907	156,676
33UE	King's Lynn and West Norfolk	Construction	36,164	40,324	43,869	48,255	53,238	58,667	64,773	71,515	78,958

LAD	LAD Name	Sector	2016	2021	2026	2031	2036	2041	2046	2051	2056
33UE	King's Lynn and West Norfolk	Consumer services	40,480	45,238	51,378	58,564	66,431	74,825	82,612	91,211	100,704
33UE	King's Lynn and West Norfolk	Manufacturing	69,456	76,522	83,728	92,499	101,868	111,877	123,521	136,377	150,571
33UE	King's Lynn and West Norfolk	Producer services	59,344	69,205	80,201	92,933	106,755	121,411	134,048	148,000	163,404
33UF	North Norfolk	Construction	36,490	40,833	44,600	49,235	54,478	60,179	66,443	73,358	80,993
33UF	North Norfolk	Consumer services	36,832	41,412	46,563	52,586	59,176	66,183	73,072	80,677	89,074
33UF	North Norfolk	Manufacturing	65,461	72,348	79,811	86,742	96,070	106,263	117,323	129,534	143,016
33UF	North Norfolk	Producer services	59,067	68,613	79,499	92,369	106,454	121,451	134,092	148,049	163,458
33UG	Norwich	Construction	36,225	40,598	44,391	49,071	54,352	60,089	66,343	73,248	80,872
33UG	Norwich	Consumer services	41,759	47,205	53,048	59,887	67,313	75,186	83,011	91,651	101,190
33UG	Norwich	Manufacturing	67,814	75,235	82,827	92,395	102,941	114,494	126,411	139,567	154,094
33UG	Norwich	Producer services	80,846	92,954	107,325	123,754	141,464	160,007	176,660	195,047	215,348
33UH	South Norfolk	Construction	36,332	40,516	44,082	48,495	53,507	58,966	65,104	71,880	79,361
33UH	South Norfolk	Consumer services	42,418	48,138	53,837	60,533	68,042	76,111	84,032	92,779	102,435
33UH	South Norfolk	Manufacturing	68,742	76,478	84,831	94,823	105,919	117,745	130,000	143,531	158,469
33UH	South Norfolk	Producer services	54,774	63,694	73,570	85,411	98,498	112,559	124,274	137,209	151,490
42UH	Waveney	Construction	36,562	40,586	44,280	48,843	54,039	59,674	65,885	72,742	80,314
42UH	Waveney	Consumer services	37,295	41,863	46,953	53,015	59,672	66,744	73,690	81,360	89,828
42UH	Waveney	Manufacturing	70,472	77,643	84,678	93,506	103,226	113,682	125,515	138,578	153,002
42UH	Waveney	Producer services	61,632	70,319	79,767	91,102	103,649	117,159	129,353	142,816	157,681

INDEX OF PRODUCTIVITY PER WORKER

LAD	LAD Name	Index
33UB	Breckland	0.8857
33UC	Broadland	0.9380
33UD	Great Yarmouth	0.9336
33UE	King's Lynn and West Norfolk	0.9581
33UF	North Norfolk	0.7683
33UG	Norwich	0.8976
33UH	South Norfolk	0.9872
42UH	Waveney	0.8595

Appendix G – TUBA Annualisation Factors

TECHNICAL NOTE 1

DATE:	29 November 2018	**CONFIDENTIALITY:**	Restricted
SUBJECT:	GYTRC – TUBA Annualisation Factors		
PROJECT:	GYTRC		

1 INTRODUCTION

1.1 This technical note outlines the methodology that was adopted to produce the annualisation factors that have been used for TUBA and WITA appraisal of the Great Yarmouth Third River Crossing. The annualisation factors have been derived from the observed count data that were collected during the development of the base year.

1.2 This note is a direct extract from GYTRC Outline Business Case March 2017, Appendix G – Note on TUBA Methodology, section 3.13 Non-modelled Hours and Annualisation Factors.

2 NON-MODELLED HOURS AND ANNUALISATION FACTORS

2.1 The forecast models consist of three distinct peak hours: AM peak hour (08:00-09:00), average inter-peak hour (10:00-15:30), and PM peak hour (16:30-17:30). TUBA analysis is, however, required to be carried out for all the hours for the whole year.

2.2 For non-modelled hours (i.e. AM Peak shoulders (07:00-08:00 and 09:00-10:00), PM peak shoulders (15:30-16:30 and 17:30-18:30), off-peak and weekend + bank holiday), it is only appropriate to calculate benefits for hours in which traffic levels are similar to the modelled hours. For example, it would not be appropriate to expand the AM peak hour to the AM period in the event that traffic was significantly lower in the peak shoulders as it would result in significantly less actual delays caused by traffic in the peak shoulders as opposed to the peak hour, thus resulting in overestimating the modelled benefits of the proposed scheme if the peak shoulders were included in the calculation of benefits. 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 the changes in the modelled hours.

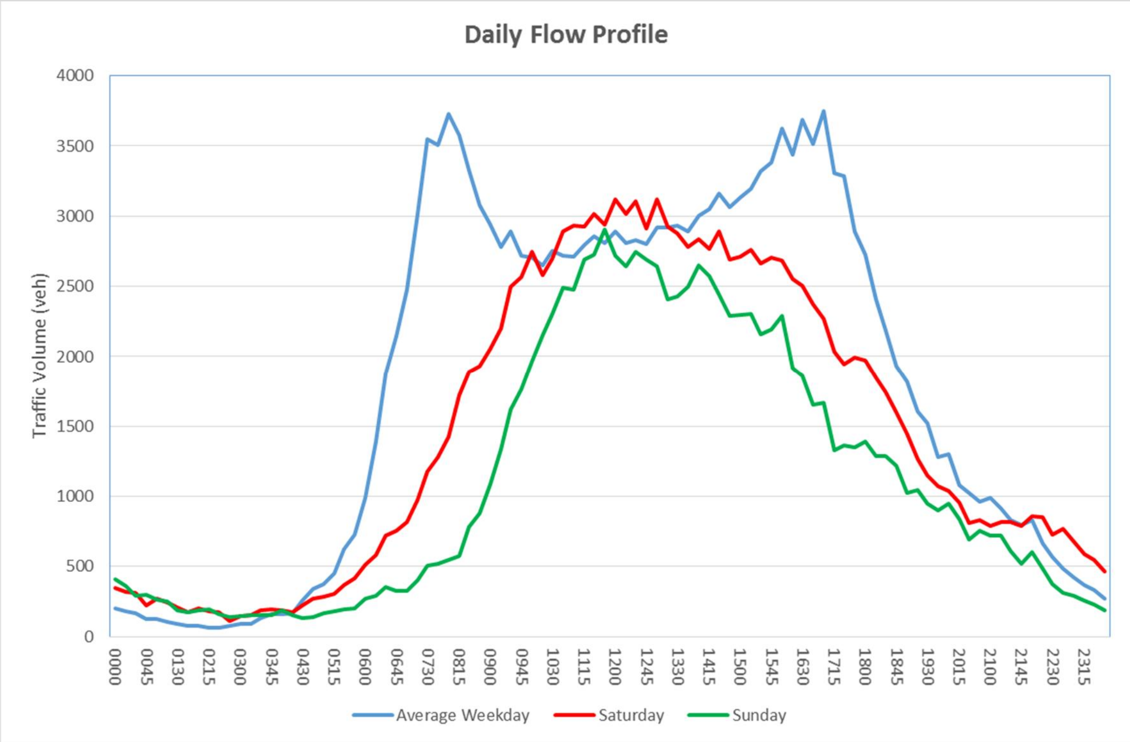
2.3 It is common practice that the peak shoulder traffic exceeding 90% of that in the peak hour should be included in the derivation of the annualisation factors as the change in travel time between the Do-Minimum and Do-Something in the peak shoulders would be close to the changes experienced in the peak hour. The 90% threshold was employed.

2.4 Observed traffic counts from 9 Automatic Traffic Counts (ATC) at the RSI locations in Great Yarmouth that were collected for the two weeks in November 2016 for the purpose of the base year model validation were used to identify this profile.

2.5 Plate 1 below shows the locations of the 9 ATC counts and Plate 2 provides a summary of the traffic daily profile that was produced from the sites.

Plate 1 – Location of ATC counts

Plate 2 – Traffic Flow Profile



2.6 As can be seen from Plate 2, weekday traffic volume peaks between 08:00-09:00 before reducing significantly to the inter-peak. Peak conditions re-emerge at 15:30 and continue to 17:30 before receding into the off-peak period. During weekend, the traffic volume shows similarly to the inter-peak period on Saturday with slightly lower flow on Sunday. It was therefore suggested that only about 1.5 hours for the AM and about 2 hours for the PM period that will be used for the calculation of the benefits of the scheme. this was based on the assumption that the traffic volume in the peak shoulders of more than 90% of the peak hour volume is deemed to be appropriate to be included in the derivation of the annualisation factors.

2.7 Table 1 to Table 3 below provide a quick summary derivation of the annualisation factors that have been adopted for the calculation of the TUBA benefits for the Great Yarmouth Third River Crossing scheme. Flows outside the 90% threshold are excluded.

Table 1 – Derivation of Annualisation Factors – Weekday Traffic

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
AM Period	0700	2,479	IP	0.86	×	Off-Peak	1900	1,819	IP	0.63	×
	0715	3,015	IP	1.04	✓		1915	1,603	IP	0.55	×
	0730	3,547	AM	1.04	✓		1930	1,525	IP	0.53	×
	0745	3,508	AM	1.02	✓		1945	1,282	IP	0.44	×
	0800	3,728	AM	1.00	✓		2000	1,301	IP	0.45	×
	0815	3,574	AM	1.00	✓		2015	1,078	IP	0.37	×
	0830	3,328	AM	1.00	✓		2030	1,022	IP	0.35	×
	0845	3,078	AM	1.00	✓		2045	966	IP	0.33	×
	0900	2,939	IP	1.02	✓		2100	989	IP	0.34	×
	0915	2,779	IP	0.96	✓		2115	914	IP	0.32	×
	0930	2,893	IP	1.00	✓		2130	834	IP	0.29	×
	0945	2,720	IP	0.94	✓		2145	799	IP	0.28	×
Inter-Peak Period	1000	2,708	IP	1.00	✓		2200	833	IP	0.29	×
	1015	2,649	IP	1.00	✓		2215	666	IP	0.23	×
	1030	2,750	IP	1.00	✓		2230	570	IP	0.20	×
	1045	2,718	IP	1.00	✓		2245	484	IP	0.17	×
	1100	2,711	IP	1.00	✓		2300	426	IP	0.15	×
	1115	2,792	IP	1.00	✓		2315	371	IP	0.13	×
	1130	2,855	IP	1.00	✓		2330	333	IP	0.12	×
	1145	2,805	IP	1.00	✓		2345	269	IP	0.09	×
	1200	2,895	IP	1.00	✓		0000	200	IP	0.07	×
	1215	2,808	IP	1.00	✓		0015	184	IP	0.06	×
	1230	2,827	IP	1.00	✓		0030	168	IP	0.06	×
	1245	2,799	IP	1.00	✓		0045	127	IP	0.04	×
	1300	2,918	IP	1.00	✓		0100	126	IP	0.04	×
	1315	2,917	IP	1.00	✓		0115	106	IP	0.04	×
	1330	2,932	IP	1.00	✓		0130	91	IP	0.03	×

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
	1345	2,893	IP	1.00	✓		0145	80	IP	0.03	×
	1400	2,999	IP	1.00	✓		0200	78	IP	0.03	×
	1415	3,054	IP	1.00	✓		0215	67	IP	0.02	×
	1430	3,159	IP	1.00	✓		0230	66	IP	0.02	×
	1445	3,065	IP	1.00	✓		0245	79	IP	0.03	×
	1500	3,136	IP	1.00	✓		0300	90	IP	0.03	×
	1515	3,196	IP	1.00	✓		0315	88	IP	0.03	×
PM Period	1530	3,320	PM	0.93	✓		0330	133	IP	0.05	×
	1545	3,381	PM	0.95	✓		0345	158	IP	0.05	×
	1600	3,624	PM	1.02	✓		0400	159	IP	0.06	×
	1615	3,439	PM	0.97	✓		0415	170	IP	0.06	×
	1630	3,683	PM	1.03	✓		0430	255	IP	0.09	×
	1645	3,516	PM	0.99	✓		0445	338	IP	0.12	×
	1700	3,751	PM	1.05	✓		0500	376	IP	0.13	×
	1715	3,304	PM	0.93	✓		0515	453	IP	0.16	×
	1730	3,287	PM	0.92	✓		0530	626	IP	0.22	×
	1745	2,891	IP	1.00	✓		0545	730	IP	0.25	×
	1800	2,723	IP	0.94	✓		0600	990	IP	0.34	×
	1815	2,404	IP	0.83	×		0615	1,391	IP	0.48	×
Off-Peak	1830	2,186	IP	0.76	×		0630	1,878	IP	0.65	×
	1845	1,930	IP	0.67	×		0645	2,147	IP	0.74	×

Table 2 – Derivation of Annualisation Factors – Saturday Traffic

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
AM Period	0700	817	IP	0.28	×	Off-Peak	1900	1,449	IP	0.50	×
	0715	975	IP	0.34	×		1915	1,270	IP	0.44	×

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
	0730	1,178	IP	0.41	×		1930	1,152	IP	0.40	×
	0745	1,283	IP	0.44	×		1945	1,070	IP	0.37	×
	0800	1,423	IP	0.49	×		2000	1,036	IP	0.36	×
	0815	1,723	IP	0.60	×		2015	957	IP	0.33	×
	0830	1,892	IP	0.65	×		2030	812	IP	0.28	×
	0845	1,929	IP	0.67	×		2045	832	IP	0.29	×
	0900	2,056	IP	0.71	×		2100	793	IP	0.27	×
	0915	2,200	IP	0.76	×		2115	815	IP	0.28	×
	0930	2,499	IP	0.86	×		2130	820	IP	0.28	×
	0945	2,564	IP	0.89	×		2145	792	IP	0.27	×
Inter-Peak Period	1000	2,744	IP	0.95	✓		2200	862	IP	0.30	×
	1015	2,583	IP	0.89	×		2215	852	IP	0.29	×
	1030	2,696	IP	0.93	✓		2230	731	IP	0.25	×
	1045	2,894	IP	1.00	✓		2245	769	IP	0.27	×
	1100	2,930	IP	1.01	✓		2300	678	IP	0.23	×
	1115	2,929	IP	1.01	✓		2315	586	IP	0.20	×
	1130	3,014	IP	1.04	✓		2330	546	IP	0.19	×
	1145	2,939	IP	1.02	✓		2345	465	IP	0.16	×
	1200	3,117	IP	1.08	✓		0000	348	IP	0.12	×
	1215	3,013	IP	1.04	✓		0015	323	IP	0.11	×
	1230	3,108	IP	1.08	✓		0030	314	IP	0.11	×
	1245	2,913	IP	1.01	✓		0045	223	IP	0.08	×
	1300	3,123	IP	1.08	✓		0100	273	IP	0.09	×
	1315	2,923	IP	1.01	✓		0115	241	IP	0.08	×
	1330	2,881	IP	1.00	✓		0130	210	IP	0.07	×
	1345	2,784	IP	0.96	✓		0145	174	IP	0.06	×
	1400	2,839	IP	0.98	✓		0200	204	IP	0.07	×
	1415	2,768	IP	0.96	✓		0215	181	IP	0.06	×

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
	1430	2,892	IP	1.00	✓		0230	172	IP	0.06	×
	1445	2,690	IP	0.93	✓		0245	110	IP	0.04	×
	1500	2,712	IP	0.94	✓		0300	147	IP	0.05	×
	1515	2,760	IP	0.95	✓		0315	155	IP	0.05	×
PM Period	1530	2,666	IP	0.92	✓		0330	190	IP	0.07	×
	1545	2,702	IP	0.93	✓		0345	198	IP	0.07	×
	1600	2,686	IP	0.93	✓		0400	186	IP	0.06	×
	1615	2,554	IP	0.88	×		0415	176	IP	0.06	×
	1630	2,502	IP	0.87	×		0430	225	IP	0.08	×
	1645	2,374	IP	0.82	×		0445	269	IP	0.09	×
	1700	2,269	IP	0.79	×		0500	282	IP	0.10	×
	1715	2,034	IP	0.70	×		0515	306	IP	0.11	×
	1730	1,947	IP	0.67	×		0530	369	IP	0.13	×
	1745	1,994	IP	0.69	×		0545	420	IP	0.15	×
	1800	1,972	IP	0.68	×		0600	510	IP	0.18	×
	1815	1,851	IP	0.64	×		0615	583	IP	0.20	×
Off-Peak	1830	1,742	IP	0.60	×		0630	723	IP	0.25	×
	1845	1,596	IP	0.55	×		0645	753	IP	0.26	×

Table 3 – Derivation of Annualisation Factors – Sunday Traffic

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
AM Period	0700	329	IP	0.11	×	Off-Peak	1900	1,022	IP	0.35	×
	0715	400	IP	0.14	×		1915	1,047	IP	0.36	×
	0730	509	IP	0.18	×		1930	951	IP	0.33	×
	0745	520	IP	0.18	×		1945	899	IP	0.31	×
	0800	549	IP	0.19	×		2000	949	IP	0.33	×

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
	0815	575	IP	0.20	×		2015	840	IP	0.29	×
	0830	784	IP	0.27	×		2030	692	IP	0.24	×
	0845	879	IP	0.30	×		2045	752	IP	0.26	×
	0900	1,088	IP	0.38	×		2100	718	IP	0.25	×
	0915	1,338	IP	0.46	×		2115	719	IP	0.25	×
	0930	1,617	IP	0.56	×		2130	609	IP	0.21	×
	0945	1,766	IP	0.61	×		2145	521	IP	0.18	×
Inter-Peak Period	1000	1,965	IP	0.68	×		2200	602	IP	0.21	×
	1015	2,150	IP	0.74	×		2215	489	IP	0.17	×
	1030	2,305	IP	0.80	×		2230	378	IP	0.13	×
	1045	2,491	IP	0.86	×		2245	316	IP	0.11	×
	1100	2,479	IP	0.86	×		2300	294	IP	0.10	×
	1115	2,693	IP	0.93	✓		2315	256	IP	0.09	×
	1130	2,728	IP	0.94	✓		2330	229	IP	0.08	×
	1145	2,902	IP	1.00	✓		2345	188	IP	0.07	×
	1200	2,719	IP	0.94	✓		0000	411	IP	0.14	×
	1215	2,643	IP	0.91	✓		0015	361	IP	0.12	×
	1230	2,748	IP	0.95	✓		0030	289	IP	0.10	×
	1245	2,691	IP	0.93	✓		0045	302	IP	0.10	×
	1300	2,643	IP	0.91	✓		0100	264	IP	0.09	×
	1315	2,407	IP	0.83	×		0115	253	IP	0.09	×
	1330	2,429	IP	0.84	×		0130	191	IP	0.07	×
	1345	2,499	IP	0.86	×		0145	177	IP	0.06	×
	1400	2,650	IP	0.92	✓		0200	189	IP	0.07	×
	1415	2,572	IP	0.89	×		0215	196	IP	0.07	×
	1430	2,444	IP	0.85	×		0230	161	IP	0.06	×
	1445	2,290	IP	0.79	×		0245	143	IP	0.05	×
	1500	2,297	IP	0.79	×		0300	149	IP	0.05	×

Period	Hour	Volume	Donor Model	Factor / Donor	Include	Period	Hour	Volume	Donor Model	Factor / Donor	Include
	1515	2,307	IP	0.80	×		0315	151	IP	0.05	×
PM Period	1530	2,161	IP	0.75	×		0330	151	IP	0.05	×
	1545	2,193	IP	0.76	×		0345	157	IP	0.05	×
	1600	2,289	IP	0.79	×		0400	189	IP	0.07	×
	1615	1,916	IP	0.66	×		0415	153	IP	0.05	×
	1630	1,862	IP	0.64	×		0430	135	IP	0.05	×
	1645	1,654	IP	0.57	×		0445	140	IP	0.05	×
	1700	1,670	IP	0.58	×		0500	169	IP	0.06	×
	1715	1,326	IP	0.46	×		0515	181	IP	0.06	×
	1730	1,363	IP	0.47	×		0530	194	IP	0.07	×
	1745	1,349	IP	0.47	×		0545	204	IP	0.07	×
	1800	1,392	IP	0.48	×		0600	274	IP	0.09	×
	1815	1,289	IP	0.45	×		0615	289	IP	0.10	×
Off-Peak	1830	1,288	IP	0.45	×		0630	354	IP	0.12	×
	1845	1,218	IP	0.42	×		0645	329	IP	0.11	×

2.8 From the calculation set out in the tables above above, the following factors were applied to the relevant modelled hour to include the non-modelled hours into the calculation of the TUBA benefits, thus derive the annualisation factors for the purpose of the TUBA benefits, as provided in Table 4 below.

Table 4 – Annualisation Factors

No	Time Slice	Duration (min)	Traffic Model	Annualisation Factor
1	Weekday AM Period	60	AM Peak Hour Model	1.51 x 253 = 383
2	Weekday Inter-Peak Period	60	Inter-Peak Hour Model	7.23 x 253 = 1,828
3	Weekday PM Period	60	PM Peak Hour model	2.20 x 253 = 556
4	Weekday Off-Peak period	60	Inter-Peak hour model	0.00 x 253 = 0
5	Weekend	60	Inter-Peak hour model	8.06 x 52 = 419
Total annualised Hours				**3,186 hours**

2.9 Around 36% of annual hours are reflected in the annualisation. It is noted that the ATC counts were collected for 2 weeks during November 2016. They therefore do not represent the whole year of traffic travelling within the area, particularly during the summer seasons where weekend traffic volume is likely to be higher than those in November. Furthermore, the ATC counts during November do not include any bank holidays, therefore these benefits are also excluded. The annualisation factors derived for the weekends using November are therefore considered conservative in the calculation of the benefits for the proposed scheme.

Appendix H – Outline Business Case – Response to DfT Queries

Norfolk County Council

GREAT YARMOUTH THIRD RIVER CROSSING

OBC - Response to DfT Modelling Queries

70046035/DFT
OCTOBER 2018

PUBLIC

Norfolk County **Council**

GREAT YARMOUTH THIRD RIVER CROSSING

OBC - Response to DfT Modelling Queries

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70046035

OUR REF. NO. 70046035/DFT

DATE: OCTOBER 2018

Norfolk County **Council**

GREAT YARMOUTH THIRD RIVER CROSSING

OBC - Response to DfT Modelling Queries

WSP

St. Johns House
Queen Street
Manchester
M2 5JB

Phone: +44 161 602 8400

WSP.com

CONTENTS

TABLES

PLATES

ANNEXES

INTRODUCTION

A transport model was developed by WSP in 2017 and used to inform an Outline Business Case (OBC) for the Great Yarmouth Third River Crossing (GYTRC). The OBC was submitted in May 2017 and approved by the Department for Transport (DfT).

