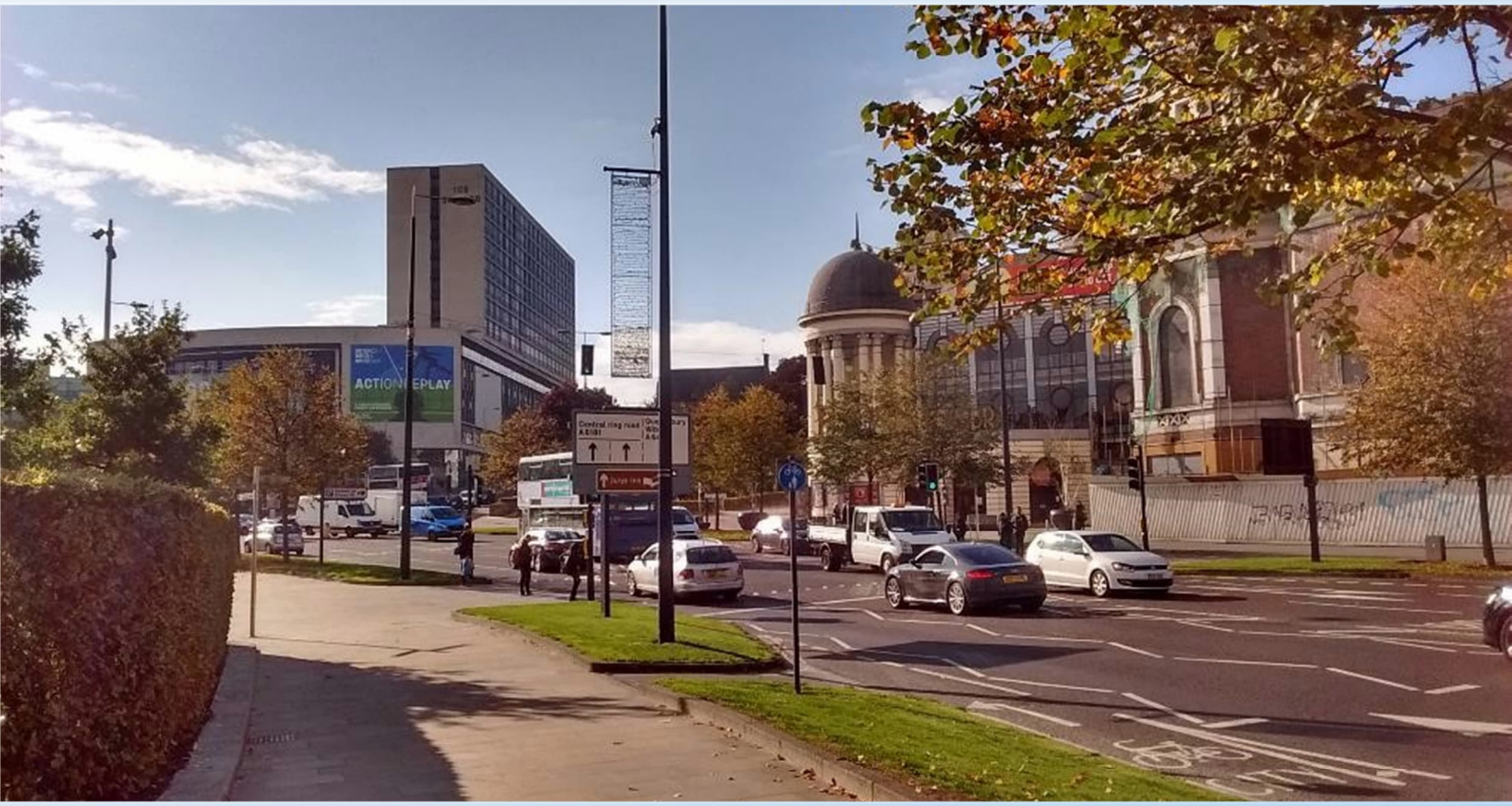
North Yorkshire County Council and Selby District Council

SELBY DISTRICT TRAFFIC MODEL

Transport Forecasting Report



TFR
AUGUST 2022

CONFIDENTIAL

North Yorkshire County Council and Selby District Council

SELBY DISTRICT TRAFFIC MODEL

Transport Forecasting Report

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70081319

OUR REF. NO. TFR

DATE: AUGUST 2022

North Yorkshire County Council and Selby District Council

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Transport Forecasting Report

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	Version 1.0 – Initial Draft			
Date	24/08/2022			
Prepared by	Samuel Callaghan/ Shourya Dadhich			
Signature				
Checked by	Narendra Sadhale			
Signature				
Authorised by				
Signature				
Project number	70081319			
Report number	TFR v1.0			

CONTENTS

1 INTRODUCTION 12

1.1 PURPOSE OF THIS REPORT 12
1.2 BACKGROUND 12
1.3 STRUCTURE OF REPORT 12
1.4 FORECASTING – KEY ASSUMPTIONS AND RISKS 13

2 BASE MODEL OVERVIEW 14

2.1 INTRODUCTION 14
2.2 SUMMARY OF MODEL AREA 14
2.3 SEGMENTATION 16
2.4 FITNESS FOR PURPOSE 17

3 FORECASTING APPROACH AND REQUIREMENTS 18

3.1 INTRODUCTION 18
3.2 APPROACH TO FORECASTING 18
3.3 FORECASTING REQUIREMENTS 19
3.4 SUMMARY OF FORECASTING STAGES 20

4 FUTURE YEAR SCENARIOS 21

4.1 INTRODUCTION 21
4.2 FORECAST YEARS 21
4.3 SCENARIO DEFINITIONS 21
4.4 UNCERTAINTY 22
4.5 DEVELOPMENT SITES 23
4.6 INFRASTRUCTURE AND SERVICES 31

5 REFERENCE DEMAND FORECASTING 33

5.1 INTRODUCTION 33
5.2 BACKGROUND GROWTH 34
5.3 DEVELOPMENT TRIP GENERATION 35
5.4 DEVELOPMENT TRIP DISTRIBUTION 40
5.5 CORE SCENARIO REFERENCE MATRIX TOTALS 41