Following this WSP contacted the DfT in November 2017 to request any comments on the traffic modelling and economic appraisal. The purpose of this was to ascertain what the DfT requirements would be for Full Business Case (FBC) approval, and to ensure there was sufficient time in which to address their comments.

On 22nd December 2017 WSP received an email from Betty Leow of the DfT. The email stated four points for further consideration while progressing to FBC submission. A further email was received by Norfolk County Council (NCC) on 18th June 2018 from Betty Leow, in which two additional points (4 and 5 below) were also added for consideration for the FBC submission. The six points were:

1 Have there been any significant changes to the scheme design/assumptions since the OBC stage? What are the impacts of these changes to the modelling and appraisal? For example, there is a possibility that Highways England might undertake some work improving A47 Harfrey's Roundabout.

2 The traffic for less important areas of the town has been updated from its original 2008 base year but the methodology is not well aligned to DfT guidance and is likely to introduce some errors in the estimated travel pattern in the base year. Is there any scope to reduce this uncertainty? I remember some recent RSIs data were processed but not incorporated into the model update due to the time constraint for OBC submission. I'd just like to emphasize this does not mean a major model update.

3 Comments from James Canton - There are some gaps in the analysis which need to be addressed (e.g. around Noise, Air Quality and Affordability). Also, the presentation of the results from the DI appraisal does not follow WebTAG guidance and will need to be updated (see comments 15 and 16 in the attached).

4 The forecasting should include a review on the Uncertainty Log, update as appropriate and update matrices and networks accordingly.

5 DfT will publish Road Traffic Forecasts end of this month. This publication updates previous forecasts published in 2015 (RTF15), setting out forecasts of traffic, congestion and emissions to 2050. It would be necessary to produce updated traffic forecasts with/without the scheme in line with latest versions of NTEM and RTF.

6 Whether the latest WebTAG have any impacts on the scheme appraisal. Please see TAG Forthcoming Changes Overview document

This document provides responses to all six of the points above. Many of the points can be addressed directly, so the focus of the document will be providing additional evidence to address point 2 which relates to the matrix build methodology and the matrix integrity results.

POINT 1 - CHANGES SINCE OUTLINE BUSINESS CASE (OBC) SUBMISSION

The transport model used to support the OBC was developed in 2017 and had a base year of 2016. Recently the SATURN highway and CUBE demand model has been updated to inform the Transport Assessment (TA) which in turn feeds into the Environmental Statement (ES) and Development Consent Order (DCO) submission.

The TA has a requirement for a base year of 2018. Following a comparison of traffic counts and land use data from both 2016 and 2018 the model was updated to represent 2018 flows. The model network was updated to include the recently completed scheme at Fullers roundabout along with the improvements on North Quay and The Conge. It is envisaged the 2018 base year model will be used for developing the final forecast models for the Final Business Case (FBC) submission.

As before demand was forecasted to 2023 (opening year), 2038 (design year) and 2051 (final forecast year). Committed land use development sites were included with the same trip generation and build out rates as used in the OBC modelling. These are still the anticipated forecast years to be used for FBC submission.

The forecast network now includes three committed highway schemes that had not been included in the OBC modelling; the Highways England junction improvements at both Gapton and Vauxhall roundabouts, and improvements to the rail station access on the A149. These schemes are included in both the Do Minimum and Do Something models. The bridge signal timings have also been recalculated. There is now slightly less green time on the GYTRC than modelled for OBC submission. This reduces the additional network capacity the TRC provides. These additional committed highway schemes and bridge signal timings changes will be carried forward to FBC modelling.

POINT 2 - MATRIX BUILD METHODOLOGY

BACKGROUND

The model matrices were constructed from the following data sources:

- Road Side Interview (RSI) data from four sites, two on the peninsula, and one each at Haven and Breydon bridges. These sites were selected to observe vehicle movements that are likely to be impacted by the TRC;
- Trafficmaster Origin Destination (TMOD) data was used to supplement the RSI data collected at Site 3 – Breydon bridge. This RSI site yielded a lower sample rate due to it being conducted by postcard surveys, the TMOD data was used to boost the sample, with some compromise required on knowledge of purpose. TMOD data is more strategic and therefore was only suited to be used for Site 3 which is on the trunk road network and will carried longer distance trips;
- Prior 2008 model matrices factored to 2016. These are referred to as background matrices.

The RSI / TMOD partial matrices were merged with the background matrices subject to the relative confidence in each dataset in order to produce prior matrices that contained both observed (RSI / TMOD) and unobserved movements (background matrices). Full details of the prior matrix construction are given in Chapter 7 of the Local Model Validation Report (LMVR).

The prior matrices were then subjected to a Matrix Estimation (ME) process, the results of which did not fully satisfy the criteria specified in DfT TAG Unit M3.1.

However, the model performs well against DfT TAG criteria for link and screenline calibration and validation, and for journey time validation.

In order to investigate confidence in the modelled Origin Destination (OD) movements this section contains the following:

- Additional RSI data analysis – there were five sites that were not used in the matrix build process due to time constraints, these are compared to the modelled OD movements;
- TMOD data – provision of further information on this dataset and comparison with other data sources;
- Comparison of model purpose splits with national and local data; and
- Further information on sector changes brought about by Matrix Estimation (ME).

ADDITIONAL RSI DATA

A set of nine RSIs were commissioned in November 2016 that involved both face to face and postcard interviews with drivers in various locations around Great Yarmouth to gather data concerning origin / destination and trip purpose.

Survey locations are shown in Plate 1 and listed in Table 1.

Plate 1 Road Side Interview Locations for Great Yarmouth

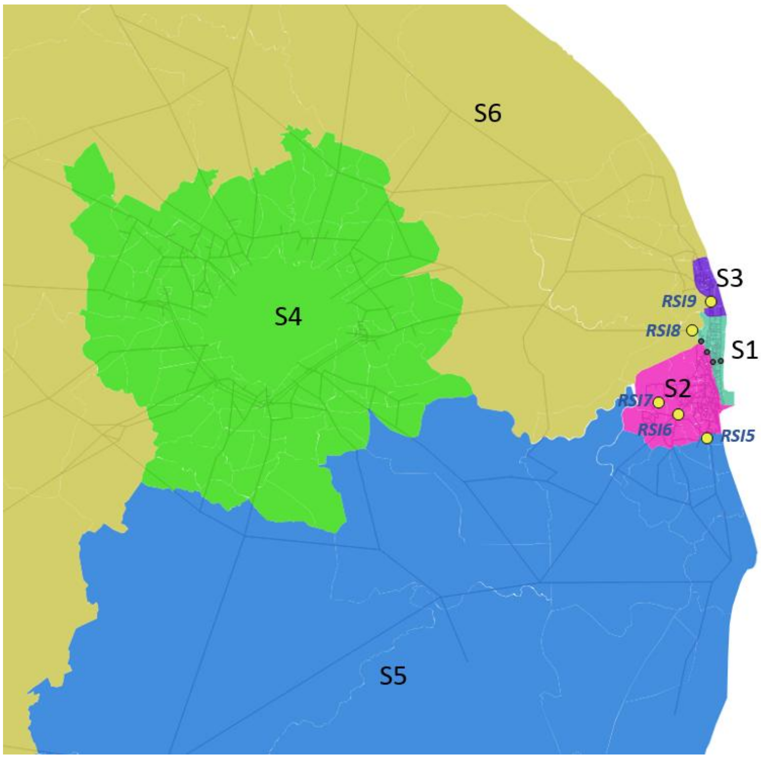
Table 1 Road Side Interview Site Descriptions Great Yarmouth

Site	Location	RSI Direction
1	South Quay	NB
2	Marine Parade	NB
3	A47 (formerly A12) (for Breydon Bridge)	NB
4	A149 Haven Bridge	WB
5	A47 (formerly A12) Lowestoft Road	SB
6	A143 Beccles Road	SB
7	Mill Road	SB
8	A47 New Road	WB
9	Yarmouth Road	NB

Of the RSIs listed, only sites 1-4, South Quay, Marine Parade, the A47 (Breydon Bridge) and Haven Bridge were used in the RSI matrix building.

The remaining sites were unused due to time constraints in the model build process. As such they provide an independent source of origin and destination data that can be compared to the final model matrices. A select link analysis of the final base year assigned matrices at the relevant RSI site location was compared to the RSI data. Given the sample sizes associated with RSI sites and in order to provide a meaningful comparison zonal trips were aggregated to a sector system. The original sector system used for reporting in the LMVR comprised of 10 sectors. Given the sample size being compared and the location of the RSIs, this sector system was further aggregated to a 6 sector system. The three Great Yarmouth town sectors were merged into one, and the external sectors were reduced to three – north, Norwich and south (including Lowestoft). The remaining two sectors cover Caister and the area immediately south of Great Yarmouth (includes Southtown, Bradwell and Gorleston). The sector system and RSI site locations are shown in below. These sectors cover a mix of localised Yarmouth trips (both town centre and suburban). Longer distance trips from Norwich and longer distance trips from areas to West/North and South of the town.

Plate 2 Sector system for Select Link Analysis and Road Side Interview data comparison



Sector	Description
S1	Great Yarmouth
S2	Area south of Great Yarmouth
S3	Caister
S4	Norwich
S5	South
S6	North

Car trips were compared by all purposes, LGV and HGV trips were not compared due to low sample sizes.

To review the trip distribution by site the percentage of sector to sector trips from the SLA were subtracted from the percentage of sector to sector trips from the RSI. The comparison for AM, IP and PM of RSI sites 5–9 are given below. Differences of greater than 5% are highlighted, red if the SLA is over 5% greater than the RSI, green if the RSI is over 5% greater than the SLA.

RSI 5 – A47 (FORMERLY A12) LOWESTOFT ROAD SB

Table 2 – Comparison of RSI and SLA sector to sector car movements for AM (RSI minus SLA) at RSI 5

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	3%	0%	0%	-12%	0%	**-10%**
2 – South of GY	0%	18%	0%	0%	-9%	0%	**9%**
3 – Caister	0%	1%	0%	0%	1%	0%	**3%**
4 – Norwich	0%	1%	0%	0%	-1%	0%	**0%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	4%	0%	0%	-6%	0%	**-2%**
Total	**0%**	**27%**	**0%**	**0%**	**-28%**	**0%**	**0%**

Table 3 – Comparison of RSI and SLA sector to sector car movements for IP (RSI minus SLA) at RSI 5

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	5%	0%	0%	-15%	0%	**-10%**
2 – South of GY	0%	21%	0%	1%	-5%	0%	**17%**
3 – Caister	0%	1%	0%	0%	-1%	0%	**0%**
4 – Norwich	0%	1%	0%	0%	-1%	0%	**0%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	3%	0%	0%	-9%	0%	**-7%**
Total	**0%**	**30%**	**0%**	**1%**	**-31%**	**0%**	**0%**

Table 4 – Comparison of RSI and SLA sector to sector car movements for PM (RSI minus SLA) at RSI 5

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	3%	0%	0%	-10%	0%	**-7%**
2 – South of GY	0%	16%	0%	0%	-6%	-1%	**9%**
3 – Caister	0%	0%	0%	0%	0%	0%	**1%**
4 – Norwich	0%	0%	0%	0%	-3%	0%	**-3%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	1%	0%	0%	-2%	0%	**0%**
Total	**0%**	**20%**	**0%**	**0%**	**-20%**	**-1%**	**0%**

Comparison between the RSI and SLA distribution is consistent across all time periods and generally the distribution comparison appears reasonable. However, the RSI produces a higher proportion of trips that begin and end in Sector 2. Examination of the RSI interview data shows that these intra sector trips are east west movements along the sector boundary (between Sector 2 and Sector 5) to and from Belton, presumably using Beaufort Way. The RSI surveys at the A47 / Links Rd / Beaufort Way roundabout were conducted on the west, north and east arms, and while the interviews on the west and east side arms captured southbound movements on the A47 towards Lowestoft, it is also likely they would intercept east west movements. The SLA data has been taken from the north arm only and as such, will not capture many of the east west movements. In addition, the zone granularity in the south west of Sector 2 around Belton is coarse with relatively large zones (i.e. Belton itself is represented as a single zone) meaning that trips are likely to route via other east west links.

The SLA is also producing a slightly higher proportion of trips from Sector 1 than the RSI, but otherwise the remaining trip distribution comparison is reasonable.

Sample size – AM (RSI/SLA) 226/626, IP 641/646 and PM 208/1240

RSI 6 – A143 BECCLES ROAD SB

Table 5 – Comparison of RSI and SLA sector to sector car movements for AM (RSI minus SLA) at RSI 6

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	2%	0%	0%	-1%	0%	**1%**
2 – South of GY	0%	-13%	0%	4%	3%	-1%	**-7%**
3 – Caister	0%	1%	0%	0%	2%	0%	**3%**
4 – Norwich	0%	0%	0%	0%	1%	0%	**0%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	1%	0%	0%	3%	0%	**3%**
Total	**0%**	**-10%**	**0%**	**4%**	**7%**	**-1%**	**0%**

Table 6 – Comparison of RSI and SLA sector to sector car movements for IP (RSI minus SLA) at RSI 6

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	7%	0%	1%	2%	0%	**9%**
2 – South of GY	0%	0%	0%	1%	-16%	-2%	**-16%**
3 – Caister	0%	1%	0%	0%	0%	0%	**1%**
4 – Norwich	0%	1%	0%	0%	1%	0%	**1%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	3%	0%	0%	2%	0%	**5%**
Total	**0%**	**12%**	**0%**	**2%**	**-12%**	**-2%**	**0%**

Table 7 – Comparison of RSI and SLA sector to sector car movements for PM (RSI minus SLA) at RSI 6

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	7%	0%	1%	5%	0%	**12%**
2 – South of GY	0%	3%	0%	1%	-15%	-4%	**-15%**
3 – Caister	0%	0%	0%	0%	-1%	0%	**-1%**
4 – Norwich	0%	1%	0%	0%	0%	0%	**1%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	1%	0%	0%	2%	0%	**3%**
Total	**0%**	**11%**	**0%**	**2%**	**-9%**	**-4%**	**0%**

The comparison between trip distributions shows reasonable fit across all time periods. The main variations are intra-sector movements in AM for sector 2, and sector 2 to sector 5 movements in the IP and PM. In all cases the SLA proportion is higher than the RSI. The proportion of trips from sector 2 is also higher in the SLA compared to the RSI, this is more evident in the IP and PM, and is at the expense of trips from Sector 1. This is the opposite of the pattern shown by RSI 5, which may suggest a routing issue, as the sites are on adjacent routes.

Sample size – AM (RSI/SLA) 155/379, IP 347/341 and PM 172/513.

RSI 7 – MILL ROAD SB

Table 8 – Comparison of RSI and SLA sector to sector car movements for AM (RSI minus SLA) at RSI 7

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	-47%	0%	0%	0%	0%	**-47%**
2 – South of GY	0%	50%	0%	0%	13%	0%	**63%**
3 – Caister	0%	3%	0%	0%	0%	0%	**3%**
4 – Norwich	0%	-7%	0%	0%	0%	0%	**-7%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	-15%	0%	0%	2%	0%	**-12%**
Total	**0%**	**-15%**	**0%**	**0%**	**15%**	**0%**	**0%**

Table 9 – Comparison of RSI and SLA sector to sector car movements for IP (RSI minus SLA) at RSI 7

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	-29%	0%	0%	1%	0%	**-28%**
2 – South of GY	0%	42%	0%	0%	5%	0%	**47%**
3 – Caister	0%	-4%	0%	0%	0%	0%	**-4%**
4 – Norwich	0%	-2%	0%	0%	0%	0%	**-2%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	-13%	0%	0%	0%	0%	**-13%**
Total	**0%**	**-6%**	**0%**	**0%**	**6%**	**0%**	**0%**

Table 10 – Comparison of RSI and SLA sector to sector car movements for PM (RSI minus SLA) at RSI 7

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	-3%	0%	0%	3%	0%	**-1%**
2 – South of GY	0%	7%	0%	0%	7%	0%	**14%**
3 – Caister	0%	1%	0%	0%	0%	0%	**1%**
4 – Norwich	0%	-5%	0%	0%	0%	0%	**-5%**
5 – South	0%	0%	0%	0%	0%	0%	**0%**
6 - North	0%	-10%	0%	0%	0%	0%	**-10%**
Total	**0%**	**-9%**	**0%**	**0%**	**9%**	**0%**	**0%**

This site is on a relatively low flow link and as such there will be large percentage differences based on small trip numbers. The major difference in distribution is a higher proportion from sector 1 in the SLA as opposed to sector 2 in the RSI distribution. This occurs in both the AM and IP periods.

Sample size – AM (RSI/SLA) 46/83, IP 152/115 and PM 76/200.

RSI 8 – A47 NEW ROAD NB

Table 11 – Comparison of RSI and SLA sector to sector car movements for AM (RSI minus SLA) at RSI 8

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	-5%	0%	0%	2%	-2%	-1%	**-5%**
2 – South of GY	-2%	0%	0%	6%	0%	-2%	**2%**
3 – Caister	0%	0%	0%	0%	0%	1%	**1%**
4 – Norwich	0%	0%	0%	0%	0%	0%	**0%**
5 – South	0%	0%	0%	4%	0%	-1%	**2%**
6 - North	0%	0%	0%	0%	0%	0%	**0%**
Total	**-7%**	**0%**	**0%**	**12%**	**-2%**	**-3%**	**0%**

Table 12 – Comparison of RSI and SLA sector to sector car movements for IP (RSI minus SLA) at RSI 8

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	-3%	0%	0%	1%	-1%	-1%	**-4%**
2 – South of GY	-1%	0%	0%	4%	-1%	-1%	**1%**
3 – Caister	0%	0%	0%	1%	0%	0%	**2%**
4 – Norwich	0%	0%	0%	0%	0%	0%	**0%**
5 – South	0%	0%	0%	6%	0%	-4%	**2%**
6 - North	0%	0%	0%	0%	0%	0%	**0%**
Total	**-4%**	**0%**	**0%**	**13%**	**-2%**	**-6%**	**0%**

Table 13 – Comparison of RSI and SLA sector to sector car movements for PM (RSI minus SLA) at RSI 8

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	-7%	0%	0%	7%	-1%	2%	**1%**
2 – South of GY	-1%	0%	0%	2%	-1%	-7%	**-6%**
3 – Caister	0%	0%	0%	0%	0%	0%	**0%**
4 – Norwich	0%	0%	0%	0%	0%	0%	**0%**
5 – South	0%	0%	0%	9%	-1%	-2%	**5%**
6 - North	0%	0%	0%	0%	0%	0%	**0%**
Total	**-9%**	**0%**	**0%**	**18%**	**-2%**	**-7%**	**0%**

The comparison between trip distributions shows reasonable fit across all time periods. The SLA shows a greater proportion of trips with a destination in sector 4 than the RSI which shows more trips with destinations in sectors 1 and 6. The trips to sector 1 are all to a zone representing the Vauxhall Holiday Park which is just north of the RSI site. Accepting that this skews the results for sector 1 means the main difference is between destinations of sectors 4 and 6.

Sample size – AM (RSI/SLA) 229/534, IP 419/546 and PM 266/777.

RSI 9 – YARMOUTH ROAD NB

Table 14 – Comparison of RSI and SLA sector to sector car movements for AM (RSI minus SLA) at RSI 9

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	1%	1%	6%	0%	0%	-9%	**0%**
2 – South of GY	0%	0%	8%	1%	0%	-9%	**1%**
3 – Caister	0%	0%	-2%	0%	0%	-1%	**-2%**
4 – Norwich	0%	0%	0%	0%	0%	0%	**1%**
5 – South	0%	0%	0%	0%	0%	2%	**3%**
6 - North	0%	0%	-4%	0%	0%	1%	**-3%**
Total	**1%**	**2%**	**8%**	**3%**	**1%**	**-15%**	**0%**

Table 15 – Comparison of RSI and SLA sector to sector car movements for IP (RSI minus SLA) at RSI 9

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	1%	-4%	1%	0%	0%	**-2%**
2 – South of GY	0%	0%	1%	1%	0%	-2%	**-1%**
3 – Caister	0%	0%	1%	0%	0%	0%	**1%**
4 – Norwich	0%	0%	0%	0%	0%	0%	**0%**
5 – South	0%	0%	2%	0%	0%	1%	**3%**
6 - North	0%	0%	-2%	0%	0%	0%	**-2%**
Total	**0%**	**1%**	**-2%**	**2%**	**0%**	**-1%**	**0%**

Table 16 – Comparison of RSI and SLA sector to sector car movements for PM (RSI minus SLA) at RSI 9

Sector	1	2	3	4	5	6	Total
1 – Great Yarmouth	0%	0%	3%	0%	0%	5%	**8%**
2 – South of GY	0%	0%	-7%	1%	0%	-7%	**-12%**
3 – Caister	0%	0%	0%	0%	0%	1%	**1%**
4 – Norwich	0%	0%	0%	0%	0%	0%	**0%**
5 – South	0%	0%	1%	0%	0%	2%	**4%**
6 - North	0%	0%	-1%	0%	0%	0%	**-1%**
Total	**1%**	**0%**	**-3%**	**1%**	**0%**	**1%**	**0%**

The comparison between trip distributions varies across each time period. In the AM period the RSI shows a higher proportion of trips to sector 3, whereas the SLA shows a higher proportion to sector 6. In the PM period the RSI shows a higher proportion of trips from sector 1, the SLA shows a higher proportion from sector 2.

Sample size – AM (RSI/SLA) 201/470, IP 809/724 and PM 276/1108.

SUMMARY OF RSI COMPARISON

The five unused RSIs have been compared to SLAs from the base model on a sectoral level. The sector system has been aggregated from that reported in the LMVR in order to provide a meaningful comparison with regard to traffic movements that have the potential to be influenced by the Third River Crossing (TRC). With that in mind it is the comparisons at RSI 5 and RSI 6 that are worth focussing on, specifically the difference in movements from sector 1 which is likely to be the movement influenced by the TRC. Compared to the RSI data, RSI5 has a higher proportion from sector 1 and RSI 6 a lower proportion from sector 1. This is likely to be caused by routing issues influenced by network density and zone granularity towards the edge of the simulation network. Overall the movements influenced by TRC are appropriately modelled.