6 SUPPLY FORECASTING 42

6.1 INTRODUCTION 42
6.2 DO MINIMUM SCHEME CODING 42
6.3 FUTURE YEAR SPEED FORECASTING 42
6.4 FUTURE YEAR GENERALISED COST PARAMETERS 43
6.5 FUTURE YEAR TOLL ASSUMPTIONS 43
6.6 FORECAST YEAR NETWORK CHECKS 43

7 VARIABLE DEMAND FORECASTING 45

7.1 INTRODUCTION 45
7.2 VARIABLE DEMAND MODEL METHODOLOGY 45
7.3 VARIABLE DEMAND MODEL CONVERGENCE 47
7.4 VARIABLE DEMAND FORECAST MATRIX TOTALS 47
7.5 IMPACTS OF VARIABLE DEMAND MODELLING 53

8 CORE SCENARIO ASSIGNMENT RESULTS 71

8.1 INTRODUCTION 71
8.2 DEFINITION OF VARIOUS PARAMETERS USED FOR REPORTING 71
8.3 RESULTS FOR 2040DM 74
8.4 HIGHWAY ASSIGNMENT IMPACTS 76
8.5 RESULTS FOR 2040 DS1 84
8.6 HIGHWAY ASSIGNMENT IMPACTS 86
8.7 RESULTS FOR 2040 DS2 95

8.8 HIGHWAY ASSIGNMENT IMPACTS 97
8.9 RESULTS FOR 2040 DS3 105
8.10 HIGHWAY ASSIGNMENT IMPACTS 107
8.11 RESULTS FOR 2040 DS4 116
8.12 HIGHWAY ASSIGNMENT IMPACTS 118
8.13 SUMMARY (BEING PREPARED) 126
9 SUMMARY AND CONCLUSIONS 130
9.1 SUMMARY 130
9.2 CONCLUSIONS 130
9.3 NEXT STAGES 130

TABLES

Table 2-1 – SDSTM Modelled Time Periods 16
Table 2-2 – SDSTM Modelled User Classes 17
Table 4-1 – Classifications of Uncertainty 22
Table 4-2 – Selby District Residential Sites 24
Table 4-3 – Selby District Employment Sites included in 2040 DM 29
Table 4-4 – Selby District Employment Sites included in 2040 DS1 30
Table 4-5 – Employment Densities 30
Table 4-6 – Selby District Highway Infrastructure Schemes and service 31
Table 5-1 – Summary of NTEM Growth Factors (2019-2040) 35
Table 5-2 – Summary of NTM Growth Factors 35
Table 5-3 – AM Peak Trip Rates 36
Table 5-4 – Inter Peak Trip Rates 37
Table 5-5 – PM Peak Trip Rates 38
Table 5-6 – 2040 DM AM Development Trips (vehs) 39
Table 5-7 – 2040 DM Inter Peak Development Trips (vehs) 39
Table 5-8 – 2040 DM PM Peak Development Trips (vehs) 39
Table 5-9 – 2040 DS1 AM Development Trips (vehs) 39

Table 5-10 – 2040 DS1 Inter Peak Development Trips (vehs) 40
Table 5-11 – 2040 DS1 PM Peak Development Trips (vehs) 40
Table 5-12 – Gravity Model Calibration Summary 40
Table 6-1 – Highway Assignment Generalised Cost Parameters (2019-2040) 43
Table 7-1 – Variable Demand Model Convergence 47
Table 7-2 – Reference Demand Core 2040 DM (Person Trips) 48
Table 7-3 – Reference Demand 2040 DS1 (Person Trips) 49
Table 7-4 – Impacts of VDM on Car Average Trip Length- 2040 DM 53
Table 7-5 – Impacts of VDM on Car Average Trip Length- 2040 DS1 53
Table 7-6 – Impacts of VDM on Car Average Trip Length- 2040 DS2 54
Table 7-7 – Impacts of VDM on Car Average Trip Length- 2040 DS3 54
Table 7-8 – Impacts of VDM on Car Average Trip Length- 2040 DS4 54
Table 8-1 – Core Scenario Highway Assignment Convergence Statistics 74
Table 8-2 – Highway Assignment Network Statistics: AM Peak 75
Table 8-3 – Highway Assignment Network Statistics: Inter Peak 75
Table 8-4 – Highway Assignment Network Statistics: PM Peak 75
Table 8-5 – Journey Time Routes, 2040 DM compared with 2019 Base 76
Table 8-6 – Core Scenario Highway Assignment Convergence Statistics, 2040 DS1 84
Table 8-7 – Highway Assignment Network Statistics: AM Peak 85
Table 8-8 – Highway Assignment Network Statistics: Inter Peak 85
Table 8-9 – Highway Assignment Network Statistics: PM Peak 86
Table 8-10 – Journey Time Routes, 2040 86
Table 8-11 – Core Scenario Highway Assignment Convergence Statistics 95
Table 8-12 – Highway Assignment Network Statistics: AM Peak 96
Table 8-13 – Highway Assignment Network Statistics: Inter Peak 96
Table 8-14 – Highway Assignment Network Statistics: PM Peak 96
Table 8-15 – Journey Time Routes, 2040 DS2 97
Table 8-16 – Core Scenario Highway Assignment Convergence Statistics 105
Table 8-17 – Highway Assignment Network Statistics: AM Peak 106
Table 8-18 – Highway Assignment Network Statistics: Inter Peak 106
Table 8-19 – Highway Assignment Network Statistics: PM Peak 107

Table 8-20 – Journey Time Routes, 2040 DS3 107
Table 8-21 – Core Scenario Highway Assignment Convergence Statistics 116
Table 8-22 – Highway Assignment Network Statistics: AM Peak 117
Table 8-23 – Highway Assignment Network Statistics: Inter Peak 117
Table 8-24 – Highway Assignment Network Statistics: PM Peak 117
Table 8-25 – Journey Time Routes, 2040 DS4 118
Table 8-26 – Highway assignment network statistics summary, AM peak hour 126
Table 8-27 – Highway assignment network statistics summary, IP hour 127
Table 8-28 – Highway assignment network statistics summary, PM peak hour 127
Table 8-25 – Junction Volume over Capacity summary 129

FIGURES

Figure 2-1 – Selby District Transport Model 14
Figure 2-2 – Fully Modelled Area Network Coverage 15
Figure 3-1 – Approach to Forecasting 18
Figure 5-1 – Reference Demand Methodology – to be updated 34
Figure 7-1 – SVDM Structure and Hierarchy 46
Figure 7-2 – Impacts of VDM Sector System 55
Figure 8-1 – Journey Time Routes 73
Figure 8-2 - Demand Flow Difference 2040DM – 2019 Base (AM) 79
Figure 8-3 - Demand Flow Difference 2040DM – 2019 Base (IP) 79
Figure 8-4 - Demand Flow Difference 2040DM – 2019 Base (PM) 80
Figure 8-5 - Link VOC 2040 DM (AM) 81
Figure 8-6 - Link VOC 2040 DM (IP) 81
Figure 8-7 - Link VOC 2040 DM (PM) 82
Figure 8-8 - Turn VOC 2040 DM (AM) 83
Figure 8-9 - Turn VOC 2040 DM(IP) 83
Figure 8-10 - Turn VOC 2040 DM (PM) 84
Figure 8-11 - Demand Flow Difference 2040 DS1-DM (AM) 89
Figure 8-12 - Demand Flow Difference 2040 DS1-DM (IP) 90

Figure 8-13 - Demand Flow Difference 2040 DS1-DM (PM) 90
Figure 8-14 - Link VOC 2040 DS1 (AM) 91
Figure 8-15 - Link VOC 2040 DS1 (IP) 92
Figure 8-16 - Link VOC 2040 DS1 (PM) 92
Figure 8-17 - Turn VOC 2040 DS1 (AM) 93
Figure 8-18 - Turn VOC 2040 DS1 (IP) 94
Figure 8-19 - Turn VOC 2040 DS1 (PM) 94
Figure 8-20 - Demand Flow Difference 2040 DS2-DM (AM) 100
Figure 8-21 - Demand Flow Difference 2040 DS2-DM (IP) 100
Figure 8-22 - Demand Flow Difference 2040 DS2-DM (PM) 101
Figure 8-23 - Link VOC 2040 DS2 (AM) 102
Figure 8-24 - Link VOC 2040 DS2 (IP) 102
Figure 8-25 - Link VOC 2040 DS2 (PM) 103
Figure 8-26 - Turn VOC 2040 DS2 (AM) 104
Figure 8-27 - Turn VOC 2040 DS2 (IP) 104
Figure 8-28 - Turn VOC 2040 DS2 (PM) 105
Figure 8-29 - Demand Flow Difference 2040 DS3-DM (AM) 110
Figure 8-30 - Demand Flow Difference 2040 DS3-DM (IP) 111
Figure 8-31 - Demand Flow Difference 2040 DS3-DM (PM) 111
Figure 8-32 - Link VOC 2040 DS3 (AM) 112
Figure 8-33 - Link VOC 2040 DS3 (IP) 113
Figure 8-34 - Link VOC 2040 DS3 (PM) 113
Figure 8-35 - Turn VOC 2040 DS3 (AM) 114
Figure 8-36 - Turn VOC 2040 DS3 (IP) 115
Figure 8-37 - Turn VOC 2040 DS3 (PM) 115
Figure 8-38 - Demand Flow Difference 2040 DS4-DM (AM) 121
Figure 8-39 - Demand Flow Difference 2040 DS4-DM (IP) 121
Figure 8-40 - Demand Flow Difference 2040 DS4-DM (PM) 122
Figure 8-41 - Link VOC 2040 DS4 (AM) 123
Figure 8-42 - Link VOC 2040 DS4 (IP) 123
Figure 8-43 - Link VOC 2040 DS4 (PM) 124

Figure 8-44 - Turn VOC 2040 DS4 (AM) 125
Figure 8-45 - Turn VOC 2040 DS4 (IP) 125
Figure 8-46 - Turn VOC 2040 DS4 (PM) 126

APPENDICES

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1 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

1.1.1. This Transport Forecasting Report (TFR) documents the forecasting assumptions, methodology and outcomes of the development test for the Do-Minimum forecast scenario in year 2040 using the updated Selby District Strategic Transport Model (SDSTM).

1.1.2. The analysis is based on the principles included in DfT's Transport Analysis Guidance (TAG) which defines the best practice for transport modelling, with particular reference to Unit M4 Uncertainty and Forecasting.

1.1.3. This TFR reports on the traffic modelling and analysis undertaken and the resulting outputs associated with the development of the future year reference forecast.

1.1.4. Specifically, this report describes the impact of changes due to selected major developments most likely to be developed by year 2040 on the highway network and summaries the highway performance both on the strategic and local links and on key individual junctions within the simulation area of the model.

1.2 BACKGROUND

1.2.1. Selby is a local government district of North Yorkshire. Selby District Council (SDC) is the local authority for a number of wards within Selby district, including Selby East, Selby West, Tadcaster, Sherburn in Elmet and Eggborough.

1.2.2. It is the southernmost district of North Yorkshire, bound by the unitary authority of City of York to its north, East Riding of Yorkshire to its east, Wakefield council to its south and City of Leeds to its west. Selby district has a population of around 84,000 based on 2011 Census information.

1.2.3. WSP were commissioned by North Yorkshire County Council (NYCC) and SDC to develop the (SDSTM) for a 2019 base year. This modelling suite includes a SATURN highway assignment model in addition to a high-level variable demand model (VDM) being developed in CUBE Voyager.

1.2.4. As part of the scoping work, in 2020, the details of methodology and deliverables were agreed with NYCC and SDC in form of a Model Specification Report (MSR).

1.2.5. This Traffic Forecasting Report is part of the deliverable agreed within the in the MSR and is based on the 2019 Base year model.

1.3 STRUCTURE OF REPORT

1.3.1. The content of this report is structured as follows:

- Chapter 2 –Base Model Overview;
- Chapter 3 – Forecasting approach and requirements;
- Chapter 4 – Future year scenarios;
- Chapter 5 – Reference demand forecasting;
- Chapter 6 – Supply forecasting;
- Chapter 7 – Variable demand forecasting;
- Chapter 8 – Core scenario assignment results
- Chapter 9 – Summary and conclusions.