TRAFFICMASTER OD DATA

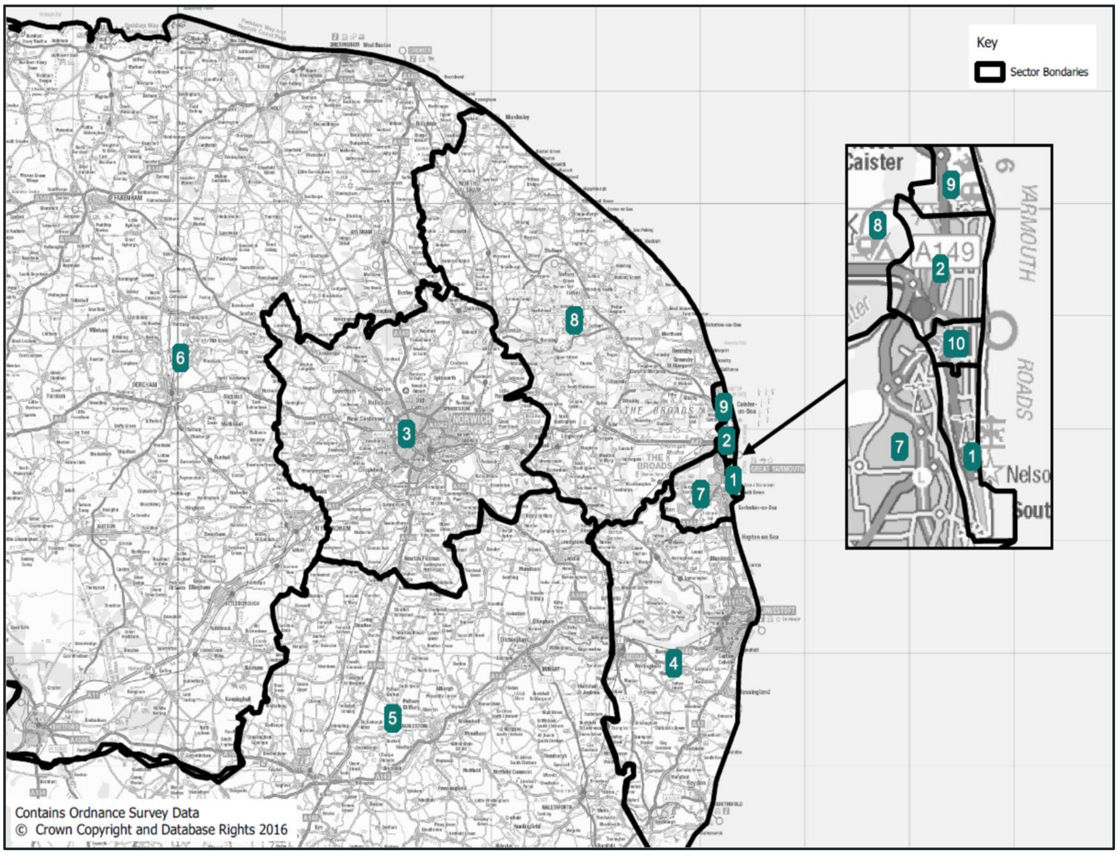
Trafficmaster Origin Destination (TMOD) data was used to supplement the RSI data collected at Site 3 – Breydon Bridge. This section provides a comparison of TMOD with other data sources.

COMPARISON WITH NATIONAL TRIP END MODEL (NTEM)

The proportion of trip ends on a sectoral level was compared between NTEM and TMOD. This made use of the 10 sector system. The sector system is shown in

Plate 3 below.

Plate 3 Great Yarmouth sector system



Tripend proportions for all purpose car trips are shown in the Plates below. Sectors 3, 5 and 6 were not included in the analysis. Overall the comparison shows that both datasets identify sector 4 as the largest trip generator, with mid-town (sector 10) and lower peninsula (sector 1) lowest trip generator. Both datasets show evidence of tidality in sectors 2 and 4. Sector 2 has more destinations than origins in the AM, and more origins than destinations in the PM. This is reversed for sector 4.

Plate 4 Comparison of TEMPRO and TM OD proportions per sector – AM peak

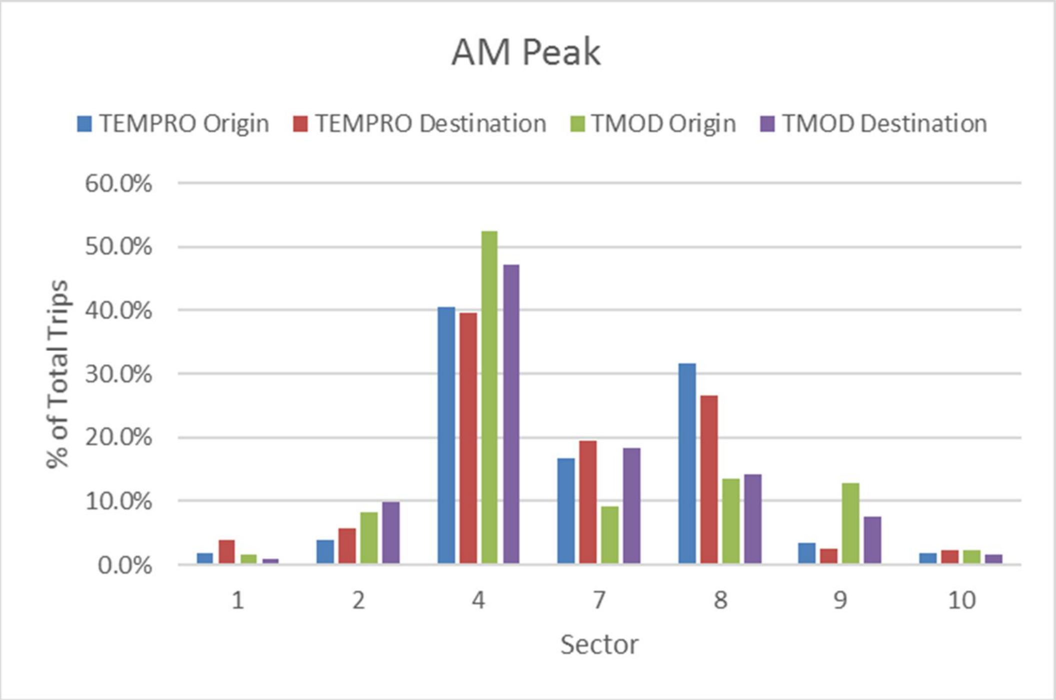


Plate 5 Comparison of TEMPRO and TM OD proportions per sector – IP

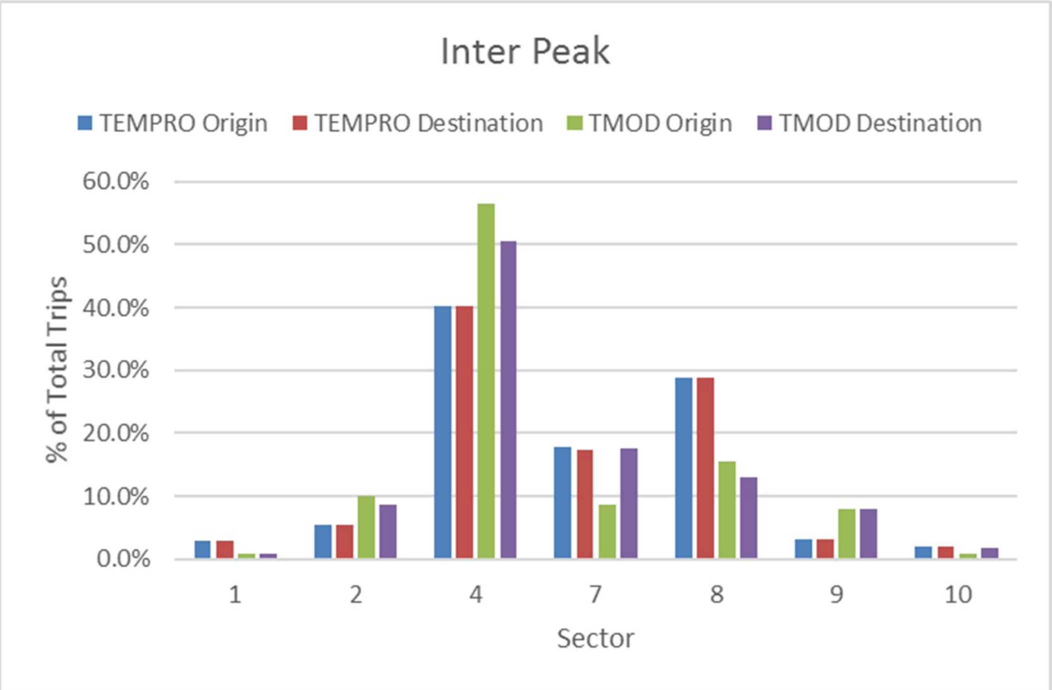
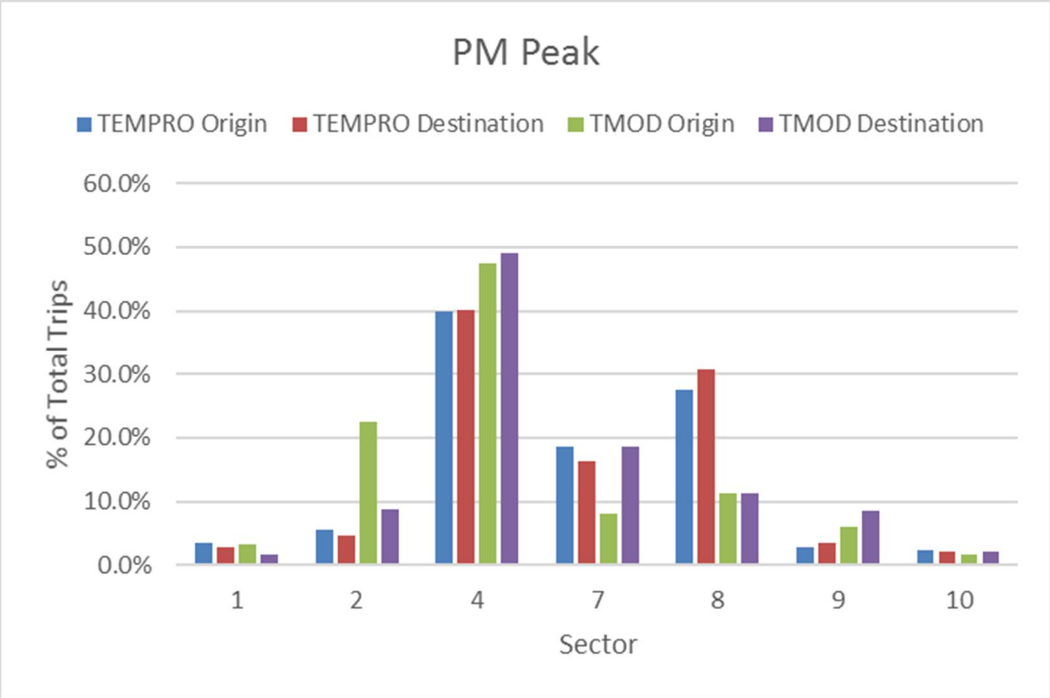


Plate 6 Comparison of TEMPRO and TM OD proportions per sector – PM peak



COMPARISON WITH NATIONAL TRAVEL SURVEY

The TMOD matrices were assigned in isolation to the network and the average trip length and time was calculated. This was compared to National Travel Survey (NTS) average trip length and time for cars and vans from the 2015 survey. The results are presented in Table 17 below.

Table 17 – Comparison of NTS and TMOD trip length and time

	NTS (2015)	TMOD
Average Trip Length (miles)	8.6	9.0
Average Trip Time (minutes)	21.9	16.9

Average trip lengths are very similar. Average travel time for TMOD data is quicker than NTS, this will be due to being assigned in isolation, i.e. on a network with lees traffic than it would normally have resulting in less delay.

MODE PURPOSE SPLITS

The final (post ME) base year matrices displayed a mode purpose split that was slightly different to the expected purpose splits, based on national averages. The final mode purpose splits are presented in Table 18,

Table 19 and

Table 20, compared with national, district and local MSOAs that comprise Great Yarmouth town centre. All purpose splits are derived from NTEM using TEMPRO software.

Table 18 – Mode purpose split comparison AM

AM Peak	Base Model (Post ME)		Tempro GB		Tempro Gt Yarmouth		Tempro Gt Yarmouth 005 and 006 (Town Centre and Peninsula)	
	Trips	% of Car	Trips	% of Car	Trips	% of Car	Trips	% of Car
Car Work	5,114	36.9%	15,309,092	55.1%	21,471	48.0%	4,255	48.1%
Car Employer Business	868	6.3%	2,428,150	8.7%	3,608	8.1%	748	8.5%
Car Other	7,895	56.9%	10,066,822	36.2%	19,688	44.0%	3,837	43.4%
Total	13,877		27,804,064		44,767		8,840	

Table 19 – Mode purpose split comparison IP

Inter Peak	Base Model (Post ME)		Tempro GB		Tempro Gt Yarmouth		Tempro Gt Yarmouth 005 and 006 (Town Centre and Peninsula)	
	Trips	% of Car	Trips	% of Car	Trips	% of Car	Trips	% of Car
Car Work	1,507	12.1%	6,650,520	14.2%	9,842	10.9%	1,973	10.1%
Car Employer Business	950	7.6%	4,084,316	8.7%	6,162	6.8%	1,411	7.2%
Car Other	9,967	80.2%	36,037,780	77.0%	74,133	82.2%	16,197	82.7%
Total	12,424		46,772,616		90,137		19,581	

Table 20 – Mode purpose split comparison PM

PM Peak	Base Model (Post ME)		Tempro GB		Tempro Gt Yarmouth		Tempro Gt Yarmouth 005 and 006 (Town Centre and Peninsula)	
	Trips	% of Car	Trips	% of Car	Trips	% of Car	Trips	% of Car
Car Work	4,605	29.6%	11,325,044	37.5%	16,224	31.3%	3,133	28.6%
Car Employer Business	895	5.7%	2,315,422	7.7%	3,450	6.6%	728	6.7%
Car Other	10,082	64.7%	16,571,762	54.9%	32,212	62.1%	7,083	64.7%
Total	15,582		30,212,228		51,886		10,944	

From the tables above, it can be seen that the base model purpose splits align more closely to the local purpose splits (GY district and town centre) than the national. The comparison is good for IP and PM periods. In the AM period other purpose trips occur at the expense of work trips, though the model data again compares better with local rather than national data, indicating that there are possible reasons for this.

SECTOR CHANGES DUE TO MATRIX ESTIMATION

The changes in sector to sector movement due to matrix estimation were presented in Section 9.3.4 of the LMVR. A six sector system was used and many of the sector changes did not meet the TAG criteria of within 5%.

In order to allay fears that the impact of matrix estimation may be overestimating the benefits of the TRC, the sectoral changes were re-examined, this time using the 10 sector system used in the economic reporting. The key movements that are most likely to use or be directly impact by the new bridge were identified and the change in trip movements was quantified to provide a monetised value of benefit. The sectoral changes due to matrix estimation are presented in Table 21 to

Table 26 below, both in absolute and % terms.

Table 21 – Sector to sector changes due to matrix estimation (Post – Prior), all vehicles, AM

Sector	1	2	3	4	5	6	7	8	9	10	Total
1 -Peninsula	21	36	-32	-40	-1	-11	14	-2	36	23	45
2 - Great Yarmouth north	84	82	7	26	6	-9	224	-15	-27	5	384
3 - Norwich	-25	-57	0	25	0	0	20	0	5	-5	-37
4 - Lowestoft	-83	41	-19	83	9	-14	-129	-29	-8	33	-116
5 - South of England	-6	-2	0	-1	0	0	12	0	0	-3	1
6 - North and RUK	-3	3	0	-8	0	0	46	0	0	0	38
7 - Gorleston and Bradwell	-6	179	-10	-42	51	-4	596	8	-9	239	1001
8 – North of Great Yarmouth	33	40	-1	-20	-2	-3	-45	-7	45	9	49
9 - Caister-on-Sea	29	64	-10	-5	-1	-5	-6	10	0	30	107
10 - Great Yarmouth mid-town	15	94	-13	-22	-1	-7	43	2	6	6	122

Table 22 – Percentage sector to sector changes due to matrix estimation (Post – Prior), all vehicles, AM

Sector	1	2	3	4	5	6	7	8	9	10	Total
1 -Peninsula	18.5%	35.5%	-52.3%	-33.2%	-9.8%	-67.6%	8.8%	-3.5%	62.5%	41.9%	6.1%
2 - Great Yarmouth north	78.6%	27.1%	8.3%	49.0%	48.1%	-18.2%	91.9%	-13.3%	-9.4%	2.8%	26.6%
3 - Norwich	-31.6%	-37.6%	0.0%	72.6%	0.0%	0.0%	7.9%	0.0%	16.2%	-11.6%	-5.7%
4 - Lowestoft	-37.7%	40.9%	-20.1%	217.0%	190.3%	-5.5%	-8.7%	-44.1%	-45.4%	32.2%	-4.9%
5 - South of England	-33.7%	-5.8%	0.0%	-6.2%	0.0%	0.0%	16.4%	-0.1%	10.3%	-21.9%	0.7%
6 - North and RUK	-12.3%	6.9%	0.0%	-7.0%	0.0%	0.0%	23.4%	0.3%	-0.4%	5.9%	9.6%
7 - Gorleston and Bradwell	-2.2%	56.5%	-4.2%	-4.3%	47.0%	-2.7%	14.8%	4.9%	-13.3%	89.9%	15.2%
8 – North of Great Yarmouth	24.8%	16.5%	-0.9%	-17.7%	-13.2%	-6.2%	-12.4%	-3.3%	15.9%	5.6%	2.9%
9 - Caister-on-Sea	36.0%	28.7%	-12.7%	-19.8%	-8.9%	-8.4%	-3.6%	4.3%	0.0%	17.3%	7.3%
10 - Great Yarmouth mid-town	28.7%	85.7%	-28.9%	-30.0%	-17.5%	-32.2%	34.9%	4.8%	9.6%	21.5%	21.4%

Table 23 – Sector to sector changes due to matrix estimation (Post – Prior), all vehicles, IP

Sector	1	2	3	4	5	6	7	8	9	10	Total
1 -Peninsula	16	44	-24	-4	1	-8	32	-4	32	49	133
2 - Great Yarmouth north	72	10	-27	-10	-9	50	151	-33	16	89	308
3 - Norwich	-7	-28	0	0	0	0	22	-1	-2	-7	-22
4 - Lowestoft	-46	-16	0	37	4	-54	89	-30	-10	5	-20
5 - South of England	-8	-12	0	1	0	0	33	-1	-1	0	11
6 - North and RUK	-3	13	0	-17	0	0	8	0	-2	-4	-5
7 - Gorleston and Bradwell	18	100	29	57	39	12	130	8	12	186	591
8 – North of Great Yarmouth	7	-48	-1	-13	0	0	4	-8	-11	0	-71
9 - Caister-on-Sea	17	-43	-3	-6	-1	-2	31	-22	-13	22	-20
10 - Great Yarmouth mid-town	38	62	22	-34	-3	11	5	-20	2	-1	83

Table 24 – Percentage sector to sector changes due to matrix estimation (Post – Prior), all vehicles, IP

Sector	1	2	3	4	5	6	7	8	9	10	Total
1 -Peninsula	10.1%	33.6%	-50.9%	-5.3%	5.7%	-32.5%	17.7%	-6.6%	68.9%	65.5%	16.6%
2 - Great Yarmouth north	60.6%	2.9%	-42.7%	-11.6%	-32.5%	109.9%	43.3%	-14.1%	4.3%	73.9%	17.5%
3 - Norwich	-16.4%	-57.6%	0.0%	1.6%	0.0%	0.0%	13.9%	-3.1%	-7.3%	-22.4%	-5.8%
4 - Lowestoft	-46.7%	-23.4%	0.4%	113.0%	42.7%	-28.0%	9.6%	-49.7%	-48.3%	4.6%	-1.3%
5 - South of England	-41.9%	-49.9%	0.0%	5.1%	0.0%	0.0%	45.1%	-7.6%	-23.6%	1.3%	7.1%
6 - North and RUK	-19.5%	29.5%	0.0%	-16.2%	0.0%	0.0%	5.8%	-2.3%	-10.6%	-18.9%	-1.5%
7 - Gorleston and Bradwell	9.0%	32.2%	23.1%	6.6%	70.7%	13.3%	3.1%	3.7%	11.7%	67.3%	9.2%
8 – North of Great Yarmouth	10.7%	-24.2%	-3.0%	-20.5%	-5.4%	-2.0%	1.6%	-10.7%	-4.3%	0.3%	-6.9%
9 - Caister-on-Sea	35.5%	-13.5%	-9.3%	-28.7%	-9.8%	-8.3%	28.8%	-9.4%	-3.2%	20.2%	-1.6%
10 - Great Yarmouth mid-town	52.8%	53.9%	56.5%	-33.9%	-17.2%	40.7%	2.3%	-18.2%	1.8%	-4.6%	10.0%

Table 25 – Sector to sector changes due to matrix estimation (Post – Prior), all vehicles, PM

Sector	1	2	3	4	5	6	7	8	9	10	Total
1 -Peninsula	75	93	0	-39	0	-3	8	-24	-9	64	163
2 - Great Yarmouth north	76	90	-4	31	2	-19	127	-69	6	77	319
3 - Norwich	14	3	0	4	0	0	97	0	7	-8	118
4 - Lowestoft	-94	17	4	45	9	4	153	-6	4	-74	60
5 - South of England	-5	-1	0	10	0	0	86	0	0	-11	78
6 - North and RUK	4	-21	0	-2	0	0	61	0	-5	-10	28
7 - Gorleston and Bradwell	-41	182	23	-11	16	8	514	88	117	108	1006
8 – North of Great Yarmouth	10	-60	0	-20	0	0	-16	-7	-13	19	-88
9 - Caister-on-Sea	-3	-8	2	-5	0	0	-22	-1	-21	11	-47
10 - Great Yarmouth mid-town	63	173	20	-2	-4	1	-7	-3	-12	3	231

Table 26 – Percentage sector to sector changes due to matrix estimation (Post – Prior), all vehicles, IP

Sector	1	2	3	4	5	6	7	8	9	10	Total
1 -Peninsula	55.4%	110.4 %	-0.1%	-21.4%	-2.1%	-23.5%	3.2%	-14.7%	-10.5%	92.8%	15.2%
2 - Great Yarmouth north	81.0%	26.5%	-3.6%	25.9%	10.2%	-49.5%	37.3%	-31.5%	2.0%	43.5%	18.2%
3 - Norwich	35.2%	3.6%	0.0%	8.0%	0.0%	0.0%	39.1%	-0.1%	8.6%	-15.0%	18.5%
4 - Lowestoft	-81.2%	31.1%	39.2%	143.3 %	147.8 %	2.1%	15.8%	-6.5%	10.9%	-64.9%	3.8%
5 - South of England	-42.7%	-6.0%	0.0%	228.2 %	0.0%	0.0%	82.3%	-2.1%	-4.3%	-67.2%	45.4%
6 - North and RUK	47.2%	-36.5%	0.0%	-2.3%	0.0%	0.0%	37.3%	-0.2%	-8.0%	-52.8%	6.7%
7 - Gorleston and Bradwell	-23.5%	59.6%	8.9%	-0.7%	32.5%	5.8%	11.5%	23.0%	65.1%	52.3%	13.1%
8 – North of Great Yarmouth	21.1%	-38.6%	0.0%	-24.5%	-0.2%	-0.3%	-8.0%	-3.8%	-4.3%	22.1%	-7.8%
9 - Caister-on-Sea	-7.5%	-3.4%	6.8%	-17.0%	-25.9%	-4.3%	-22.2%	-0.2%	-4.5%	12.9%	-3.7%
10 - Great Yarmouth mid-town	88.4%	115.5 %	54.0%	-3.8%	-39.8%	8.4%	-3.7%	-2.3%	-7.9%	10.9%	27.6%

The majority of sector to sector changes are less than 100 trips, but given the small numbers of trips on some of the sectors this produces a percentage change that is not within TAG criteria of 5% difference.