1.3.2. This report forms part of the reporting package for the SDSTM development which also includes:

- Model Specification Report (MSR);
- Highway Local Model Validation Report (Highway LMVR); and
- Variable Demand Model Report (VDMR).

1.3.3. The MSR highlights the agreed methodology used to deliver the Selby modelling along with key deliverables. The latter two document the development, calibration and validation of the base year highway assignment model and variable demand model (VDM) respectively and are referred to extensively throughout this report.

1.4 FORECASTING – KEY ASSUMPTIONS AND RISKS

1.4.1. The development of one forecast year was included in the SDSTM project scope to enable the full functionality of the model to be tested, demonstrated and reported.

1.4.2. In this context, the forecast that has been developed and documented in this report are based on the inclusion of development, which includes any other district local plan testing and schemes that are considered “more than likely” or “near certain”, based on local and national scheme uncertainty.

1.4.3. It is worth noting that the assumptions used for this work will be subject to change for future applications of the model based on the intervention to be tested, given that the listed schemes are at various stages of development through the scheme gateway process and the uncertainty assumptions will likely change as each scheme progresses.

1.4.4. This is particularly pertinent in respect to the ongoing COVID-19 outbreak, where the scale of impacts resulting from Government advice and restrictions, and how individuals and businesses respond to those circumstances are difficult to predict for the short, medium and longer term. For example, data has been regularly presented at the daily Government COVID-19 briefings in respect of significant changes in mobility, particularly for transit modes. There will be various studies during and after the lockdown to understand whether changes in mobility endure beyond the pandemic (noting that the future shape of the pandemic itself is uncertain at this stage). Changes may include:

- Frequency of travel – including adjustment of employees and companies to remote working; and
- Mode of travel – with public transport advised to only be used where essential whilst active travel mode funding has recently been brought forward, particularly targeted at mitigating for this in urban areas.

1.4.5. The demonstration forecasts contained herein make use of current assumptions. It is expected that, over time, the assumptions for subsequent applications of the SDSTM will be reviewed, and where necessary updated, reflecting scenario and/or sensitivity testing needs as determined in respective Appraisal Specification Reports.

2 BASE MODEL OVERVIEW

2.1 INTRODUCTION

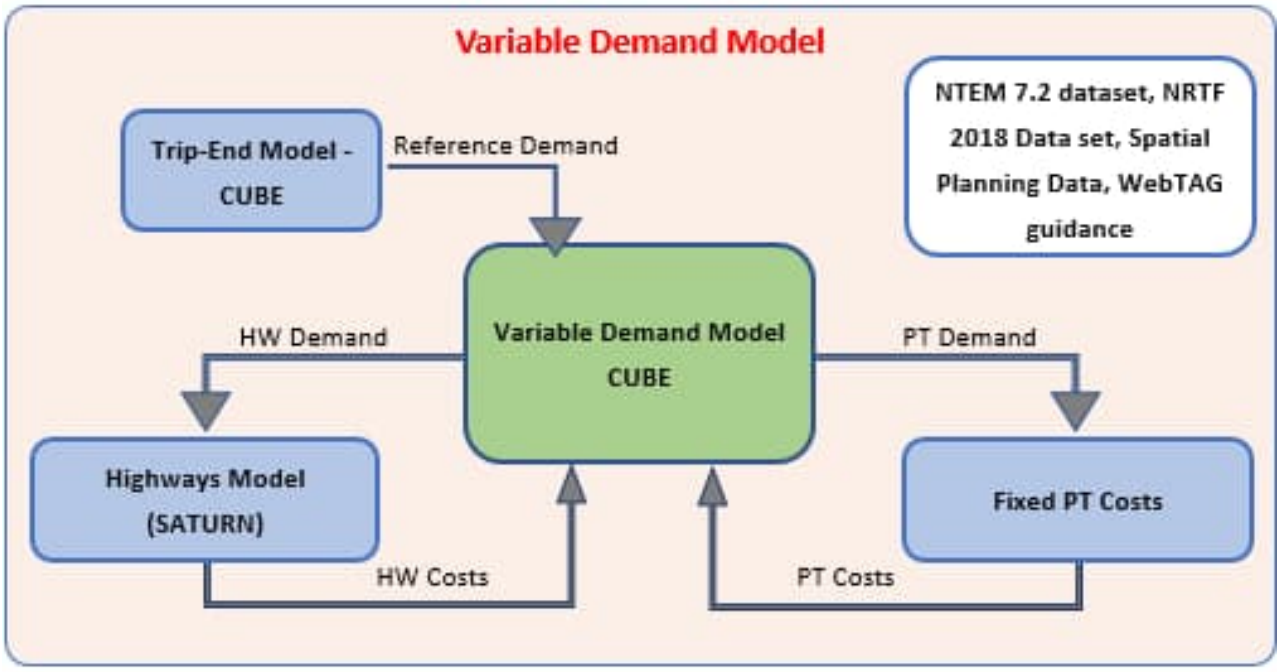
2.1.1. This section of the report provides a brief overview of the calibrated 2019 base year model and its keys assumptions and principal features.

2.1.2. The SDSTM has three key components which are illustrated in Figure 2-1 to demonstrate their interaction within the overall model structure:

- Highway assignment model developed in SATURN (SDSM),
- External forecasting model developed in CUBE Voyager (SEFM), and
- Variable demand model developed in CUBE Voyager (SVDM).

2.1.3. This report is focussed on the application of the whole SDSTM model suite in forecasting mode to prepare future year forecasts, using the calibrated base year SDSM and SVDM models.