The sector movements that would benefits from the opening of the TRC are highlighted in red in the tables above. The total change in number of trips for each time period is; AM -122, IP -7 and PM -171. An approximate economic cost has been calculated based upon an average time saving between the DM and DS models for a zone pair that would use the TRC. Over a 60 year appraisal period the benefit is calculated to be -£1,492,600 (2010 prices discounted to 2010). For reference, the TUBA User Time revenue for the OBC submission, i.e. prior to addition of Vehicle Operating Costs, Indirect Tax and Greenhouse Gas, was £307,291,000. The economic cost from matrix estimation is therefore -0.5%.

SUMMARY

The matrix build methodology was not fully aligned to DfT guidance due to data and time availability. This response has provided additional information relating to the matrices in order to give confidence in the suitability of the model as a forecasting tool to inform the Full Business Case (FBC) for Great Yarmouth Third River Crossing (GYTRC).

The comparison with independent Road Side Interview (RSI) data showed that major movements on an aggregated sector level were well aligned, allowing for network density, zone granularity and sample size. The comparison with RSI sites 5 and 6 is important given the Origin Destination movements at these locations are likely to include potential users of the GYTRC. When viewed together, RSI sites 5 and 6 show that the movements influenced by GYTRC are well represented.

The supplementary Traffic Master Origin Destination (TMOD) data used to enhance RSI 3 surveys compares well with NTEM datasets and the final base year matrices have a mode purpose split that reflects differences between Great Yarmouth and the national averages. The changes brought about by matrix estimation, while not meeting DfT guidance, have been shown not to be contributing to an over prediction of benefits due to the TRC.

The model has acceptable flow and travel time calibration and validation performance, and has produced logical economic results submitted in the Outline Business Case package. The matrix build process was influenced by programme pressures and the fundamental care taken in delivering a comprehensive and unbiased travel demand dataset should ensure that the model provides an appropriate tool for evaluating TRC Full Business Case.

POINT 3 - DISTRIBUTIONAL IMPACT ASSESSMENT

The Social and Distributional Impact analysis will be updated to address the comments raised. The updated comments log is included in APPENDIX A.

POINT 4 - FORECASTING

The latest work for the DCO submission has included a review and update of the Uncertainty Log. As with the OBC modelling, demand has been forecasted to 2023 (opening year), 2038 (design year) and 2051 (final forecast year). The fixed demand matrices were then subjected to Variable Demand Modelling. In line with TAG guidance, core, high and low growth scenarios were produced.

Prior to the FBC submission the Uncertainty Log will be reviewed and updated to reflect any further changes in committed land use after the DCO modelling has been completed. However, no major changes are anticipated.

POINT 5 - CHANGES TO NTEM AND RTF

The forecasting is still based on National Trip End Model (NTEM) v7.2 and Road Traffic Forecasts (RTF) 2015. At the time of modelling (May 2018) these are still the most up to date datasets.

RTF 2018 has been made available from September 2018. Forecasting for the FBC will be updated to reflect this.

If NTEM is updated prior to FBC submission, the forecasting will be changed accordingly.

POINT 6 - CHANGES TO TAG

The main changes that have been made to TAG parameters since the OBC submission that may impact upon scheme appraisal are:

- TUBA version – the OBC economic assessment used TUBA version 1.9.8, the DCO models have used version 1.9.10, which was the latest at the time (May 2018). Since then TUBA version 1.9.111 has been released.
- Values of Time – TUBA version 1.9.8 used forthcoming VoTs (Data Book July 2016 Forthcoming Change), whereas the highway assignment and variable demand models used the then current VoTs from the TAG databook (Data Book July 2016). The highway and variable demand models have been updated accordingly and now used parameters derived from TAG Data Book v1.9.1 December 2017, which also aligns with the version of TUBA being used.
- Reliability – this calculation uses a parameter called Reliability Ratio. This is taken from the TAG Data Book. The latest Data Book (v.1.9.1 December 2017) has changed this value from 0.8 to 0.4 which would result in halving the reliability benefits.

The FBC submission will align with the latest version of TAG (guidance and data) at the time of modelling. It is not considered that any of the items above will result in a significant impact on scheme appraisal.

Annex A

DISTRIBUTIONAL IMPACTS ASSESSMENT

Annex A.1

DISTRIBUTIONAL IMPACTS ASSESSMENT

Summary	Overall a good piece of distributional analysis for the DI assessment for Great Yarmouth Crossing. However, there are some gaps in the analysis which need to be addressed, perhaps at a later stage (e.g. around Noise, Air Quality and Affordability). Also, the presentation of the results from the DI appraisal does not follow WebTAG guidance and will need to be updated (see e.g. comments 15 and 16 below).			
Type	DI Analysis comments	Original Location / Page number	New Location/ Page number	Response (if appropriate)
Minor / typographical	Not clear why significant increase in pedestrians, cyclists/motorcylists using the network will lead to a decrease in accidents, as suggested. Could give slightly more information in the screening table.	Plate A-0-1 (p.38)	Appendix B, page 32	A detailed analysis of forecast traffic flow data demonstrates that the proposed scheme will remove traffic from some local roads in areas with vulnerable groups. This is reflected in the COBA-LT accident analysis reported in the Business Case that shows a significant reduction in slight, serious and fatal injury accidents. New pedestrian and cyclist crossing facilities incorporated as part of the scheme design within the impact area will further help towards achieving lower accident rates.
Minor / typographical	The TAG Unit references (left column) need to be updated	Table 1-1, p10	Table 1, page 3	Complete and updated
Minor / typographical	The table (and analysis) is missing Older People for Noise (see Table 2, WebTAG A4.2, December 2015)	Table 1-2	Table 2, page 4	Complete and updated
Query	What is meant by "high degree of commonality"?	Paragraph 2.3 (p.14)	Paragraph 2.5, page 7	Taken from paragraph 2.4.3 of TAG Unit A4.2 - 'Alternatively, the model zones may be larger than LSOAs, or the zone and LSOA boundaries may not share a high degree of commonality. In such cases, it will be necessary to convert the model data from the model zone level to LSOA level'. Text updated within report to make more clear
Results	The assessment (ticks) for 60-80% and 80%-100% should both be two ticks (current one tick). See WebTAG A4.2 Table 8	Table 2-1, p.15	Table 5, page 7	Complete and updated
	Item has been addressed by BL.			N/A
Presentational	The maps 2-2 and 2-3 are not clear to the reader as they do not directly relate to the core modelled impact area (especially 2-3). Could you please clarify whether the User Benefit analysis has been conducted on the core impact area, or the areas highlighted in maps 2-2, 2-3 and B-5. (Also, 2-2 and 2-3 do not cover the same areas - I suggest that map 2-3 is replaced with B-5).	Table 2-1, 2-2 and 2-3	Plate 3 and Plate 4, pages 8 and 9	The User Benefit analysis was conducted on the core modelled impact area. The outputs were then aggregated using the 'sectors' function in TUBA to a system that corresponded closely to LSOA boundaries to allow a direct comparison with IMD data, in line with paragraph 2.4.2 of Tag Unit 2.4.2. Where there were multiple LSOAs within one sector, the user benefits were split based on area (rural) and/or the proportion of the population residing each respective LSOA (urban), in line with paragraph 2.4.3 of Tag Unit A4.2. The end result provides user benefits assigned to each individual LSOA as shown in Plate 3 (previously Plate 2.2), in line with TAG Unit A4.2, and therefore

Summary	Overall a good piece of distributional analysis for the DI assessment for Great Yarmouth Crossing. However, there are some gaps in the analysis which need to be addressed, perhaps at a later stage (e.g. around Noise, Air Quality and Affordability). Also, the presentation of the results from the DI appraisal does not follow WebTAG guidance and will need to be updated (see e.g. comments 15 and 16 below).			
				allowing the appraisal to focus on the impact across income deprivation quintiles. Plate 4 (previously Plate 2.3) has been replaced with the Plate that was previously B-5, as requested.
General	Section 3.4 highlights that a number of schools are likely to experience negative impacts. It would be good to know whether any mitigations have been considered for this. This could be done in section 3.4 and/or in the conclusions (or a separate chapter in mitigations)	Noise / Air Quality	-	No mitigation has been considered for air quality impacts. If mitigation was considered it would need to be traffic based. Without model results, the assumption is that schools within 200m of the affected roads may experience a negative impact, not that they definitely will. Should the impact shown by the modelling be negative but within the statutory limits there may be no need for mitigation. Modelling results will not be available until the end of October 2018.
Analysis	The analysis for accidents could be a little clearer. For example, what group is Appendix C referring to? The Appendix C worksheet should be used to estimate the benefit or disbenefit for each vulnerable group, which doesn't currently seem to have been done. See WebTAG A4.2, 5.4.12 - 5.4.19. The assessment (ticks and crosses, large beneficial to large adverse) should also be carried out for each group	Accidents	Table 9, page 19/20	Complete and updated. Report includes table that assesses vulnerable users and groups in line with WebTAG unit A4.2.
Minor / typographical	"Error! Reference source not found"	Section 5.3	Paragraph 6.4, page 21	Complete and updated
Minor / typographical	reference to wrong tables "Plates 6-2 to 6-5"	p.32	Paragraph 6.5, page 26	Complete and updated
Analysis	The section on severance examines changes in vehicle flow, but it doesn't examine the reduction in severance from introducing a crossing between two previously poorly connected parts of Great Yarmouth. The OBC outlines on of key objectives is to reduce community severance, so i think this should be considered (even if just qualitatively) and if possible integrated into Table 5-2 benefit assessment. As the paragraph at start of section 5 highlights, access to local community facilities and services should be considered. I assume this type of access will be greatly enhanced by the scheme?	Severance	Paragraph 6.5, page 27	As requested, appraisal section has been updated and considers that regardless of vehicle flow changes associated with the redistribution of traffic across the highway network, the provision of a new crossing and associated infrastructure (e.g William Adams Way crossing) between two previously poorly connected parts of Great Yarmouth will have a significant positive impact on community severance by offering an alternative central crossing, providing access to the town centre and other key amenities and facilities.

Summary	**Overall a good piece of distributional analysis for the DI assessment for Great Yarmouth Crossing. However, there are some gaps in the analysis which need to be addressed, perhaps at a later stage (e.g. around Noise, Air Quality and Affordability). Also, the presentation of the results from the DI appraisal does not follow WebTAG guidance and will need to be updated (see e.g. comments 15 and 16 below).**			
General	The summary of findings (Chapter 7) should be presented in a DI appraisal matrix, to allow the distributional impacts on different groups to be gauged quickly and easily (see table 6, page 12 WebTAG A4.2). At the moment, the assessment is at an overall aggregate level - it should be presented for each indicator for each group.	Chapter 7, summary of findings, p.36	Appendix D, page 40	Complete and updated. DI appraisal matrix added
General	For each indicator there should be an assessment for each of the relevant groups. This has been done for some of the indicators, for example User Benefits (Table 2), but not all indicators	Throughout	Throughout	Complete and updated (Noise and Air Quality to be confirmed once modelling has been completed)

St. Johns House
Queen Street
Manchester
M2 5JB

wsp.com

Appendix I – Addendum to GYTRC Outline Business Case

Great Yarmouth Third River Crossing

Outline Business Case

Addendum to 2017 Financial, Commercial and Management Case

May 2018

Prepared by

Community and Environmental Services
Norfolk County Council
County Hall
Martineau Lane
Norwich NR1 2SG

This page has been intentionally left blank.

Document Control Sheet

Project Title	Great Yarmouth Third River Crossing
Report Title	Outline Business Case - Addendum to 2017 Financial, Commercial and Management Case
Report ref no.	N/A
Version	0.4
Status	Final
Report Date	May 2018

Record of Issue

Version	Status	Author	Date	Checked by	Date	Approved by	Date
0.1	DRAFT	Mark Kemp	30 April 18				
0.2	DRAFT	Mark Kemp	08 May 18				
0.3	DRAFT	Mark Kemp	17 May 18				
0.4	FINAL	Mark Kemp	30 July 18	David Allfrey	31 July 18	David Allfrey	31 July 18

Distribution

Date	Organisation	Contact	Format	Copies
31 July 18	DfT	Robert Fox	Electronic	N/A

Contents

List of Appendices

Figures

Tables

1 Introduction

1.1 The Outline Business Case (OBC) for Great Yarmouth Third River Crossing was submitted to the Department of Transport (DfT) in March 2017. Programme Entry for the scheme within the Large Local Majors Schemes Programme was confirmed by DfT on 28 November 2017.

1.2 As a condition of Programme Entry the DfT requested an update to the management, financial and commercial aspects of the case to the Department's satisfaction within 6 months of the date of the Programme Entry letter.

1.3 The Financial and Management cases have not been rewritten but the updates to these documents since the submission of the OBC are presented in this addendum.

1.4 The Commercial case has been rewritten and the contents of this addendum now supersede Chapter 5 of the March 2017 OBC.

2 Update of the 2017 Financial Case

2.1 Introduction

The cost of delivering the Great Yarmouth Third River Crossing as stated in the 2017 OBC was £119.910 million at out-turn prices from 2017/18 onwards. A query was raised regarding the spend profile following submission of the OBC to DfT in March 2017 which identified an error. The result was that when the error was corrected whilst the base cost of £111.651m did not change the out-turn prices increased to £120.653 million. This chapter provides a further update since March 2017.

2.2 Base Costs

NCC appointed Turner and Townsend (T&T) to act as independent commercial and cost consultants for the project in December 2017.

T&T have undertaken an independent review of the cost estimates previously developed by WSP and included in the OBC.

The review concluded that the basic construction cost as presented in the OBC appears reasonable.

2.3 Managing Risk

The scheme risks identified within the OBC Risk Register have been actively managed, updated and reported to the Project Board on a monthly basis. This arrangement has served the project to date but it is recognised that there is a need to update the project risk management strategy. At this early pre-award stage no further Quantified Risk Assessment (QRA) has been undertaken and therefore the Quantified Risk as presented in the OBC of **£25.714 million** at 2016 Q3 prices has not changed. However, taking care to avoid premature revision of final project cost, it is envisaged that the outturn QRA figure will ultimately be reduced to reflect use of the provision to balance forecast changes in spend and increased inflation costs arising from spend profile revisions.

The scheme risks will be managed in line with the risk management strategy set out in Chapter 6.10 of the March 2017 OBC.

T&T working with NCC are in the process of updating the strategy to re-evaluate and re-map risks, financially quantify, and develop a framework for review, update, management and reporting as we move into the next phase of the project to in essence identify a risk ‘critical path’ to identify areas of focus and prioritisation.

The apportionment of risk, and risk management will be an ongoing dynamic process working with the Contractor once appointed through to completion of construction.

2.4 Spend profile

Subject to funding, construction of the scheme remains on programmed to start in October 2020 and the new bridge will open to traffic in January 2023. The expected profile of expenditure has been reviewed taking into account scheme development since the submission of the OBC in March 2017 and is set out in Table 2-1 below.

Scheme element	TOTAL %	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
Construction	**100%**	0%	0%	3%	33%	46%	19%
Utilities	**100%**	0%	0%	38%	48%	8%	6%
Land	**100%**	0%	13%	23%	24%	11%	12%
Fees	**100%**	15%	27%	37%	10%	6%	6%

Table 2-1 Spending profile (%)

Some of the land acquisition costs were incurred prior to 2017-18.

The risk-adjusted forecast spend in each year, still at 2016 Q3 prices, is set out in Table 2-2 below:

Scheme element	TOTAL £,000	2017-2018 £,000	2018-2019 £,000	2019-2020 £,000	2020-2021 £,000	2021-2022 £,000	2022-2023 £,000
Construction	57,387			2,000	19,000	26,000	10,387
Utilities	2,500			960	1,200	190	150
Land	11,434	20	1,867	3,206	3,260	1,493	1,588
Fees	11,943	1,851	3,241	4,330	1,140	710	671
Base cost	83,264	1,871	5,108	10,496	24,600	28,393	12,796
QRA	25,714		2,057	3,343	10,029	9,000	1,286
Risk-adjusted base cost	108,978	1,871	7,166	13,839	34,628	37,393	14,081

Table 2-2 Risk adjusted forecast expenditure (2016 Q3 prices)

Similar to the OBC the QRA has been apportioned across the future scheme years only.

2.5 Out-turn price adjustment (inflation)

The 2016 prices have been inflated through the delivery and construction period based on the Bank of England CPI forecasts of general inflation presented in the OBC and set out in Table 2-3 below.

Factors applied to 2016 Q3 to give out-turn prices	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
General inflation rate	2.44%	2.69%	2.48%	2.36%	2.36%	2.36%
Inflation factors	1.024	1.052	1.078	1.103	1.129	1.156

Table 2-3 Inflation (based on Bank of England CPI forecasts of general inflation)

2.6 Scheme cost

The £120,653k "scheme cost" as defined by DfT, is the out-turn capital cost of the scheme excluding costs incurred prior to completion of the OBC. The inflation factors have been applied to the forecast costs shown in Table 2.2 to produce the total scheme out-turn spend profile.

Scheme element	TOTAL £,000	2017-2018 £,000	2018-2019 £,000	2019-2020 £,000	2020-2021 £,000	2021-2022 £,000	2022-2023 £,000
Construction	64,496			2,156	20,965	29,366	12,008
Utilities	2,747			1,035	1,324	215	173
Land	12,560	20	1,964	3,456	3,597	1,686	1,836
Fees	12,763	1,851	3,409	4,668	1,257	802	775
Base cost	92,566	1,871	5,373	11,315	27,144	32,069	14,793
QRA	28,088		2,164	3,604	11,066	9,768	1,486
Risk-adjusted base cost	120.653	1,871	7,537	14,918	38,210	41,836	16,280

Table 2-4 Out-turn spending profile

The total forecast scheme cost remains at £120,653k. This is the amount of money actually needed to deliver the scheme, and is the basis for the funding bid and future local contributions.

2.7 Expenditure prior to financial year 2017-2018

As presented within the March 2017 OBC. Some of the land acquisition costs were incurred prior to 2017-18.

2.8 Whole life costs

There has been no change to the forecast for operating and maintenance costs from that presented within the March 2017 OBC.

2.9 Budgets and funding cover

2.9.1 Funding strategy

It is anticipated that the Great Yarmouth Third River Crossing will be funded entirely from public finances.

2.9.2 Funding request and profiling

Table 2-5 sets out the funding required from 2017/18 onwards to deliver the Great Yarmouth Third River Crossing.

A contribution of **£98.088 million** of government funding has been confirmed subject to Full Approval of the scheme being granted from the DfT following the completion of statutory procedures.

The New Anglia LEP will make a £2 million contribution.

Norfolk County Council will make a local contribution from 2017/18 onwards of **£20,565 million.**

£,000	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Total £,000
DfT funding requested		3,941	4,668	31,362	41,837	16,280	**98,088**
LA (NCC) contribution	189	3,278	10,250	6,848	0	0	**20,565**
LEP contribution	1,682	318					**2,000**
Total	1,871	7,537	14,918	38,210	41,837	16,280	**120,653**

Table 2-5 Funding request and profiling (£, 000)

2.10 Summary of the update to the 2017 Financial Case

The cost of delivering the Great Yarmouth Third River Crossing, including allowances for risk and inflation will be **£120,653 million**.

A robust risk management strategy is in place and continues to be developed to identify, quantify, manage and review risks, including financial risks.

Norfolk County Council is seeking a contribution of **£98.088 million** from the Government's DfT towards the capital costs of the scheme, and the New Anglia LEP will make a contribution of £2m. The Council will support this managing a local contribution of **£20,565 million**.

3 Update of the 2017 Commercial Case

3.1 Introduction

The Commercial Case provides evidence of the commercial viability of the proposed scheme, and describes the procurement strategy that will be used to engage the market and deliver the scheme. It provides evidence on the approach to risk allocation and transfer, contract and implementation timescales, and the approach to managing of the contract.

The principal changes from the version previously submitted to DfT are:

(i) The switch from restricted procedure to competitive dialogue;

(ii) Updating from NEC3 to NEC4;

(iii) Use of X22, rather than a separate NEC PSC contract for Stage One;

(iv) A more-detailed discussion of risk and of the key commercial terms

3.2 Output based specification

The Commercial Case is based on strategic outcomes and outputs, against which alternative procurement and contractual options are assessed.

The outcomes which the preferred procurement strategy and contract must deliver are to:

- Achieve cost certainty, or certainty that the scheme can be delivered within the available funding constraints;
- Minimise further preparation costs with respect to scheme design by ensuring best value, and appropriate quality;
- Obtain contractor experience and input to the construction programme to ensure the implementation programme is robust and achievable; and
- Obtain contractor input to risk management and appraisals, including mitigation measures, to capitalise at an early stage on opportunities to reduce construction risk and improve out-turn certainty thereby reducing risks to a level that is ‘As Low as Reasonably Practicable’

3.3 Procurement strategy

The proposed Third River Crossing is a relatively straightforward highway scheme, together with a Bascule bridge. A high proportion of the cost and risk is associated with provision of the bridge. An appropriate procurement strategy is one which manages these risks and reduce cost uncertainty.

The Official Journal of the European Union (OJEU) is the publication in which all public sector tenders valued above £4,104,394 (for infrastructure projects) must be advertised[1]. There are four main procurement procedures available for schemes to which the OJEU values apply, as illustrated and described below:

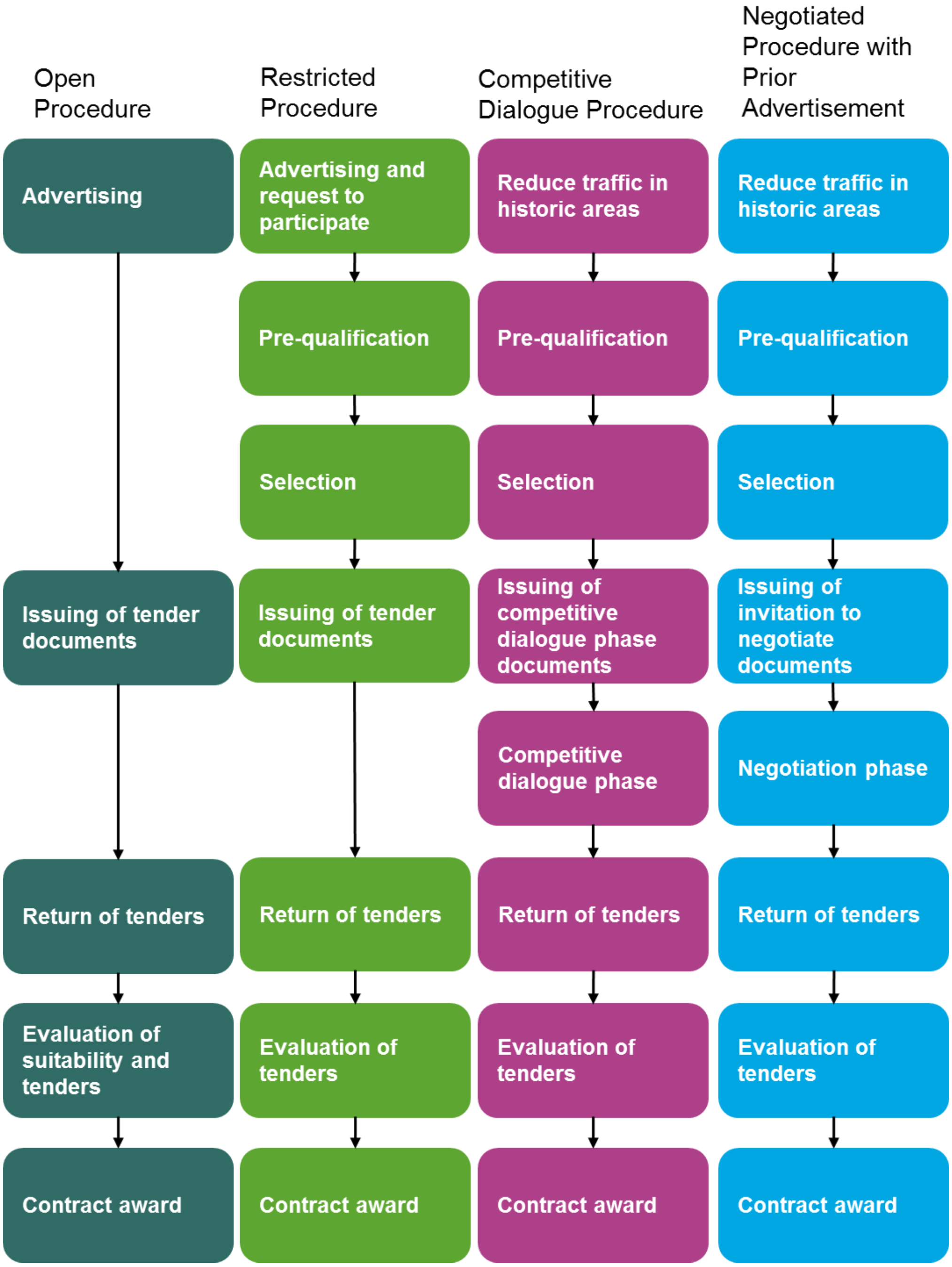


Figure 3-1 Procurement options

[1] OJEU thresholds are reviewed annually. Level quoted applies to end 2017.

3.3.1 *Open Procedure*

This procedure allows an unlimited number of interested parties to tender against defined parameters. There are no restrictions (e.g. pre-qualification) on the parties who are permitted to tender, meaning that some parties may not be suitable to carry out the work. This procedure is straightforward and transparent but can attract a large number of potential bidders (which will require a greater degree of assessment and resource requirements).

3.3.2 *Restricted Procedure*

This is a two-stage procedure. The first stage allows the contracting authority to set the minimum criteria relating to technical, economic and financial capabilities that the potential bidders have to satisfy. Following evaluation of the responses to the first stage a minimum of five bidders (unless fewer qualify) are invited to tender in the second stage.

3.3.3 *Accelerated Restricted Procedure*

This procedure allows an unlimited number of interested parties to tender against defined parameters. There are no restrictions (e.g. pre-qualification) on the parties who are permitted to tender, meaning that some parties may not be suitable to carry out the work. This procedure is straightforward and transparent but can attract a large number of potential bidders (which will require a greater degree of assessment and resource requirements).

3.3.4 *Competitive Dialogue*

This procedure is appropriate for complex contracts where contracting authorities:

- are not objectively able to define the technical means capable of satisfying their needs or objectives; and/or
- are not objectively able to specify the legal and/or financial make-up of a project.

This is a multi-stage procedure. The first stage is a pre-qualification to select the potential bidders to participate in the dialogue. In the second stage the contracting authority enters into a dialogue with the potential bidders to identify and define the means best suited to satisfying their needs

Any aspect of the contract may be discussed, including technical requirements for the works to be delivered and the commercial/contractual arrangements to be used. The dialogue may be conducted in successive phases with the remaining bidders being invited to tender. By the end of the dialogue phase the contracting authority’s requirements will have been determined such that the scheme can be tendered. In the final stage, the remaining bidders from the dialogue phase are invited to tender for the scheme.

3.3.5 *Competitive Procedure with Negotiation*

This relatively new procedure is intended to be used where minimum requirements are able to be specified but negotiations with bidders may be needed to improve the initial tenders. The grounds for using this procedure are as follows:

- Where needs cannot be met without adaptation of readily available solutions;
- Where the contract includes design or innovative solutions;
- Where the requirement is complex in nature, in its legal and financial make-up or because of its risks;
- Where the technical specifications cannot be established with sufficient precision;
- In the case of unacceptable/irregular tenders.

Within this procedure, bidders initially submit tenders based on the information issued by the contracting authority. The contracting authority is then able to review the tenders it has received and negotiate with the bidders, following which the tenders will be resubmitted. This procedure may therefore be useful where the requirements are well developed initially and full tender documents can be produced but it is felt that there may be advantage in retaining the ability to hold negotiations if there are certain aspects which bidders raise.

3.4 **Preferred procurement strategy**

3.4.1 *Procurement route*

The procurement routes that are candidates for this tender are the restricted procedure, the competitive procedure with negotiation and the competitive dialogue procedure.

The restricted procedure is not considered suitable for a scheme of this value and complexity. It does not permit any substantive discussion with the shortlisted bidders. As a result, there is a high probability either that bidders will withdraw, because they are unwilling to accept the council's terms, or that they will price in perceived risk, increasing costs.

The differences between the other two procedures are minor; the competitive dialogue allows slightly more flexibility. As the authority has extensive experience of running procurements under competitive dialogue, it makes sense to use this route rather than the competitive procedure with negotiation.

Accordingly, the project will use competitive dialogue. Dialogue will be based on the lean sourcing principles developed by the Cabinet Office (http://bit.ly/VU10pH) and successfully implemented by the authority. The authority's recent experience of competitive dialogue includes a number of procurements of similar scale and complexity, as well as a series of smaller contracts:

Project	Estimated value
Highway works	Up to £780m depending on contract extensions and workload
Healthy child programme	£156m
Specialist public health services	£60m
Highways professional services	Up to £54m depending on contract extensions and workload
Specialist drug and alcohol service	£50m
Residential rehabilitation for adults with functional mental health needs	£30m
Waste disposal	£30m
Managed IT services	£25m
Data & voice network services	£18m
Traffic signals	£18m
Norwich Park & Ride concession	Up to £16m

Table 3-1 Procurement experience

3.4.2 *Procurement process*

A PQQ based on PAS91:2017 has been issued.

The minimum standards set out at that stage were:-

- A track record of reliably delivering projects of a similar scope and nature, as evidenced by satisfactory references
- Evidence that:
  - candidates comply with regulatory requirements relating to the filing of statutory accounts;
  - candidates' statutory accounts (if any) have received a 'clean' audit opinion or, where the audit opinion is qualified, suitable, appropriate and timely action has been taken to deal with the issues raised;
  - the financial aspects of candidates' businesses (including but not limited to the payment of tax and social security authorities and of other creditors) are properly managed;

    - candidates' businesses are financially sustainable, including adequate liquidity, turnover, profitability, balance sheet strength and cash flow.

- Evidence of satisfactory equalities, health and safety, environmental and quality track record, competencies and systems.

The following shortlisting criteria were applied, and four bidders were short-listed:

Subject area	Weighting
Bridge design and construction experience	15%
Highways design and construction experience	10%
Efficiencies and savings through innovation & ECI	15%
Supply chain management capability	10%
Stakeholder management capability	10%
Marine and coastal experience	15%
MEICA experience	15%
Experience in dealing with environmental constraints and statutory bodies	10%
TOTAL	100%

Table 3-2 Shortlisting criteria

We will use the following award criteria.

Technical Award Criteria		
Subject area	**Weighting**	
	Outline Proposal	**BAFO**
Engineering design methodology (including whole life cost, value for money (within budget), innovation to drive efficiency, organisation chart, achieving objectives (Strategic, maintenance & operations))	15	15
Construction methodology (including traffic management, programme, logistics, testing & commissioning considerations, organisation structures and impact on port operation)	20	20
Experience and qualifications of key personnel (including CVs for design & construction key personnel, organisation chart, programme and retention approach)	20	20
Project controls (including project QSRA, risk management approach, programme management approach and approach to cost management, including the financial system)	Pass/fail	Pass/fail
Change management approach to Brexit and any other changes	Pass/fail	Pass/fail
Stakeholder management and engagement strategy	Pass/fail	Pass/Fail
Collaborative approach	Pass/fail	Pass/Fail
Health and Safety management approach	Pass/fail	Pass/Fail
Total for technical criteria	55	55
Commercial criteria		
Completed price workbooks, fee percentages and preliminary items	N/A	24
Risk	8	8
Contract Compliance	N/A	4
Programme Robustness	N/A	4

Supply Chain (procurement & management, including the recruitment and development of local labour)	5	5
Total for commercial criteria	13	45
GRAND TOTAL	68	100

Table 3-3 Award Criteria

The provisional timeline for the remainder of the procurement process is set out below.

Publish OJEU notice	28 February 2018
Issue of Invitation to Participate in Dialogue to shortlisted Bidders; inform unsuccessful Bidders	20 April 2018
Outline Solution Presentations	From 17 to 18 May 2018
Outline Solution Dialogue	From 22 May to 23 May 2018 and from 7 June to 8 June 2018
Closing date for submission of Outline Proposal	3 July 2018
Dialogue with three shortlisted bidders including design development	30 July 2018 – 2 November 2018
Issue Invitation to Final Tender	Monday 5 November 2018
Deadline for submission of final tender documents	10am UK time on Monday 26 November 2018
Period for which offers must remain open for acceptance	120 days from the tender submission deadline
Expected date for issuing intention to award letters and for standstill period to commence	Before the Christmas break 2018
Expected date for standstill period to finish	Midnight UK time on Thursday 20 December 2018
Contract Award	Early January 2019

Table 3-4 Provisional procurement timeline

3.5 Type of contract

The proposed scheme is a relatively straightforward highway scheme with a high proportion of the cost and risk associated with the provision of the bascule bridge. An appropriate type of contract is one which manages these risks and reduce cost uncertainty.

A number of options were considered:

- Private-public partnership
- Traditional contract
- Partnering contract
- Design and build contract

The advantages and disadvantages of each, and the likely contract form, are summarised below:

3.5.1 *Private-public partnership: Design, build, finance and operate (DBFO) or Public Finance Initiative (PFI)*

It is envisaged that funding will be secured from the DfT Local Majors fund with a local funding contribution. There would be no particular benefit for this project in the DBFO or PFI types of contract, and they have not been considered further.

3.5.2 *Traditional contract*

Advantages

- Principles developed over many years and widely understood
- Client develops the specification
- Risk managed by the Client
- Client retains control and flexibility to change specification
- Award of contract on lowest price basis demonstrates Value for Money

Disadvantages

- Client retains risk of delivery on time and to budget
- No incentive for contractor to innovate
- No link between design and construction
- Nature of all risks are not fully realised at the point of award resulting in the potential for an increase in outturn cost and delays with completion.

3.5.3 *Partnering contract with early contractor involvement (ECI)*

Advantages

- Collaboration between parties
- Risks are better defined than more traditional
- Opportunities to link design and construction

Disadvantages

- Many of the disadvantages of traditional procurement can remain
- Difficult to get the right people involved at an early stage in the development of the project

3.5.4 *Design and build contract*

Advantages

- Integration of design and construction leads to efficiencies in cost and time
- Single point of responsibility for the Client
- Risks clearly identified and allocated during the procurement phase
- Stimulates innovation, reducing cost
- Allows the contractor to review the buildability of the design

Disadvantages

- Reduced competition with fewer companies interested
- Contractor takes on greater risk and prices accordingly
- Lack of flexibility to change the specification
- Quality may be overridden by cost efficiency

3.6 Preferred contract type

Although the highways elements of the project are relatively straightforward, the lifting bridge Mechanical and Electrical (M&E) elements are complex. A traditional contract would not provide an active link between design and construction. Risks would not be fully known at the point of award, resulting in the potential for increased out-turn costs and delays.

A partnering contract with early contractor involvement (ECI) would provide a link between design and construction, though it may not result in full integration of design and construction disciplines. It would however provide a better definition of risks than a conventional contract. It would add value by enabling some input into construction methodology or impacts at the anticipated Examination process. However the procurement process would take longer than with a design and build contract if substantial contractor involvement, such as detailed design work, was required prior to Development Consent Order (DCO) submission, and this would lengthen the overall timescale for delivery.

With a Design and Build contract the Contractor would take on the responsibility and risk related to the detailed design and construction of complex elements. This reduces risk to the client, whilst the integration of detailed design with construction could bring about efficiencies. Ensuring affordability and reducing the risk of cost increases are key considerations, because the funding from DfT is likely to be capped at a level which cannot be increased.

For these reasons, it is concluded that a Two Stage Design and Build form of contract would be the most appropriate for this project.

The recently introduced NEC X22 option will be used to enable Contractor design and ECI, to avoid the complexity of integrating a separate PSC contract.

The inevitable risks arising from losing leverage during stage one, which is non-competitive, will be mitigated by:

(i) Clear NEC Pricing Information, setting the ground rules for arriving at the target price from the tendered price;

(ii) A budget incentive mechanism to encourage the Contractor to reduce the target price to below the tendered price;

(iii) The backstop position that the council can go out to tender using the completed design at the end of Stage One if the target is more than 7.5% (plus indexation) above the tendered price.

3.7 Proposed form of contract

3.7.1 Form of NEC contract

The Council will use the NEC form of contract which is the standard form of contract for infrastructure works in the UK.

Following the publication of the NEC4 series in June 2017, the decision has been taken to use NEC4, rather than NEC3. This will to some extent reduce the need to use 'Z' clauses to deal with efficiencies in NEC3.

The engineering and construction contract (ECC) is considered the most appropriate form of NEC for a contract of this complexity.

3.7.2 Dispute resolution

a. As the Construction Act applies, we will use dispute resolution option W2.

b. An additional tiered dispute resolution process has been included to encourage resolution of disputes without resort to adjudication or the courts.

3.7.3 Additional clauses

a. Clause Z will apply and 'Z' clauses will cover, amongst other things:

(i) Transparency, as required by the Freedom of Information Act and the Environmental Impact Regulations

(ii) The passing of prompt payment obligations down through the supply chain, as required by the Public Contracts Regulations 2015

(iii) Bribery and corruption

(iv) Social value obligations

b. 'Z' clauses will also be used to join together the three stages of the contract – design, construction, and operations and maintenance – and to allow for the use of different main option clauses at each stage.

3.7.4 Insurance and limits of liability

a. We will take an approach to insurance and limits of liability based on market norms, as advised by our professional advisers and subject to testing in dialogue.

3.7.5 Social value

a. This is a works procurement and as such is not subject to the Public Contracts (Social Value) Act 2012. Nevertheless, it is appropriate to consider how social value (the economic, social and environmental well-being of the area) might best be promoted via the scheme.

b. Great Yarmouth contains areas of significant economic and educational deprivation. We propose therefore that apprenticeships and employment should be at the centre of the social value requirements under the contract. It will also be important to include adequate provisions for environmental protection and to manage the impact of construction work on local residents and businesses.

<u>Local employment and apprenticeships</u>

c. We propose to dialogue with contractors on the appropriate level of apprenticeships to be delivered under the contract and then set a common standard across bidders.

d. The promotion of local employment and local sub-contracting forms part of the award criteria.

<u>Environmental considerations</u>

e. The scheme will bring environmental benefits through encouraging walking and cycling between the residential areas west of the river and the employment and retail areas to the east; through reducing congestion and associated pollution; and through supporting low-carbon electricity generation through the offshore wind industry.

f. Construction work has the potential for significant environmental impacts. This will be considered as part of the evaluation of the construction methodology.

3.7.6 *Other commercial considerations*

Issue	Approach	Rationale
Specification	Based on the DfT *Specification for Highway Works*. Because this is a design and build contract, the contractor's designer will be responsible for completion of aspects of the works specification in accordance with its design. It will do so in conformance to the performance specification developed by the council and its advisers.	The DFT specification is the industry standard and is an integrated system including the standards for the works and the approach to testing.
Operation and maintenance and defects period	Bidder to operate and maintain the structure for the first year and to be responsible for its maintenance for a further two years. Completion of the works and the passing of tests will constitute sectional completion. At that stage, the council will take over the bridge and the one year operation and maintenance phase will begin. At the end of that year, the further two years of maintenance will commence. This period will coincide with the defects period.	Experience suggests (and our advisers confirm) that most faults and snags will become apparent in the first year. Having the contractor responsible for operation and maintenance for that year removes any opportunity for 'finger-pointing' and means that the contractor has an on-site team in place to deal with any snags and to train-up the long-term operators of the bridge. It is logical for the further maintenance period to correspond with the period during which the contractor must correct any defects. The approach proposed provides for an overall defects correction period of 3 years, which is considered sufficient to ensure the overall reliability of the bridge in its early years of operation.
Ultimate holding company guarantee	We will require an ultimate holding company guarantee	An ultimate holding company guarantee protects us against a contractor avoiding its liabilities by winding up the company that would otherwise be liable.
Delay damages	We will require delay damages to cover the cost of keeping our project team	A delay in completing the project does not have a direct monetary impact on the

Issue	Approach	Rationale
	mobilised for any delay period.	authority, other than the cost of its project team.
Performance bond	We will not require a performance bond.	The premium for a performance bond is significant and would be passed on to the authority. In practice performance bonds are heavily caveated and hard to claim against. The cost is therefore judged to exceed the benefit.
Retention	We will not retain any part of the price	Retentions have a significant impact on cash flow and as such are usually limited such that they are of limited effect. This means that the administrative burden outweighs their effectiveness.

Table 3-5 Other commercial considerations

3.8 Sourcing options

As described above, the scheme will be sourced through advertisement in the Official Journal of the European Union (OJEU) due to its value. This will allow companies from across the EU to bid for the work.

3.9 Payment mechanisms

It is anticipated that payment will be made to the contractor by monthly valuation with a BACS payment within 30 days after the due date for payment.

NEC option C (target cost) has been adopted for the construction phase. The pros and cons of option A (lump sum) and option C are set out below.

Option	Advantages	Disadvantages
A	• Somewhat greater price predictability at start of Stage Two • Simpler to administer • Quantity and price risks borne by Contractor	• Contractor incentivised to cut corners at the expense of quality • Contractor's price likely to include high contingency • Adversarial relationship more likely to develop • Less commercial transparency around compensation events

C	• More incentive on Contractor to innovate to achieve a better outturn cost • Contractor commercially rewarded for performance • Contractor encouraged to identify supply chain efficiency to benefit of both contractor and client • Collaborative behaviour incentivised • Commercial transparency	• Particularly tight project controls needed • Reduced cost predictability • Reliant on audit accuracy; administratively burdensome

Table 3-6 Option A and Option C comparison

3.10 Pricing framework and charging mechanisms

The council intends to make payments in relation to the proposed products and services as follows.

Contract Stage	Element	Payment mechanism
Stage 1	Design	Lump sum
Stage 1	Support to DCO process	Cost-reimbursable
Stage 2	Construction	Target cost
Stage 3	Initial operation and planned maintenance	Lump sum

Table 3-7 Payment mechanisms

Contractors will be invited to bid on a pricing model, based on the illustrative design material available.

The purpose of the pricing model is to provide:

i) A basis for comparison of tenders.

ii) A basis for building up the Stage 2 Prices, tied to the Contractor's tendered rates

The model would include all the major quantities, allowing the client to compare the bids against each other. Greater detail would be requested on those elements of work where it is envisaged that significant design changes may occur.

Because of the early stage of the design it will not be possible to make the commercial schedules fully inclusive. Many elements will excluded on the basis that inclusion would require bidders to make assumptions which might lead to disparity between each bidders' submissions.

Most of the design will be carried out by the Contractor. The Contractor's solutions may differ from the concept designs in many instances.

The contract documents will inform contractors that the pricing model will form the basis for the build-up of the target price.

The contractor would then work with the design delivery team to develop the Target Price over a number of months as the design is finalised (Stage 1).

The contractor and the design delivery team would hold regular risk and opportunities workshops (possibly on a monthly basis) to develop and manage the avoidance of risk, develop mitigation strategies and review the risk pot. The contractor would use this information, and the ongoing detail design to produce a monthly indicative Target Price which would be reviewed by the delivery team.