Figure 2-1 – Selby District Transport Model



2.2 SUMMARY OF MODEL AREA

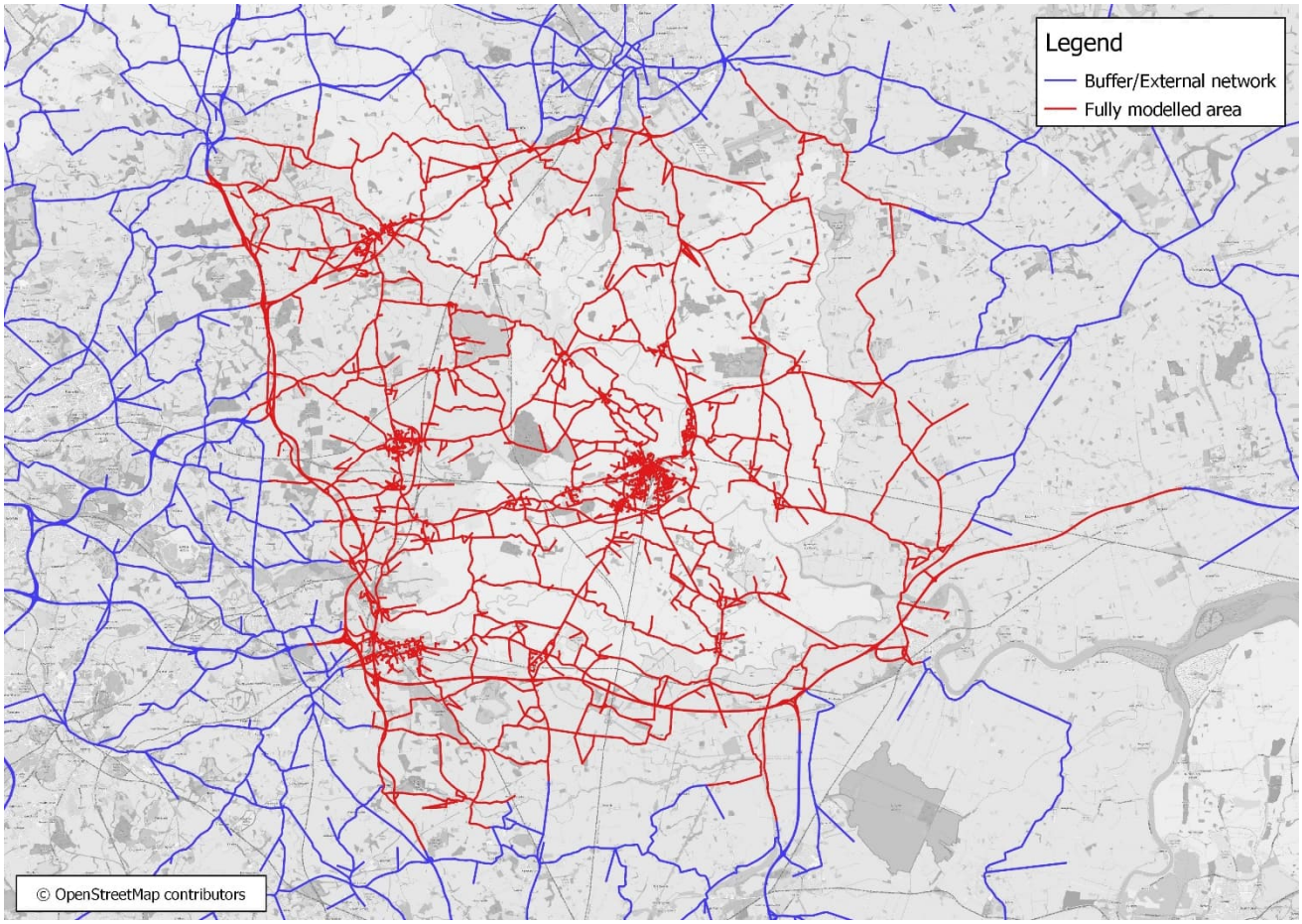
2.2.1. The SDSTM base year model coverage adopts a hierarchical approach to level of detail, in line with TAG. The network coverage and areas of detail, referring to the fully modelled area (FMA), buffer and external area definitions, have been developed as they were defined in the MSR.

- The FMA over which interventions are expected to impact (based on where flow and delay changes are likely to occur given the locations of schemes) includes full trip movements and the network is simulated.
- The extended buffer area over which flow changes will induce speed changes has speed flow curves coded on links.

- The external area over which interventions are not expected to have an impact has only partial representation of trips and a sparse network with fixed speed/flow relationships.

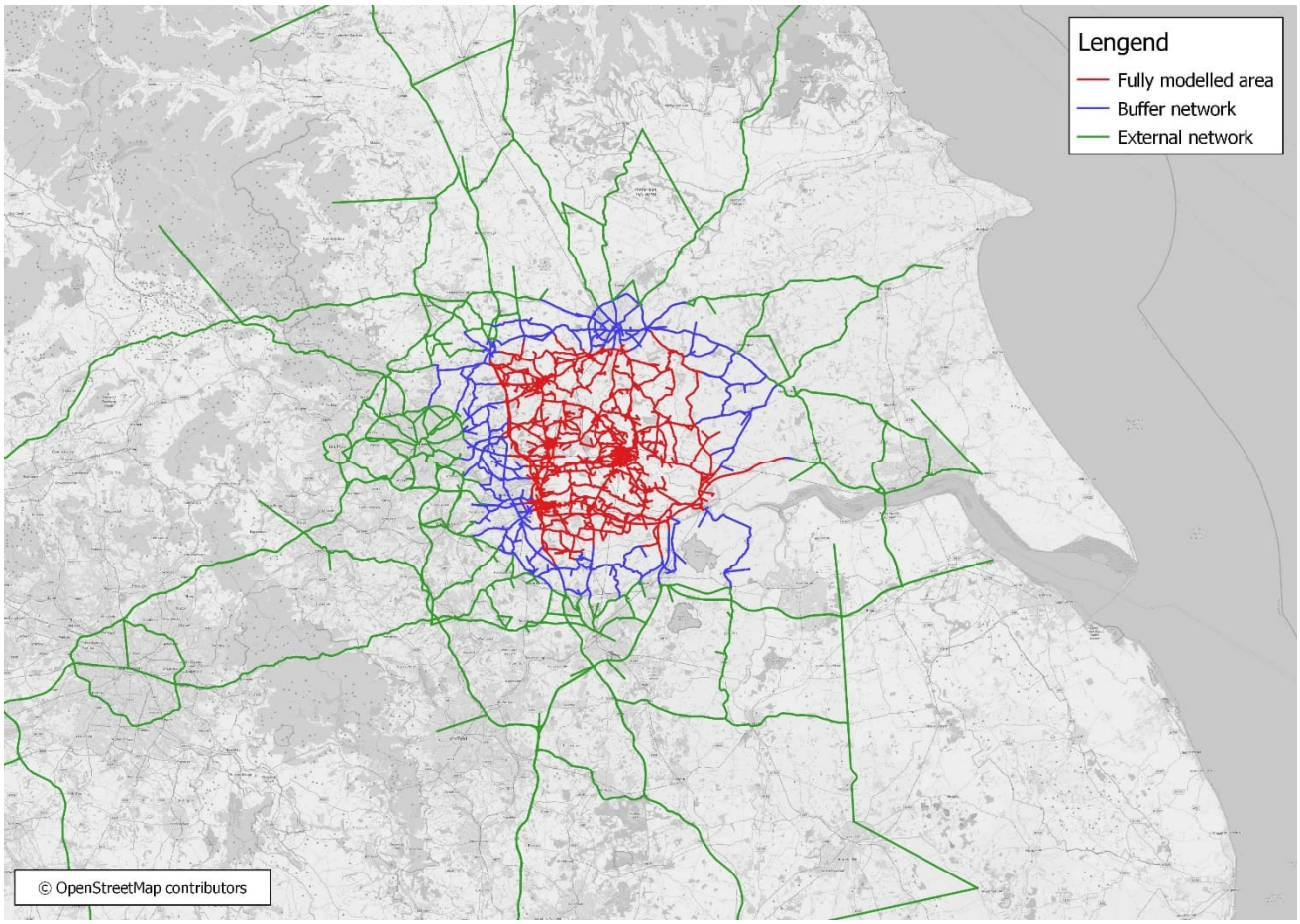
2.2.2. The extent of the FMA is illustrated in Figure 2-2 and covers the whole Selby District area and slightly beyond, including Knottingley and major routes into/across the district, such as the M62, A1(M) and A64.