Once the client is satisfied with the Target Price the contractor would be given the go-ahead to start construction (Stage 2). If the client is not satisfied with the Target Price the client has the option of cancelling the contract and going out to tender on the full design

3.11 Risk allocation and transfer

The general principle is that risks should be passed to the party best able to manage them, subject to value for money.

This section provides an assessment of how the associated risks might be apportioned between the council and the contractor.

Risk Category	Potential allocation	
	Council	Contractor
Design risk		The Contractor will have single-point design responsibility
Construction & development risk	The starting point will be the standard risk allocation in the NEC4 ECC contract. This will be tailored to reflect the specifics of the scheme. See further discussion below.	
Transition and implementation risk	Risks associated with marine and vehicle traffic flow will (subject to the bridge performing in accordance with the contract, which is a Contractor risk) be borne by the Client	Successful commissioning will be a contractor risk

Risk Category	Potential allocation	
	Council	**Contractor**
Availability and performance risk	The contract will contain a performance specification; failure to meet this would be a defect. As this will be a target cost contract, the cost of rectification would be shared.	
Operating risk	The council will take the operating risk	
Variability of revenue risks	Not applicable	
Termination risks	The contract will enable the council to terminate in Stage One in the event that funding is not made available or if the final target price exceeds the tendered price by more than 7.5% (subject to indexation). Otherwise, the standard ECC termination position applies, with additional grounds for termination if the Contractor: • is convicted or has been convicted of a criminal offence relating to the conduct of its business or profession; or • commits or is found to have committed an act of grave misconduct in the course of its business or profession; or • fails or has failed to comply with any obligations relating to the payment of any taxes or social security contributions; or • has made any serious misrepresentations in the tendering process for any project or matter in which the public sector has or had a significant participation; or • fails to obtain any necessary licences or to obtain or maintain membership of any relevant body; or • demerges into two or more firms, merges with another firm, incorporates or otherwise changes its legal form or there is a change of control as defined by section 416 of the Income and Corporation Taxes Act and, in any such change of control, there are reasonable grounds relating to the financial standing of the new entity that is proposed to Provide the Works for the Client to withhold its consent.	
Technology & obsolescence risks	The council takes the obsolescence risk during the bridge's operational life.	The Contractor takes the initial performance risk associated with choice of technology.
Residual value risks	Residual value risk is retained by the Council	

Risk Category	Potential allocation	
	Council	Contractor
Financing risks	Financing risk is retained by the public sector	
Legislative risks	A post-contract change in customs tariffs as a result of Brexit will be a compensation event.	NEC option X2 will not be used

Table 3-8 Potential risk allocation

Construction risk

The standard NEC position will be tailored as follows.

Risk	Position
Weather	Wind speed will be added to the list of weather events
Physical conditions – flood	The consequences of tidal flooding will be specifically agreed in dialogue
Utilities	The consequences of delay caused by utilities issues will be specifically agreed in dialogue

Table 3-9 Construction risk assumptions

Extensive ground investigation has been undertaken (and additional marine GI commissioned) to enable the standard NEC position on physical conditions (Clause 60.1 (12)) to be tightened. This will be discussed in dialogue.

The scheme risks will be managed in line with the risk management strategy set out in Chapter 6.10 of the March 2017 OBC.

3.12 Contract length

From contract signature, it is envisaged that the support to the DCO process, the development of the detailed design, appointment of any sub-contractors not forming part of the original consortium, enabling works and mobilisation will together take up to 22 months.

Construction is expected to commence in October 2020 and commissioning is expected to be complete by January 2023.

It is envisaged that the contractor will be contracted to operate the bridge for an initial one-year period and to deliver maintenance for three years, to coincide with the defects period.

3.13 Human resource issues

No significant human resources issues have been identified that could affect the deliverability of the scheme. No TUPE issues are expected. The Council will provide personnel to perform the role of Project Manager and create a small site supervision team.

More information on the governance and management of the project, including details of the people involved, is set out in the Management Case.

3.14 Contract management

The form of contract selected provides the Council with a suitable contract at construction to minimise risk, but with increased ability to bring forward the detailed design process in the programme.

More detail on contract management will be provided in the Full Business Case.

3.15 Commercial viability

The information above provides evidence that the scheme is commercially viable, with a robust contracting and procurement strategy. The Council has confidence that the contractual and commercial arrangements are appropriate and workable. Specifically:

- The OJEU "competitive dialogue" procurement strategy has been successfully used by the Council on a number of large-scale works and other schemes. The proposed approach is in full accordance with the Council's procurement systems and processes.
- The procurement route includes risk management as a core principle, using strategies of risk allocation and transfer to the contractor. It includes the use of disincentives, such as penalties for programme overruns or missing key milestones, in order to achieve delivery on time and to the required quality.
- Four high quality consortia have qualified for the dialogue.

3.16 Summary of the Commercial Case

The scheme will use the **OJEU 'competitive dialogue procedure'** procurement route. This is appropriate for a large scale infrastructure project as it provides for the "pre-qualification" of suppliers based on their financial standing and technical or professional capability and for dialogue on cost and risk.

A **Two Stage Design and Build** form of contract is considered to be the most appropriate for this project. It will involve the Contractor at an early stage to develop the design, and help ensure that a buildable and affordable scheme is available.

The contract also includes an initial operate and maintenance period of 1 year and 3 years respectively.

The proposed form of contract is the **NEC4 ECC**, using the following payment mechanisms:

Contract Stage	Element	Payment mechanism
Stage 1	Design	Lump sum
Stage 1	Support to DCO process	Cost-reimbursable
Stage 2	Construction	Target cost
Stage 3	Initial operation and planned maintenance	Lump sum

Table 3-10 Payment mechanisms

The Commercial Case demonstrates that the scheme is commercially viable, with a robust contracting and procurement strategy.

4 Update of the 2017 Management Case

4.1 Introduction

The management case has been updated to reflect changes since the submission of the OBC in March 2017.

4.2 Project governance, organisation structure and roles

The organisational and governance structure has been updated since the submission of the OBC. The current structure is reproduced below as Figure 4-1.

4.2.1 Project Sponsor

The Project Sponsor is Norfolk County Council, represented by Tom McCabe, the Council's Executive Director of Community and Environmental Services.

4.2.2 Senior Responsible Officer

There is no change to the Senior Responsible Officer.

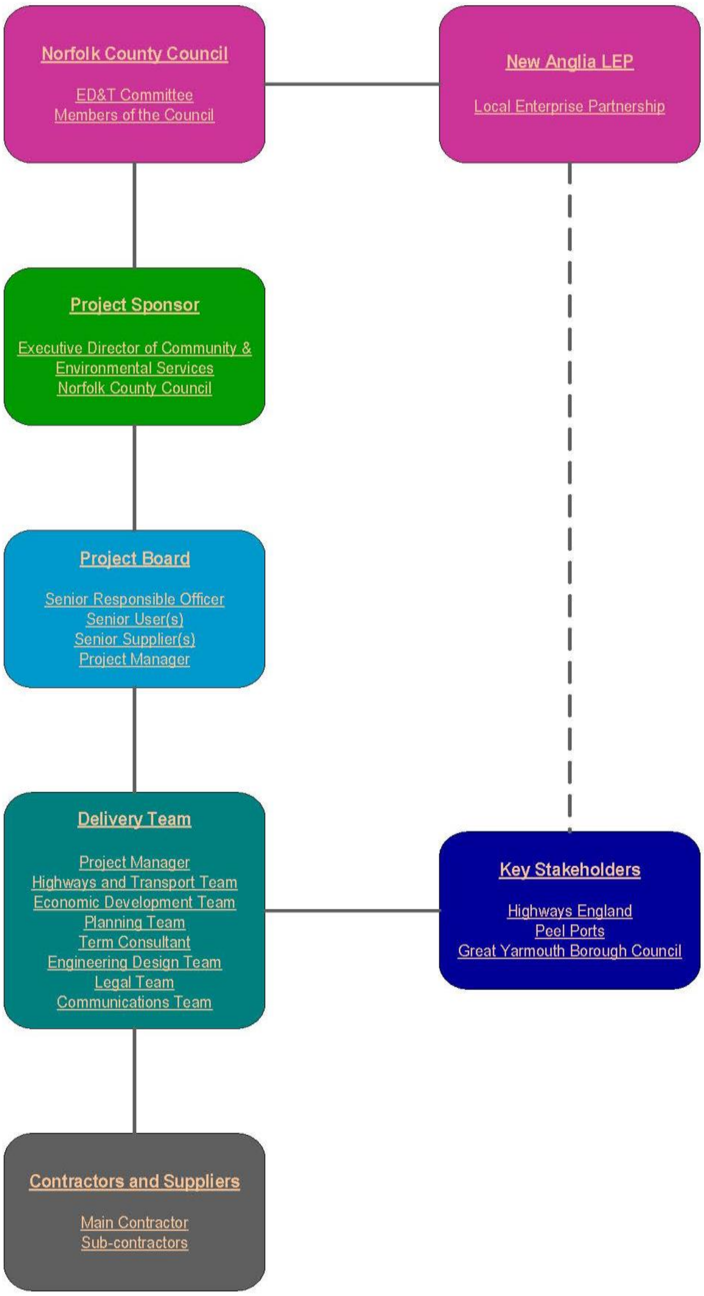


Figure 4-1 Governance diagram

4.2.3 Project Board

The Project Board will meet monthly until the project has been completed, after which it will make arrangements for ongoing oversight and reporting of monitoring and evaluation.

The Project Board has been updated since the submission of the March 2017 OBC. The current Project Board is shown in the table below and will consist of people in the following roles:

Role	Responsibilities	Name	Position
Project Sponsor	Chair of Project Board	Tom McCabe	Executive Director of Community and Environmental Services (NCC)
Project Owner and Senior Responsible Owner (SRO) The "customer" for the scheme, representing the public's interests	Responsible for the successful delivery of the project, ensuring that it meets its objectives and delivers its intended benefits	David Allfrey	Infrastructure Delivery Manager (NCC)
Senior User	Represents the interests of all those who will use the scheme. Monitors and manages user-related risks	David Glason	Group Manager for Growth (GYBC)
New Anglia LEP Representative	Represents the interests of the LEP	Ellen Goodwin	Infrastructure Manager (NA LEP)
Department for Transport Representative	Represents the interests of the DfT	TBC	
Senior Supplier	Represents those who are designing, developing, facilitating, procuring and implementing the scheme. Verifies the quality of products delivered by suppliers, resolves supplier conflicts, and monitors and manages supplier-related risks.	Joanna Lyon	Project Director (WSP)

Project Director/Executive	Oversee the development and coordination of the case for the project and ensure it remains in line with the wider county council and LEP priorities	Vince Muspratt	Assistant Director Economic Development and Strategy and Infrastructure and Economic Growth Manager (NCC)
Project Director/Executive	Oversee the development and coordination of the case for the project and ensure it remains in line with the wider county council and LEP priorities	Nick Tupper	Assistant Director Highways (NCC)
Project Assurance	Considering the end product of each work package against the plan and specification, and confirming that it is fit for purpose	Ian Parkes	Principal Infrastructure and Economic Growth Planner (NCC)
Project Communication	Responsible for communication planning and management	Susie Lockwood	Project communication lead officer (NCC)
Project Finance	Review budget and costs to ensure funding available	Andrew Skiggs	Finance lead and CES Business Partner (NCC)
Procurement Advisor	Leading procurement strategy/delivery process	Al Collier	Head of Procurement (NCC)
Project Manager	Managing the project to ensure that it delivers the required products within the agreed constraints. Co-ordinating the work of the delivery team	Mark Kemp	Project Manager (NCC)

Table 4-1 Project Board membership and roles

4.2.4 Delivery Team

The Delivery Team has been updated since the submission of the OBC. The current Delivery Team is shown in the table below and will consist of people in the following roles:

Role	Responsibility	Name
Senior Responsible Officer/ Project Owner (NCC)	Chair of Delivery Team Provides reports to Project Board	David Allfrey *(Infrastructure Delivery Manager)*
Project Manager (NCC)	Project delivery lead, coordinating workstreams and key activities	Mark Kemp *(Project Manager)*
Infrastructure and Economic Growth Team (NCC)	Alignment with wider planning and economy strategies/targets	Ian Parkes (Principal IEG Planner)
Finance Team (NCC)	Financial monitoring and reporting	Andrew Skiggs *(Finance Business Partner)*
Legal team (NPLaw)	Specialist legal advice & coordination with Counsel	Jane Linley *(Team Lead (Planning and Environment)*
Communications Lead (NCC)	Develop communications plan Stakeholder management Press liaison	Susie Lockwood (*Project communications lead officer*)
Project Director: Term consultant (WSP)	Develop Full Business Case Co-ordinate design and delivery Monitoring and evaluation	Joanna Lyon (*WSP project director and project resource coordination*)
Programme Manager (WSP)	Overall programme management and the management of WSP workstreams	Shay Goane *(Project Manager)*
Discipline lead for Procurement (NCC)	Develop procurement strategy and overall management and coordination of the procurement workstream	Al Collier *(Head of Procurement)*

Discipline lead for Procurement (WSP)	Management and coordination of WSP input into the procurement documents	Dennis Hill
Discipline lead for Commercial (NCC)	Financial management including task order management. Risk management and review. CES commercial input into the procurement process	Nigel Seago *(Special Projects Manager)*
Discipline lead for Design (WSP)	Management and coordination of the design workstream	Richard Flowers *(Design Coordinator)*
Discipline lead for DCO (WSP)	Management and coordination of the DCO workstream	Mike Denny
Consultation lead (NCC)	Management and coordination of the statutory consultation process including informal consultation and meetings with stakeholders, preparation of SOCC, statutory noticing, preparation of public consultation material and arranging venues. Coordinating consultation responses and the preparation of the Consultation Report	Gavin Broad *(Project Engineer)*
Maritime lead (WSP)	Management and coordination of all maritime aspects of the project. Liaison with Peel Ports.	Stephen Horne
Land lead (NPS)	Undertake negotiations with directly and indirectly affected landowners. To act as the Land 'lead' through the DCO application and examination process	Grant Brewer *(Land Agent)*
Independent commercial consultant (T&T)	Lead on procurement and commercial project strategy	Garima Singh *(Turner and Townsend)*
Independent cost management consultant (T&T)	Lead on project cost management	Lucinda Seagrave *(Turner and Townsend)*

Table 4-2 Delivery Team members and roles

An organisation diagram of the delivery team is shown in Figure 4-2.

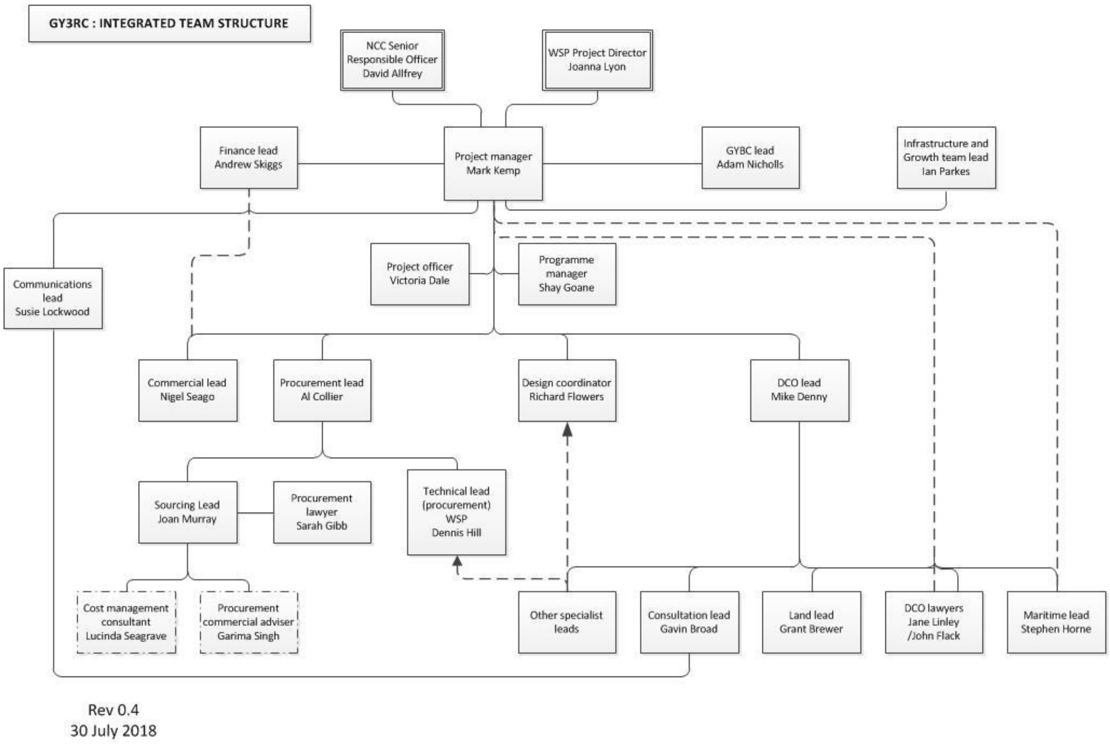


Figure 4-2 Organisation diagram of the delivery team

4.3 Programme and project plan

The project programme has been updated and developed in greater detail since the submission of the March 2017 OBC. Key milestones completed include:

- Informal public consultation undertaken on the project during September and October 2017;
- A Direction was received from the Secretary of State under Section 35 of the Planning Act 2008 that the project is to be treated as development for which development consent is required on 26 February 2018;
- An OJEU Contract Notice was placed on 28 February 2018 and Invitation to Participate in Dialogue was issued to shortlisted Bidders on 20 April 2018.

The key delivery milestone are set out in Table 4.3 below.

Milestone		
Closing date for submission of Outline proposals from bidders		July 2018
NCC commence Statutory Consultations		August 2018
NCC complete Statutory Consultations		October 2018
Submission of initial design from shortlisted bidders		October 2018
NCC issue Invitation to submit final tender		Early November 2018
Bidders submit final tender		Late November 2018
Contract award		January 2019
Development Consent Order application		March 2019
Examination period	June 2019	October 2019
Contractor detailed design	January 2019	May 2020
Development Consent Order decision		February 2020
Mobilise for Construction		May 2020
Start of Construction		October 2020
Bridge completed and open		January 2023

Table 4 3 Key delivery milestones

The current project programme is set out in Appendix A. This is a rolled up version of the full programme and shows the critical path.

4.4 Assurance and approvals plan

Assurance – Gateway reviews

An independent Gateway 1 (Business Justification) review was undertaken by Local Partnerships in July 2017. Recommendations from the review and progress to date for each recommendation are set out in the Gateway Review Action Plan in Appendix B.

The next Gateway review stage for the Great Yarmouth Third Crossing scheme is proposed prior to appointment of a preferred contractor.

4.5 Communications and Stakeholder Management

4.5.1 The communications and engagement strategy is set out in the Chapter 6.7 of the March 2017 OBC.

4.5.2 Update on public consultation carried out

A three stage consultation process has been adopted for the project as shown in Table 4-4.

Stage	Purpose	Timescale
Stage 1 Initial engagement consultation	Understand views on congestion, share emerging proposals and understand level of support	Completed January 2017
Stage 2 Scheme development consultation	Understand views on the bridge development work so far	Completed September – October 2017
Stage 3 Pre- application consultation	Present details of the proposed scheme and understand views on it before an application for planning consent	Planned for August – October 2018

Table 4-4 Stages of public consultation

The preferred scheme taken forward to Stage 2 consultation was a bascule bridge with a clearance of 4.5m over the water at an average high tide. An alternative bridge type (a swing bridge) that could be built was also suggested as part of the consultation.

The consultation responses indicate an overall support for a bascule bridge over a swing bridge. However, there were responses, particularly written responses from port businesses, expressing concern regarding the effects of the Third River Crossing on port and river related activities.

Taking into consideration the consultation results, on balance the preferred option for a Third River Crossing still remains a bascule bridge with 4.5m clearance. However, the concerns relating to port and river related businesses are acknowledged, and further work is being undertaken in consultation with these businesses to fully understand their concerns and consider ways to mitigate them.

The issues raised during the Stage 2 consultation are being carefully considered during the current stage of scheme development. This will include how to better engage stakeholders during the next round of consultations.

4.6 Project reporting

Progress will be reported to the County Council's Environment, Development and Transport (EDT) Committee which has executive powers. Recent reports considered by the EDT Committee include:

- Project progress report - 15 September 2017;
- Results of the Stage 2 scheme development public consultation - 10 November 2017;
- Report to seek approval to place OJEU notice to commence the procurement process - 19 January 2018.

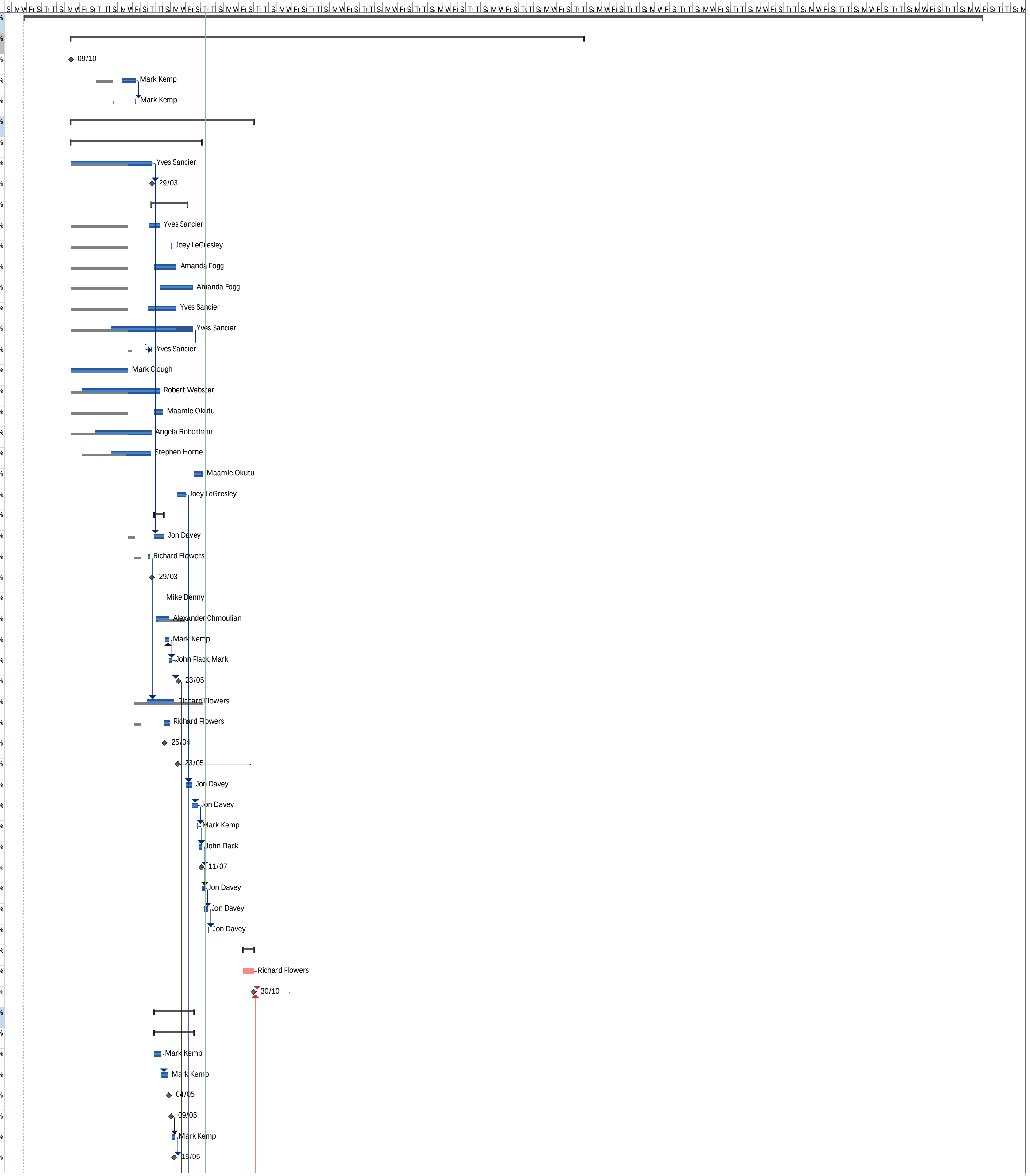
4.7 Risk Management Strategy

The risk management strategy is set out in Chapter 6.10 of the March 2017 OBC and is discussed within the updates to the finance and commercial cases within this addendum.

Appendix A – Project Programme

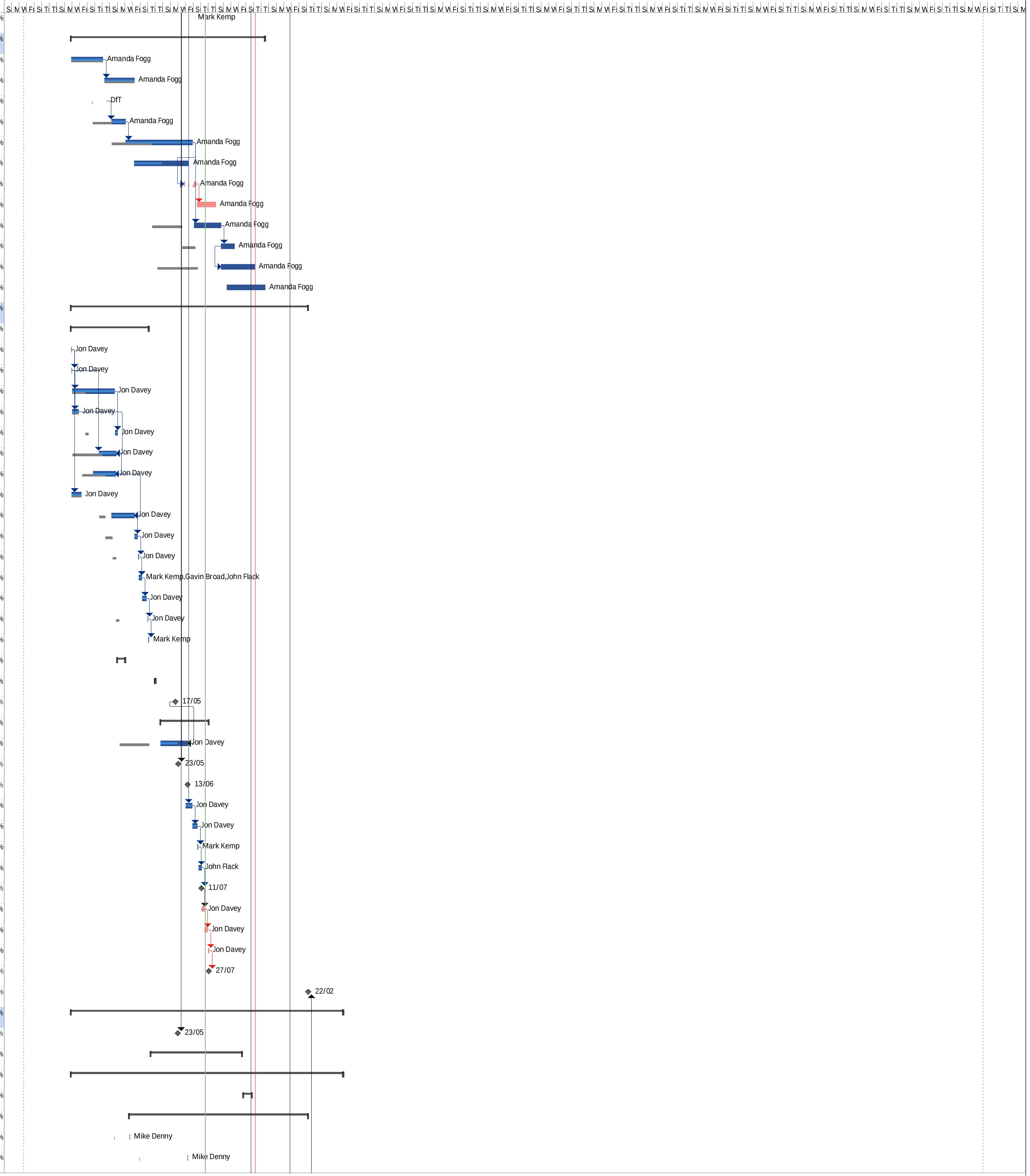
Great Yarmouth Third River Crossing
DCO
Rev 13.18 13.07.18

ID	Task Name	Owner	Duration	Start	Finish	Predecessors	Successors	Resource Names	% Complete
1	Great Yarmouth Third River Crossing		1429 days?	Sat 01/07/17	Wed 18/01/23				14%
2	DCO SUBMISSION		758 days?	Mon 09/10/17	Mon 28/09/20				14%
3	Start Date		0 days	Mon 09/10/17	Mon 09/10/17				100%
4	S35 Application	NCC	20 days	Thu 25/01/18	Wed 21/02/18		5	Mark Kemp	100%
5	SoS S35 Decision	NCC	1 day	Thu 22/02/18	Thu 22/02/18	4		Mark Kemp	100%
6	Design for Planning		266 days	Mon 09/10/17	Tue 30/10/18				91%
7	Design for PEIR and consultation		190 days	Mon 09/10/17	Fri 13/07/18				93%
8	Vertical & horizontal alignments - 3D model	WSP Highways	118 days	Mon 09/10/17	Thu 29/03/18		29,9	Yves Sancier	100%
9	Indicative sections	WSP Highways	0 days	Thu 29/03/18	Thu 29/03/18	8		Yves Sancier	100%
10	Site clearance - provisional demolition list	WSP Highways	51 days	Wed 28/03/18	Tue 12/06/18			Yves Sancier	50%
14	Fencing + pedestrian guard rails, boundary fencing	WSP Highways	15 days	Thu 22/03/18	Fri 13/04/18			Yves Sancier	100%
15	Road restraints	WSP Structures	2 days	Tue 08/05/18	Wed 09/05/18			Joey LeGresley	100%
16	Junctions - check / refine	WSP Transport F	33 days	Tue 03/04/18	Fri 18/05/18			Amanda Fogg	100%
17	Signage and road markings	WSP Highways	48 days	Mon 16/04/18	Fri 22/06/18			Amanda Fogg	95%
18	Kerbs, footways and paved areas	WSP Highways	42 days	Mon 19/03/18	Fri 18/05/18			Yves Sancier	100%
19	Integration Review and Updates	WSP Highways	120 days	Tue 02/01/18	Fri 22/06/18		20	Yves Sancier	80%
20	Update redline	WSP Highways	2 days	Wed 28/03/18	Thu 29/03/18	19		Yves Sancier	100%
21	Highway lighting concept	WSP Lighting	80 days	Mon 09/10/17	Mon 05/02/18			Mark Clough	100%
22	Highway drainage concept	WSP Drainage	110 days	Wed 01/11/17	Fri 13/04/18			Robert Webster	100%
23	Highway pavement	WSP Highways	14 days	Tue 03/04/18	Fri 20/04/18			Maamle Okutu	100%
24	Power supply concept	WSP Structures,	80 days	Tue 28/11/17	Tue 27/03/18			Angela Robotham	100%
25	Maritime modelling	WSP Maritime	60 days	Mon 01/01/18	Mon 26/03/18			Stephen Horne	100%
26	NMU Audit	WSP Design Integration	15 days	Mon 25/06/18	Fri 13/07/18			Maamle Okutu	70%
27	Alternative "Dutch-style" bridge design	WSP Structures	13 days	Mon 21/05/18	Thu 07/06/18		41,102	Joey LeGresley	100%
28	Collation of deliverables for PEIR		15 days	Tue 03/04/18	Mon 23/04/18				100%
29	ENV to confirm	WSP Environment	15 days	Tue 03/04/18	Mon 23/04/18	8		Jon Davey	100%
30	Design review	WSP Design Inte	5 days	Mon 19/03/18	Fri 23/03/18		37FS-5 days	Richard Flowers	100%
31	WSP ITPD documents submitted	WSP Design Integration	0 days	Thu 29/03/18	Thu 29/03/18			Richard Flowers	100%
32	PEIR Design Workshop	WSP DCO	1 day	Wed 18/04/18	Wed 18/04/18			Mike Denny	100%
33	Incorporation of GI data into design	WSP Geotech	20 days	Fri 06/04/18	Thu 03/05/18	1473		Alexander Chmoulian	100%
34	NCC review of PEIR Design	NCC	6 days	Wed 25/04/18	Wed 02/05/18	39	35	Mark Kemp	100%
35	NCC sign off of PEIR Design	NCC, NPLAW	5 days	Thu 03/05/18	Thu 10/05/18	34	36FS+9 days	John Flack,Mark	100%
36	Freeze design for PEIR	NCC	0 days	Wed 23/05/18	Wed 23/05/18	35FS+9 days	100	Mark Kemp	100%
37	Design refinement ahead of consultation review	WSP Design Integration	38 days	Mon 19/03/18	Mon 14/05/18	30FS-5 days		Richard Flowers	100%
38	Design review	WSP Design Integration	10 days	Mon 23/04/18	Fri 04/05/18			Richard Flowers	100%
39	Feedback from Bidders on bridge form via In-Tend	NCC	0 days	Wed 25/04/18	Wed 25/04/18		34	Mark Kemp	100%
40	Freeze design for Consultation - decision on bascule design	NCC	0 days	Wed 23/05/18	Wed 23/05/18		126,304,113	Mark Kemp	100%
41	WSP Environment Team updating PEIR chapter to incorporate design envelope	WSP Environment	10 days	Fri 08/06/18	Thu 21/06/18	27	42	Jon Davey	100%
42	WSP Internal Review of updated PEIR	WSP Environment	7 days	Fri 22/06/18	Mon 02/07/18	41	43	Jon Davey	100%
43	NCC review of PEIR Design	NCC	2 days	Tue 03/07/18	Wed 04/07/18	42	44	Mark Kemp	100%
44	NCC sign off of PEIR Design	NPLAW	5 days	Thu 05/07/18	Wed 11/07/18	43	45	John Flack	100%
45	Design Freeze to reflect bidder feedback	NCC	0 days	Wed 11/07/18	Wed 11/07/18	44	46	Mark Kemp	0%
46	WSP Environment Team Amendments	WSP Environment	4 days	Thu 12/07/18	Tue 17/07/18	45	47	Jon Davey	0%
47	NCC sign off of PEIR Design	NCC	5 days	Wed 18/07/18	Tue 24/07/18	46	48	Jon Davey	0%
48	Preparation & issue of final PEIR	WSP Environment	3 days	Wed 25/07/18	Fri 27/07/18	47		Jon Davey	0%
49	Design for ES		17 days	Mon 08/10/18	Tue 30/10/18				0%
50	Review design following consultation	WSP Design Inte	17 days	Mon 08/10/18	Tue 30/10/18	177	51	Richard Flowers	0%
51	Freeze design for DCO	NCC	0 days	Tue 30/10/18	Tue 30/10/18	50,1404,246	539,528,550,!	Mark Kemp	0%
52	Update to OBC		58 days	Tue 03/04/18	Mon 25/06/18				100%
53	Financial, Commercial & Management Case		58 days	Tue 03/04/18	Mon 25/06/18				100%
54	First Draft	NCC	10 days	Tue 03/04/18	Mon 16/04/18		55	Mark Kemp	100%
55	Review	NCC	10 days	Tue 17/04/18	Mon 30/04/18	54		Mark Kemp	100%
56	Issue to Project Board (5 days before meeting)	NCC	0 days	Fri 04/05/18	Fri 04/05/18			Mark Kemp	100%
57	Project Board	NCC	0 days	Wed 09/05/18	Wed 09/05/18		58	Mark Kemp	100%
58	Final Draft	NCC	5 days	Wed 09/05/18	Tue 15/05/18	57	59	Mark Kemp	100%
59	Issue draft to DfT	NCC	0 days	Tue 15/05/18	Tue 15/05/18	58		Mark Kemp	100%



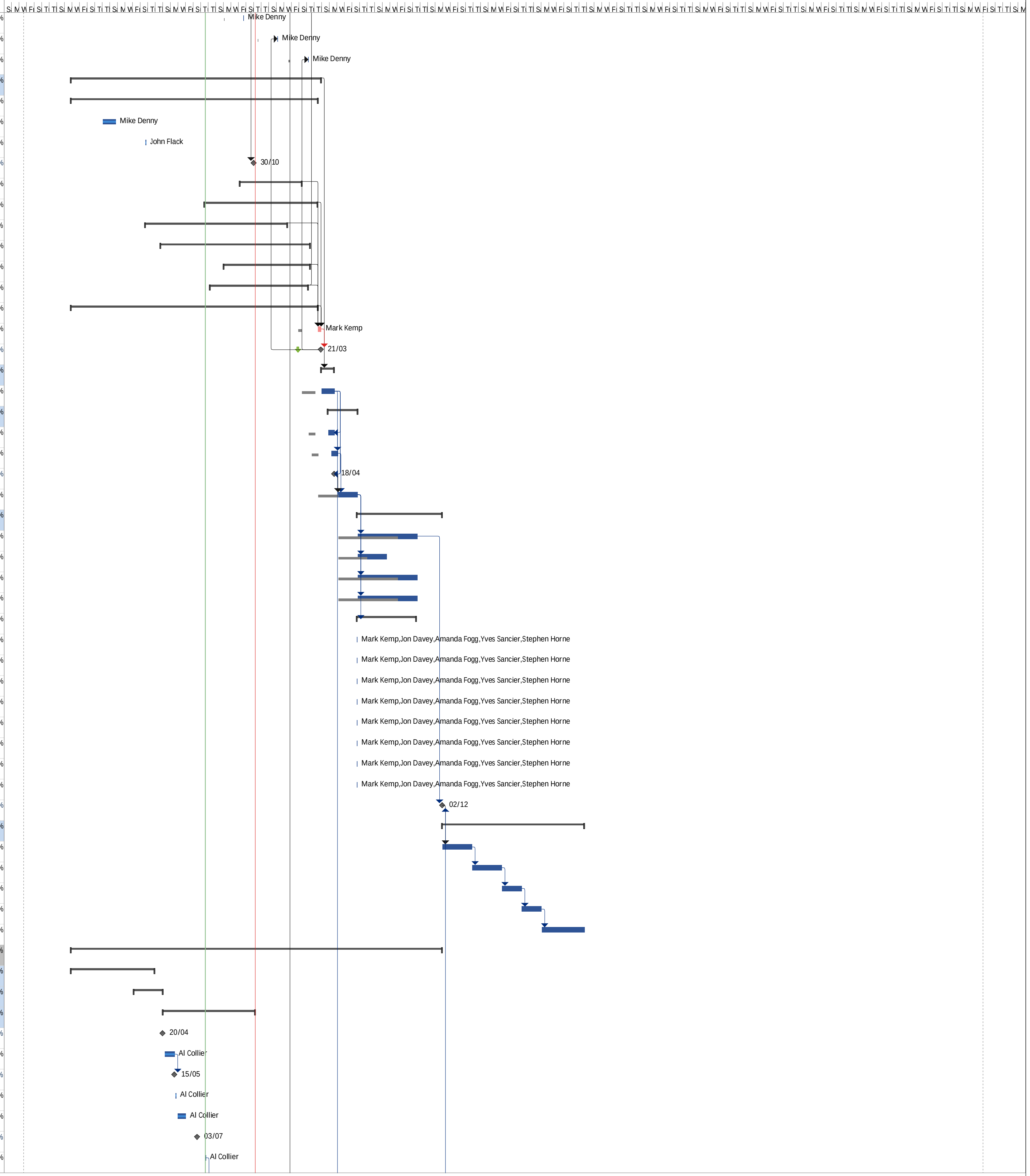
Great Yarmouth Third River Crossing
DCO
Rev 13.18 13.07.18

ID	Task Name	Owner	Duration	Start	Finish	Predecessors	Successors	Resource Names	% Complete
60	Meet with DfT	NCC	1 day	Mon 25/06/18	Mon 25/06/18			Mark Kemp	100%
61	Transport Modelling		284 days?	Mon 09/10/17	Fri 23/11/18				49%
62	Traffic data for PEIR	WSP Transport F	50 days	Mon 09/10/17	Fri 15/12/17		63	Amanda Fogg	100%
63	Transport Assessment scoping chapter for PEIR	WSP Transport F	40 days	Mon 18/12/17	Mon 19/02/18	62		Amanda Fogg	100%
64	DfT feedback on OBC modelling	WSP Transport F	1 day?	Fri 22/12/17	Fri 22/12/17		65	DfT	100%
65	Review and discussion of DfT comments re. modelling	WSP Transport Planning	22 days	Tue 02/01/18	Wed 31/01/18	64	66	Amanda Fogg	100%
66	Refine model - SATURN	WSP Transport F	98 days	Thu 01/02/18	Fri 22/06/18	65	68,70	Amanda Fogg	100%
67	Agreeing Assessment Methodology with Highways England	WSP Transport F	80 days	Mon 19/02/18	Thu 14/06/18			Amanda Fogg	50%
68	Preparation of Data for ES	WSP Transport F	20 days	Mon 04/06/18	Fri 29/06/18	66	69	Amanda Fogg	13%
69	Undertake Economics Appraisal	WSP Transport F	30 days	Mon 02/07/18	Fri 10/08/18	68	128SS	Amanda Fogg	0%
70	Refine model - Paramics	WSP Transport F	42 days	Mon 25/06/18	Tue 21/08/18	66	71	Amanda Fogg	0%
71	Operational / Junction Assessments	WSP Transport F	20 days	Wed 22/08/18	Wed 19/09/18	70	72SS	Amanda Fogg	0%
72	Transport Assessment for ES	WSP Transport F	50 days	Wed 22/08/18	Wed 31/10/18	71SS		Amanda Fogg	0%
73	Undertaking the Appraisal for Highways England	WSP Transport Planning	60 days	Mon 03/09/18	Fri 23/11/18			Amanda Fogg	0%
74	EIA - Scoping & PEIR		342 days	Mon 09/10/17	Fri 22/02/19				92%
75	EIA Scoping Preparation		113 days	Mon 09/10/17	Thu 22/03/18				100%
76	Confirmation of Options	WSP Environment	1 day	Mon 09/10/17	Mon 09/10/17		77,83	Jon Davey	100%
77	Scoping Preparation Start	WSP Environment	1 day	Tue 10/10/17	Tue 10/10/17	76	78,79,81FS+4(days	Jon Davey	100%
78	Preparation of Upfront Chapters	WSP Environment	58 days	Wed 11/10/17	Mon 08/01/18	77	80	Jon Davey	100%
79	Preliminary Consultation of SEBs and LPA	WSP Environment	10 days	Wed 11/10/17	Tue 24/10/17	77	81FF	Jon Davey	100%
80	Internal Review of Upfront Chapters	WSP Environment	5 days	Tue 09/01/18	Mon 15/01/18	78		Jon Davey	100%
81	Environmental Topics Scope Confirmation	WSP Environment	22 days	Wed 06/12/17	Fri 12/01/18	77FS+40 days,79FF	82FF-2 days	Jon Davey	100%
82	Cumulative Effects Scope Confirmation	WSP Environment	28 days	Fri 24/11/17	Wed 10/01/18	81FF-2 days	84FF+5 days	Jon Davey	100%
83	Provide planning input into Scoping Report	WSP Environment	15 days	Tue 10/10/17	Mon 30/10/17	76		Jon Davey	100%
84	Collation of Chapters	WSP Environment	35 days	Tue 02/01/18	Mon 19/02/18	82FF+5 days	85	Jon Davey	100%
85	Internal Reviews of Draft Environmental Scoping Report	WSP Environment	5 days	Tue 20/02/18	Mon 26/02/18	84	86	Jon Davey	100%
86	Address Internal Comments on Draft Environmental Scoping Report	WSP Environment	2 days	Tue 27/02/18	Wed 28/02/18	85	87	Jon Davey	100%
87	NCC Review of SCOPING REPORT	NCC	5 days	Thu 01/03/18	Wed 07/03/18	86	88	Mark Kemp,Gavin E	100%
88	WSP update of SCOPING REPORT	WSP Environmen	7 days	Thu 08/03/18	Fri 16/03/18	87	89	Jon Davey	100%
89	Final Environmental Scoping Report	WSP Environment	2 days	Mon 19/03/18	Tue 20/03/18	88	90	Jon Davey	100%
90	Scoping Report Approved	NCC	2 days	Wed 21/03/18	Thu 22/03/18	89	96	Mark Kemp	100%
91	Regulation 8 Notification to PINS		13 days	Mon 15/01/18	Wed 31/01/18				100%
95	Regulation 8 & Scoping Report		1 day	Thu 05/04/18	Thu 05/04/18				100%
97	Scoping Opinion Received	PINS	0 days	Thu 17/05/18	Thu 17/05/18		99SF+10 days	PINS	100%
98	PEIR		73 days	Mon 16/04/18	Fri 27/07/18			Jon Davey	68%
99	Environmental Assessment for PEIR	WSP Environment	40 days	Mon 16/04/18	Tue 12/06/18	97SF+10 days		Jon Davey	65%
100	Initial Design freeze review - PEIR	NCC	0 days	Wed 23/05/18	Wed 23/05/18	36		Mark Kemp	100%
101	"Dutch-style" Design freeze - PEIR	WSP Highways	0 days	Wed 13/06/18	Wed 13/06/18			Maamle Okutu	100%
102	WSP Environment Team updating PEIR chapter to incorporate design envelope	WSP Environment	10 days	Fri 08/06/18	Thu 21/06/18	27	103	Jon Davey	100%
103	WSP Internal Review of updated PEIR	WSP Environment	7 days	Fri 22/06/18	Mon 02/07/18	102	104	Jon Davey	100%
104	NCC review of PEIR Design	NCC	2 days	Tue 03/07/18	Wed 04/07/18	103	105	Mark Kemp	100%
105	NCC sign off of PEIR Design	NPLAW	5 days	Thu 05/07/18	Wed 11/07/18	104	106	John Flack	100%
106	Design Freeze to reflect bidder feedback	NCC	0 days	Wed 11/07/18	Wed 11/07/18	105	107	Mark Kemp	100%
107	WSP Environment Team Amendments	WSP Environment	4 days	Thu 12/07/18	Tue 17/07/18	106	108	Jon Davey	50%
108	NCC sign off of PEIR Design	NCC	5 days	Wed 18/07/18	Tue 24/07/18	107	109	Jon Davey	0%
109	Preparation & issue of final PEIR	WSP Environment	3 days	Wed 25/07/18	Fri 27/07/18	108	110	Jon Davey	0%
110	Final version for issue	WSP Environme	0 days	Fri 27/07/18	Fri 27/07/18	109	818,1186,118	Jon Davey	0%
111	ES delivery (see DCO deliverables Section 6)	WSP Environme	0 days	Fri 22/02/19	Fri 22/02/19	645		Jon Davey	0%
112	Consultation		394 days?	Mon 09/10/17	Tue 07/05/19				34%
113	Design Freeze - Consultation	NCC	0 days	Wed 23/05/18	Wed 23/05/18	40		Mark Kemp	100%
114	Section 47 Consultations (General Public)		135 days	Mon 26/03/18	Fri 05/10/18				57%
179	Section 42 Consultations (Statutory Parties)		394 days?	Mon 09/10/17	Tue 07/05/19				26%
292	Section 47, 42 and 48		15 days	Mon 08/10/18	Fri 26/10/18				0%
294	PINS Meetings		259 days	Fri 09/02/18	Fri 22/02/19				40%
295	Meeting 1	NCC/NPLAW/W!	1 day	Fri 09/02/18	Fri 09/02/18			Mike Denny	100%
296	Meeting 2	NCC/NPLAW/W!	1 day	Tue 12/06/18	Tue 12/06/18			Mike Denny	100%