Figure 2-2 – Fully Modelled Area Network Coverage



2.2.3. The extent of the buffer area and external area are illustrated in Figure 2-3.

Figure 2-3 – Buffer and External Area Network Coverage



2.3 SEGMENTATION

2.3.1. The base year modelled time periods are defined in Table 2-1. The peak hours had been determined through analysis of the daily traffic profile from survey data, which are referenced in the LMVR.

Table 2-1 – SDSTM Modelled Time Periods

Period	SDSM
AM Peak	Peak Hour (08:00-09:00)
Inter Peak	Average Hour (10:00-16:00)
PM Peak	Peak Hour (17:00-18:00)

2.3.2. The forecast modelled user classes are defined in Table 2-2. The base year model was developed with 5 user classes – LGVs and HGVs as single user classes.

Table 2-2 – SDSTM Modelled User Classes

User Class	BHAM
1	Employers Business
2	Commuting
3	Other
4	LGVs (Light Goods Vehicles)
5	HGVs (Heavy Goods Vehicles)

2.3.3. The period and user class segmentation meet requirements with the appropriate level of detail for the expected future applications of the SDSTM based on the model scope, including disaggregation of benefits between business and non-business and conversion of forecast year benefits by time period into annualised totals.

2.4 FITNESS FOR PURPOSE

2.4.1. The appropriateness of the SDSTM forecasting rests on producing realistic responses for proposed schemes to be tested. A key consideration is the demonstration of base year calibration/validation results in line with TAG guideline criteria. The respective model components meet these criteria in most cases, at both the strategic level, and for key areas identified in the brief.

2.4.2. TAG guidance makes clear that determining fitness for purpose is also based on the model providing a realistic traffic response. Whilst model validation provides one indication of this, adherence to benchmark criteria does not guarantee fitness for purpose. Equally, narrowly missing target criteria does not mean that the model cannot be considered fit for purpose[1].

2.4.3. As models are a simplification of reality, those developed for general application across a large study area still need to be reviewed for suitability of application against specific needs.

2.4.4. For future applications of the SDSTM, it is expected that each application should undertake a review of the local base year validation and, if necessary, conduct proportional refinement for the local area, to ensure suitability.

2.4.5. The document “TAG: Guidance for the Technical Project Manager” references this process, considered as best practice when using a generic model for specific scheme forecasting and appraisal. Similar analysis would also form part of an assessment of “realistic results” for specific interventions being tested.

[1] TAG Unit M3.1, Section 3.2

3 FORECASTING APPROACH AND REQUIREMENTS

3.1 INTRODUCTION

3.1.1. The principal purpose for the development of these future year traffic forecasts is to demonstrate the forecasting functionality of the SDSTM, such that the model can then be taken forward and applied on various applications as defined in the scope.

3.1.2. This chapter describes the forecasting requirements including:

- Approach to forecasting;
- Base model specification; and
- Forecasting requirements.

3.1.3. This report summarises the forecasting summary for the 2040 Do-minimum scenario.

3.2 APPROACH TO FORECASTING

3.2.1. The approach to forecasting is broadly summarised in Figure 3-1, reproduced from TAG M4.

3.2.2. The starting point is the validated base year model – the specification is summarised in Chapter 2.

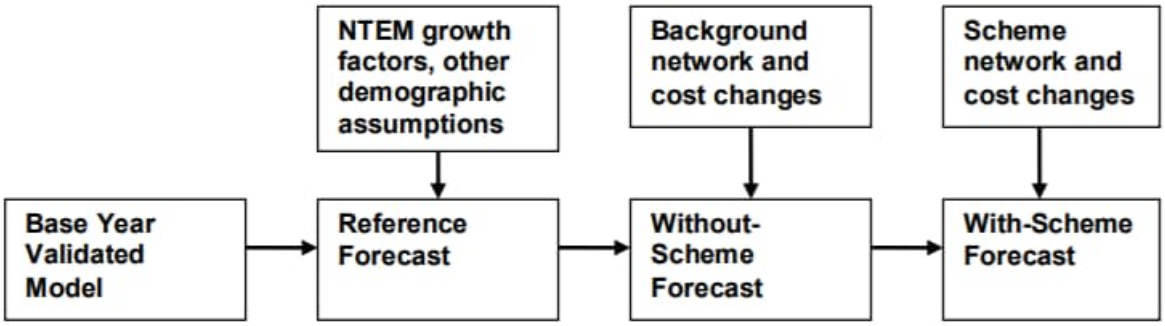
3.2.3. The Reference Case forecasts incorporate changes in travel demand incurred through demographic changes but not changes related to travel costs (including congestion and fares) or other parameters (e.g. value of time). Development of the Reference Case demand is detailed in Chapter 5.

3.2.4. Background network changes (i.e. committed schemes) and changes to travel costs were used to develop fixed and variable demand 'without scheme' forecasts. This is detailed in Chapters 6 and 7.

3.2.5. It was noted in Chapter 1 that this demonstration forecast was included in the SDSTM project scope to enable the full functionality of the model to be tested, demonstrated and reported.

3.2.6. However, the final box in Figure 3-1 demonstrates how forecasting for specific schemes or interventions would be developed, often referred to as a 'Do Something' forecast, using the SDSTM in future applications of the model.

Figure 3-1 – Approach to Forecasting



Source: TAG M4 Figure 1

3.3 FORECASTING REQUIREMENTS

3.3.1. The forecasting requirements for this work are split into three areas:

- Future year travel demand;
- Future year networks; and
- Variable demand modelling.

3.3.2. The former two areas are underpinned by the requirement, set out in TAG M4, to develop an Uncertainty Log which is a record of development and infrastructure assumptions which have been applied in the forecasting. The Uncertainty Log is described in Section 4.4.

3.3.3. Future applications of the SDSTM may have additional forecasting needs, specific to particular scheme appraisal requirements.

Future Year Travel Demand

3.3.4. Future year travel demands for the modelled forecast years take into the account the existing base year traffic demand together with the effects of traffic growth including additional traffic due to new developments.

3.3.5. Projected traffic growth is largely driven by an increasing population, changes to vehicle operating costs and increasing car ownership, linked to greater affluence. Wealth enhances economic activity and also underpins new household formation. Travel demand forecasting is required to assess network performance given these circumstances.

3.3.6. The guidance set out in Tag Unit M4 states that Do-Minimum and Do-Something sensitivity tests considering the impact of lower and higher forecast growth, in line with the Pessimistic and Optimistic growth scenarios as set out in TAG Unit M4 are required for any DfT funding applications.

3.3.7. As agreed in the MSR, this report provides analysis for the core scenario and does not include for any high/low sensitivity tests or for any additional option testing.

3.3.8. The assumptions used to derive the future year travel demands are documented in Chapter 5.

Future Year Travel Networks

3.3.9. Future year forecasts of network conditions consider the impact of user assignment route choice in the networks as a result of the committed highway infrastructure and PT service combined with the impacts from additional traffic growth in the future years.

Variable Demand Modelling

3.3.10. The primary purpose of variable demand modelling is to predict the changes in demand that will occur as a result of changes in transport conditions.

3.3.11. It is recommended in TAG M2 that variable demand modelling should be included in the model process if one (or more) of the following conditions are satisfied.

- The scheme has capital cost greater than £5million;
- There is significant congestion on the network in the forecast years without the scheme; or
- The scheme would be expected to have an appreciable impact on travel choice (e.g. mode share or distribution) in the scheme corridor.

3.3.12. The interventions expected to be tested using the SDSTM satisfy at least some, if not all, of these conditions and so variable demand forecasting is applied.

3.4 SUMMARY OF FORECASTING STAGES

3.4.1. The forecasting process comprised the following main stages:

- Defining future year travel scenarios;
- Preparing future year Reference Case demand;
- Preparing future year networks;
- Undertaking variable demand matrix forecasting; and
- Reporting of model outputs.

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

3.4.3. These achieve each of the requirements set out in Section 3.3 through defining travel scenarios to predict future year travel demand, defining future year networks and applying variable demand forecasting to facilitate changes to the future year demand as a response to changes in travel costs.

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 modelled years.

4.1.2. This chapter defines the parameters and sources of uncertainty for the future year scenarios including:

- Forecast years;
- Scenario definitions;
- Uncertainty;
- Development sites; and
- Infrastructure and services.

4.2 FORECAST YEARS

4.2.1. As per the brief, the SDSTM has been developed for the forecast year of 2040 only.

4.3 SCENARIO DEFINITIONS

Core Scenario

4.3.1. TAG M4 describes the **Core Scenario** as representing the best basis for decision-making given current evidence. It should be based on more certain, unbiased assumptions although this necessitates consideration of some sources of uncertainty. It is also the central case to be presented in the Appraisal Summary Table as part of Economic Case when the SDSTM is applied in that context.

4.3.2. This demonstration of the SDSTM has two forecasts in the 2040 Core Scenario listed below

- 2040 Do-minimum; and
- 2040 Do-Something.

4.3.3. The 2040 DM scenario is based on the inclusion of development and schemes that are considered more than likely, if not near certain, to happen based on local and national uncertainty but noting that the medium- and longer-term impacts on travel demand as a result of the COVID-19 pandemic are likely to emerge beyond the timescale for this demonstration forecast work.

4.3.4. As part of the 2040 DS scenario four do-something model runs were undertaken to model the individual impact of the three potential large sites identified within the “call of sites” for the emerging local plan, namely;

- Church Fenton
- Burn and
- Heronby (also called Stillingfleet)

4.3.5. The four do-something scenarios modelled are as below

- 2040 Do-something 1 (2040 DS1) – includes all the developments in the development log **including** Church Fenton, Heronby and Burn developments.

- 2040 Do-something 2 (2040 DS2) – includes all the developments in the development log including Church Fenton but **excluding** Heronby and Burn developments.
- 2040 Do-something 3 (2040 DS3) – includes all the developments in the development log including Burn but **excluding** Church Fenton and Heronby developments.
- 2040 Do-something 4 (2040 DS4) – includes all the developments in the development log including Heronby but **excluding** Church Fenton and Burn developments.

4.4 UNCERTAINTY

4.4.1. TAG M4 defines an Uncertainty Log as a record of assumptions in the model that will affect travel demand and supply. This is for the purpose of recording the central forecasting assumptions that underpin the Core scenario and the level of uncertainty around these assumptions.