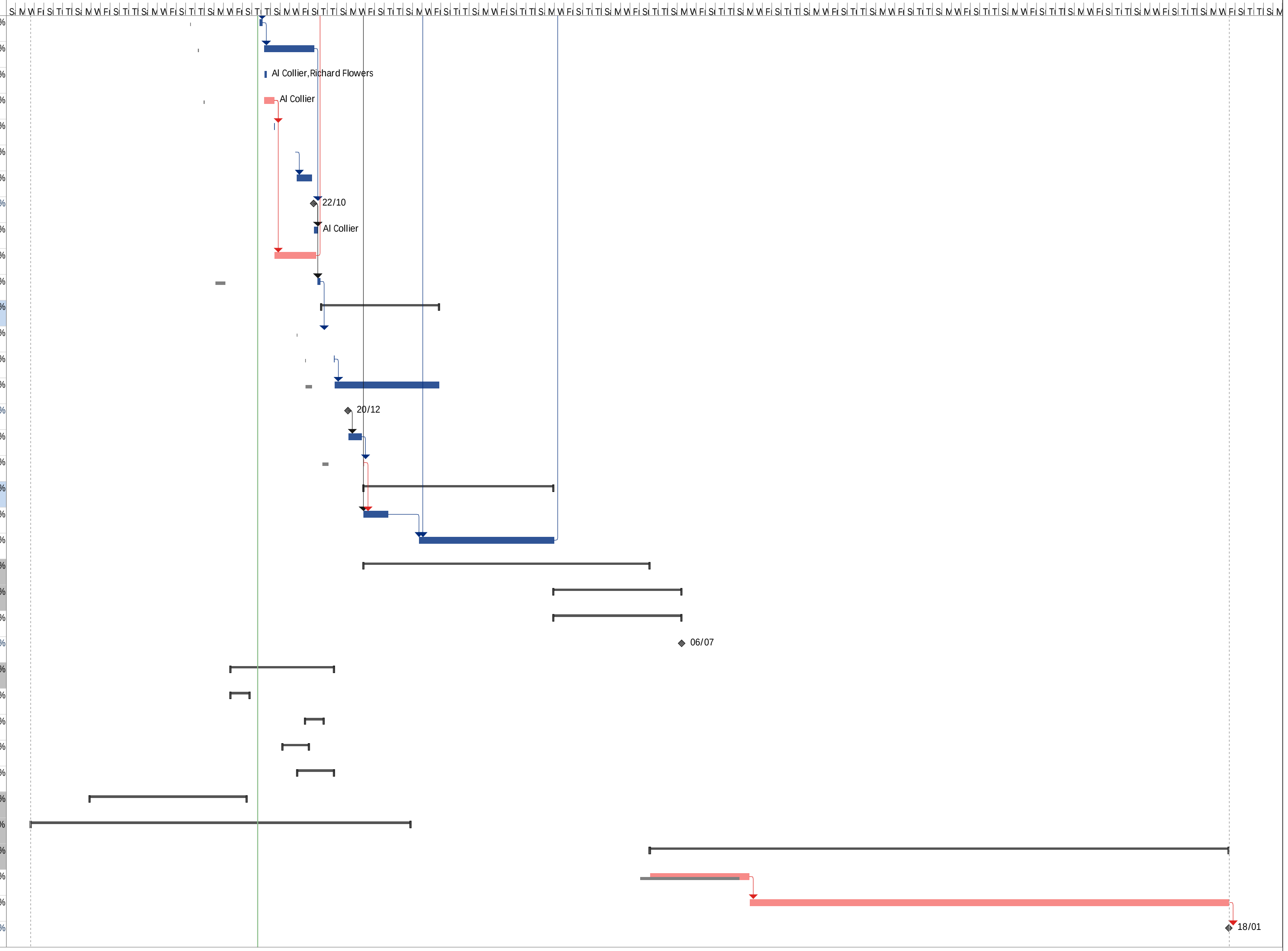
Great Yarmouth Third River Crossing
DCO
Rev 13.18 13.07.18

ID		Task Mode	Task Name	Owner	Duration	Start	Finish	Predecessors	Successors	Resource Names	% Complete
297			Meeting 3 - TBC	NCC/NPLAW/W:	1 day	Mon 08/10/18	Mon 08/10/18	177		Mike Denny	0%
298			Meeting 4 - TBC	NCC/NPLAW/W:	1 day	Wed 19/12/18	Wed 19/12/18	1310SS-60 days		Mike Denny	0%
299			Meeting 5 - TBC	NCC/NPLAW/W:	1 day	Fri 22/02/19	Fri 22/02/19	1310SS-20 days		Mike Denny	0%
300			Order Documentation		361 days	Mon 09/10/17	Thu 21/03/19		1311		1%
301			DCO Deliverables		356 days	Mon 09/10/17	Thu 14/03/19				1%
302			Finalise WSP inputs and responsibilities	WSP DCO	13 days	Fri 15/12/17	Wed 10/01/18			Mike Denny	100%
303			Final legal review and sign off of DCO Deliverable Checklist	NPLAW	2 days	Thu 15/03/18	Fri 16/03/18			John Flack	100%
304			Design Freeze DCO	NCC	0 days	Tue 30/10/18	Tue 30/10/18	40	247	Mark Kemp	0%
305			1. Application Form		88 days	Mon 01/10/18	Fri 08/02/19		1309		0%
342			2. Plans / Drawings / Sections		164 days	Wed 18/07/18	Thu 14/03/19		1309		0%
558			3. Draft DCO		203 days	Thu 15/03/18	Wed 09/01/19		1309		10%
587			4. Compulsory Acquisition Information		217 days	Mon 16/04/18	Tue 26/02/19				0%
627			5. Reports and Statements		124 days	Tue 28/08/18	Tue 26/02/19		1309		0%
645			6. Environmental Statement (and associated deliverables)		142 days	Mon 30/07/18	Fri 22/02/19		111,1309,119		0%
1182			7. Other Reports / Documents		356 days	Mon 09/10/17	Thu 14/03/19		1309		7%
1309			Final review and printing	NCC	5 days	Fri 15/03/19	Thu 21/03/19	1182,645,627,558	1310	Mark Kemp	0%
1310			DCO submission	NPLAW, NCC	0 days	Thu 21/03/19	Thu 21/03/19	1309	298SS-60 day	John Flack,Mark Ke	0%
1311			Acceptance (Statutory 28 days)		20 days	Fri 22/03/19	Thu 18/04/19	300			0%
1312			Receipt of acceptance of application		20 days	Fri 22/03/19	Thu 18/04/19		1314FF,1316F		0%
1313			Pre-examination		45 days	Fri 05/04/19	Thu 06/06/19				0%
1314			Prepare Section 56 Notice		10 days	Fri 05/04/19	Thu 18/04/19	1312FF	1315FS-5 days		0%
1315			Issue Section 56 Notice		10 days	Fri 12/04/19	Thu 25/04/19	1314FS-5 days	1317		0%
1316			Publish Section 56 Notice		0 days	Thu 18/04/19	Thu 18/04/19	1312FF,1312FF	1317		0%
1317			Registration period amnd PINS Appoint EX		30 days	Fri 26/04/19	Thu 06/06/19	1315,1316	1319,1320,13		0%
1318			Examination (Statutory 6 Months max)		129 days	Wed 05/06/19	Mon 02/12/19				0%
1319			Examination period		90 days	Fri 07/06/19	Thu 10/10/19	1317	1332		0%
1320			Responding to relevant representations		43 days	Fri 07/06/19	Tue 06/08/19	1317			0%
1321			Responding to examiners questions (2 rounds plus Rule 17s)		90 days	Fri 07/06/19	Thu 10/10/19	1317			0%
1322			Statement of Common Ground updating		90 days	Fri 07/06/19	Thu 10/10/19	1317			0%
1323			Hearings (x8)		90 days	Wed 05/06/19	Tue 08/10/19	1317			0%
1324			Hearing no. 1	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1325			Hearing no. 2	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1326			Hearing no. 3	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1327			Hearing no. 4	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1328			Hearing no. 5	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1329			Hearing no. 6	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1330			Hearing no. 7	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1331			Hearing no. 8	NCC, WSP Envirc	1 day?	Wed 05/06/19	Wed 05/06/19			Mark Kemp,Jon Da	0%
1332			End examination period		0 days	Mon 02/12/19	Mon 02/12/19	1319,1415	1334,1419		0%
1333			Determination (Two statutory periods of 3 months each)		215 days	Tue 03/12/19	Mon 28/09/20				0%
1334			Recommendation report issued by ExA to SoS		45 days	Tue 03/12/19	Mon 03/02/20	1332	1335		0%
1335			Decision issued by SoS/Making of DCO		45 days	Tue 04/02/20	Mon 06/04/20	1334	1336		0%
1336			Legal challenge window (after DCO made)		30 days	Tue 07/04/20	Mon 18/05/20	1335	1337,1427		0%
1337			Prepare materials to discharge requirements		30 days	Tue 19/05/20	Mon 29/06/20	1336	1338		0%
1338			Discharge of DCO Requirements		65 days	Tue 30/06/20	Mon 28/09/20	1337			0%
1339			PROCUREMENT		543 days	Mon 09/10/17	Mon 02/12/19				32%
1340			Procurement Documentation		119 days	Mon 09/10/17	Tue 03/04/18				100%
1380			Pre-qualification		43 days	Mon 19/02/18	Fri 20/04/18				100%
1387			Dialogue		137 days	Fri 20/04/18	Fri 02/11/18				15%
1388			Issue of Invitation to Participate in Dialogue to shortlisted Bidders; inform unsucc	NCC	0 days	Fri 20/04/18	Fri 20/04/18	1385		Al Collier	100%
1389			Opportunity for Bidders to provide feedback on initial design (see 5.3)	NCC	14 days	Wed 25/04/18	Tue 15/05/18		1390	Al Collier	100%
1390			Closing date for submission of presentation for Outline Solution	NCC	0 days	Tue 15/05/18	Tue 15/05/18	1389		Al Collier	100%
1391			Outline Solution Presentations	NCC	2 days	Thu 17/05/18	Fri 18/05/18			Al Collier	100%
1392			Outline Solution Dialogue including form of bridge	NCC	13 days	Tue 22/05/18	Fri 08/06/18			Al Collier	100%
1393			Closing date for submission of Outline Proposal	NCC	0 days	Tue 03/07/18	Tue 03/07/18			Al Collier	100%
1394			Notify shortlisted Bidders (3)	NCC	1 day	Fri 20/07/18	Fri 20/07/18		1395	Al Collier	0%



Great Yarmouth Third River Crossing
DCO
Rev 13.18 13.07.18

ID		Task Mode	Task Name	Owner	Duration	Start	Finish	Predecessors	Successors	Resource Names	% Complete
1395			Bidders prepare for dialogue sessions - Contract Schedules	Bidders	5 days	Mon 23/07/18	Fri 27/07/18	1394	1396		0%
1396			Bidders prepare initial design	Bidders	60 days	Mon 30/07/18	Mon 22/10/18	1395	1402		0%
1397			Session for bidders to discuss initial design with WSP & NCC	NCC, WSP	4 days	Tue 31/07/18	Fri 03/08/18			Al Collier,Richard Fl	0%
1398			Dialogue sessions – Contract Schedules, including risk and some elements of price		14 days	Mon 30/07/18	Thu 16/08/18		1404,1399	Al Collier	0%
1399			Bidders submit quantities for elements designed by the client; client reviews and raises any concerns	Bidders	1 day	Fri 17/08/18	Fri 17/08/18	1398			0%
1400			Bidders submit: prices for elements designed by the client risk pricing	Bidders	1 day	Fri 21/09/18	Fri 21/09/18		1401		0%
1401			Further discussions about commercial issues and method statements, if required	Bidders	20 days	Mon 24/09/18	Fri 19/10/18	1400			0%
1402			Submission of initial design and price		0 days	Mon 22/10/18	Mon 22/10/18	1396	1405FS+4 day		0%
1403			Shortlisted bidders submit initial design	NCC Procuremer	5 days	Tue 23/10/18	Mon 29/10/18	1402		Al Collier	0%
1404			Feedback from Bidder Dialogue input into DCO	Bidders	50 days	Fri 17/08/18	Fri 26/10/18	1398	51		0%
1405			Dialogue Sessions – Design and Price		5 days	Mon 29/10/18	Fri 02/11/18	1402FS+4 days	1407		0%
1406			Invitation to Final Tender (BAFO)		136 days	Mon 05/11/18	Wed 22/05/19				0%
1407			Issue Invitation to Final Tender		1 day	Mon 05/11/18	Mon 05/11/18	1405			0%
1408			Deadline for submission of final tender documents		1 day	Mon 26/11/18	Mon 26/11/18		1409		0%
1409			Period for which offers must remain open for acceptance		120 days	Tue 27/11/18	Wed 22/05/19	1408			0%
1410			Expected date for issuing intention to award letters and for standstill period to commence		0 days	Thu 20/12/18	Thu 20/12/18		1411		0%
1411			Expected date for standstill period to finish		10 days	Thu 20/12/18	Fri 11/01/19	1410	1412		0%
1412			Contract Award		1 day	Tue 15/01/19	Tue 15/01/19	1411	1414FS-1 day,		0%
1413			Contractor DCO Input		230 days	Tue 15/01/19	Mon 02/12/19				0%
1414			Review DCO submission	Contractor	30 days	Tue 15/01/19	Mon 25/02/19	1412FS-1 day,51	1415		0%
1415			Input into DCO process	Contractor	162 days	Fri 19/04/19	Mon 02/12/19	1414,1312	1332		0%
1416			CONTRACTOR Detailed Design		347 days	Tue 15/01/19	Wed 13/05/20				0%
1421			DfT APPROVALS		155 days	Tue 03/12/19	Mon 06/07/20				0%
1422			Final business case		155 days	Tue 03/12/19	Mon 06/07/20				0%
1429			DfT approval of FBC	DfT	0 days	Mon 06/07/20	Mon 06/07/20	1428			0%
1430			GOVERNANCE		124 days	Mon 04/06/18	Mon 26/11/18				0%
1431			ETD Committee Meeting - Post stage 2 consultation		25 days	Mon 04/06/18	Fri 06/07/18				0%
1435			ETD Committee Meeting - Post stage 3 consultation update		24 days	Mon 08/10/18	Fri 09/11/18				0%
1439			Full Council - Capital Expenditure Approval		31 days	Fri 31/08/18	Mon 15/10/18				0%
1443			PR - Delegated Authority to appoint Contractor		44 days	Tue 25/09/18	Mon 26/11/18				0%
1450			NCC REVIEWS		180 days	Mon 09/10/17	Mon 02/07/18				0%
1462			SURVEY WORKS		440 days?	Sat 01/07/17	Thu 04/04/19				30%
1545			SITE WORKS		700 days	Thu 14/05/20	Wed 18/01/23				0%
1546			Main Contract & M&E Mobilisation		120 days	Thu 14/05/20	Wed 28/10/20	1417	1547		0%
1547			Construction period		580 days	Thu 29/10/20	Wed 18/01/23	1546	1548		0%
1548			GYTRC opens		0 days	Wed 18/01/23	Wed 18/01/23	1547			0%



Appendix B – Gateway Review Action Plan

3RC Gateway Review Action Plan: 2017

	Gateway Review Task	Action Required	By who	By when	Progress	BRAG
1.	**NCC should incorporate GY3RC into the Corporate Risk Register and monitor/ manage emergent risks actively.**	Provide details for inclusion in NCC corporate risk register. Details to be agreed with risk manangement team.	DA	**Complete** Ongoing task to update	Details developed and discussed with corporate risk team. DMT meeting has reviewed details and confirmed acceptance, subject to confirmation of funding (to be reviewed depending on timescales for this by DfT). All details ready to be published and being managed.	GREEN
2.	**NCC should develop and roll out a comprehensive communication and engagement strategy for GY3RC.**	Develop Comms plan for project working with NCC Comms team. Develop actions to enable tracking against key tasks.	CS	By end Dec 2017 **Complete** Updates via Board mtgs	Comms plan developed and initial stage of informal consultation completed on 6 October 2017. Details to be reported to 10 November 2017 Committee meeting. Plan to then be further developed and actions from late 2017 and through 2018 to support statutory processes.	GREEN
3.	**NCC should identify an Officer at management board level (Executive Director) who can act as the visible champion for the GY3RC.**	Seek approval and agreement for revised Board membership and update governance arrangements (see next item).	DA	Critical (no timescale provided) **Complete**	Agreed with Board at meeting in September that the Executive Director Communities and Environmental Services will Chair the Board and provide necessary support to deliver the project. Details confirmed in line with updated governance, which is (also includes potential for DfT to input to the Board meetings at their discretion).	GREEN
4.	**NCC should create and / or review the Governance arrangements (including the Terms of Reference and memberships of groups/ teams) for GY3RC.**	Provide revised governance structure and assess attendance at different meetings to better support the project delivery.	DA/MK	Essential within 1 month **Complete**	Review and update of governance ongoing as the project now moves to the next stages of delivery. Governance working reasonably, but revised structure of team meetings and board meetings now established – see updated governance structure (October 17).	GREEN
5.	**NCC should appoint dedicated project resources and consider the co-location of internal and external project team resources to assist with project integration.**	Provide dedicated Project Manager for the project and agree resources required and delivery model for the project. Co-locate staff where possible.	DA	Essential within 3 months **PM in place, wider resource to be agreed**	Project Manager (MK) in role and dedicated to 3RC. Discussions ongoing with WSP and other sections of NCC to develop project team structure and locate staff where possible in close proximity or through managed meetings. Includes need for close working with NCC procurement team. Other advisors also being procured. **Amber until wider resource resolved/agreed.**	AMBER
6.	**NCC should produce a "Big Picture"/ "Critical Path" high-level timeline showing all key milestones and decision points.**	Full detailed project programme and plan to be provided. Regular 'rolled up' activity version to be provided to project board.	MK	Essential within 1 month **Complete**	Discussed at 10 October 2017 meeting of Board. This will be updated and monthly reviews provided to Board. Key milestones and achievement of target dates will be used as basis for managing project and reporting to Committee.	GREEN

7.	**NCC should develop a local contribution funding strategy,** **process and plan.**	A list of possible funding sources to be developed with a strategy setting out possible approaches to be made and by who.	DA/AS	Essential within 3 months **Complete**	Initial discussion held to develop possible sources of funding. To be discussed and next steps agreed with Board at 10 October 2017 meeting. This will be an ongoing active document/process to be discussed at Board meetings to timescales as appropriate.	**GREEN**
8.	**NCC should complete its research and engage with key stakeholders at the appropriate level before non-statutory consultation.**	Identify key stakeholders and ensure there is sufficient understanding of issues such that this can inform any consultation and project development information.	DA/MK	Critical **Complete (and ongoing)**	Meetings held with key stakeholders including GYBC, Peel Ports, Gardline and Alicat (as key port users). Wider consultee list developed and managed as part of informal consultation development and delivery. Ongoing activity and being managed to ensure responses are received from key organisations. Meeting held with Peel Ports in Liverpool at end of October 2017 (discussed initial statement of common ground).	**GREEN**

NB. *Regular updates to Members to be provided through regular Committee reporting. Monthly updates to be provided at Board meetings.*

Key = BRAG Status

RED	**AMBER**	**GREEN**	**BLUE**	**WHITE**
Significant issues exist requiring consideration by COG or Programme Board and immediate action to be taken. Benefits - this benefit will not be achieved	Some (actual or anticipated) variation from the project plan but actions in hand to maintain progress. Benefits - some of the benefit may not be achieved	On schedule – progress in line with agreed project plan Benefits - this benefit will be achieved	Project / Work Package / Benefit completed	Being developed - Project has been approved but is in Initiation Stage