4.4.2. The sources of uncertainty were considered at a national and local level.

- National uncertainty refers to national projections such as demographic changes, GDP growth and fuel price trends. This forms part of the background growth and is reflected in the data obtained from national models such as NTEM and NTM – see Section 5.2 of this report.
- Local uncertainty considers whether developments or other planned transport schemes will go ahead in the vicinity of the scheme. This information is documented in the Uncertainty Log.

4.4.3. An Uncertainty Log of residential and employment developments was provided by SDC for Selby and other authorities as part of their local plans. Non-Selby authority developments were included in full, whilst only Selby developments that were “Near certain” or “More than likely” were considered to be explicitly modelled in the 2040 DM scenario. This is in line with production of a core scenario as defined in TAG M4. The same criteria were also applied for highway and public transport schemes.

4.4.4. The Uncertainty Log has been updated to reflect the latest assumptions relating to future developments and highway network improvements, in January 2022 when this forecasting work was being undertaken.

4.4.5. The uncertainty classification for each development site is based on the best available information at that time regarding the planning status, for example ‘under construction’ or ‘planning permission granted’.

4.4.6. The classifications of uncertainty are presented in Table 4-2.

Table 4-1 – Classifications of Uncertainty

Classification	Status	Relevant scenario for modelling
Near Certain (NC) 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.	2040 DM
More than Likely (MTL) The outcome is likely to happen but there is some uncertainty.	Submission of planning or consent application imminent. Development application within the consent process.	2040 DM

Reasonably Foreseeable (RF) The outcome may happen but there is significant uncertainty.	Identified within a development plan. Not directly associated with the transport scheme but may occur if the scheme is implemented. Development conditional upon the transport scheme proceeding. A committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty.	2040 DS
Hypothetical (H) 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. A policy aspiration.	Some schemes to be considered in the 2040 DS scenario based on advised from SDC

4.4.7. This information has been provided by the planning departments of each local authority (Selby, Leeds, York, Harrogate, East Riding and Wakefield) within the modelled area and immediate surrounding areas. It is based on their best understanding of the likely development on each site and the phasing of it 2040.

4.4.8. All development sites have been allocated to the appropriate model zone. The forecasting tool has been set up so that any combination of local authorities can be included. It is therefore possible to include or exclude the development sites from any one of the nine authorities.

4.5 DEVELOPMENT SITES

4.5.1. As stated in Section 4.4, non-Selby authority developments were included in full, whilst only Selby developments that were “Near certain” or “More than likely” were considered to be explicitly modelled in the 2040 DM scenario. The 2040 DS scenario includes the developments identified as “Reasonably foreseeable”.

4.5.2. A further selection process was undertaken based upon the size and number of trips produced by the development. This was in order to only explicitly model the larger more significant developments.

4.5.3. For residential sites the lower threshold for inclusion was a site capacity of 10 units, for employment sites the threshold was a site area greater than 500 square meters. It must be noted that this threshold was applied to the sum of all developments per model zone.

4.5.4. The growth associated with the excluded sites was assumed to be contained in the general background growth described in Section 5.2.

4.5.5. The residential sites taken forward to be explicitly modelled are presented in Table 4-2. The total number of residential units is 3,515 and the total number of jobs is 4,227 in the 2040 DM scenario, whilst in the 2040 DS1 scenario the total number of residential units is 10,462 and the total number of jobs is 12,584.

4.5.6. The employment sites included in the 2040 DM and 2040 DS1 scenarios are summarised in Table 4-3 and Table 4-4

4.5.7. The development trip generation and distribution are detailed in Sections 5.3 and 5.4.

Table 4-2 – Selby District Residential Sites

Site Ref	Address	TAG Uncertainty	Total Site Capacity	Completed up to 2019	Completion by 2040
11	The Laurels, York Road, Barlby	NC	35	11	35
12	Bay Horse Inn Phase 1 & 2, York Road	NC	13	0	13
13	Land West of York Road	NC	238	212	238
31	Land adjacent to Little Common Farm, Biggin,	NC	1	0	1
32	Land adjacent to Little Common Farm, Biggin Lane	NC	1	0	1
33	Village Farm, Main Street	NC	5	0	5
34	Land at Piggy Lane	NC	2	0	2
35	Merrymoles, Cat Lane	NC	1	0	1
36	Land off Back Lane, Back Lane	NC	1	0	1
37	Granary North of Arden Grange, Back Lane	NC	1	0	1
40	Phase 2 - Barff Lane	NC	111	75	111
41	Land rear of The Poplars	NC	44	15	44
46	5A Barff Lane	NC	5	0	5
47	Manor Felde, Barff Lane	NC	1	0	1
49	Mulberry House, High Street	NC	2	1	2
50	Land Adjacent Little Cottage, Old Great North Road	NC	7	0	7
51	Dobsons Yard, High Street	NC	7	0	7
53	High Street	NC	4	1	4
54	Land To Rear of 15 To 20 Belmont	NC	2	0	2
55	1 Gauk Street	NC	2	1	2
69	The Shieling, Beech Tree Lane	NC	2	0	2
70	Land at Mill Farm	NC	9	0	9
71	Land at Oaklands Close	NC	3	0	3
72	Land adjacent to No 3 Chapel Court	NC	1	0	1
73	Jasmin Cottage, 32 Brigg Lane	NC	1	0	1
74	Land North of cemetery, Station Road	NC	67	0	67
75	Land North of cemetery, Station Road	NC	66	0	66

79	Vine Farm, Low Street	NC	7	0	7
81	The Conifers, Low Street	NC	4	0	4
82	Land Adj Thorn Tree Cottage, Low Street	NC	3	0	3
85	Pear Tree Farm, Low Street	NC	3	0	3
86	Old Street Farm, Moor Lane	NC	1	0	1
87	Old Street Farm, Moor Lane	NC	2	0	2
88	Land to the North West of Castle Close, Cawood	NC	17	0	17
89	Land between Ryther Road and the Cemetery	NC	23	0	23
94	Farm buildings to the East and South of Old Farmhouse, Oxmoor Lane	NC	1	0	1
96	Maple Cottage, Nanny Lane	NC	1	0	1
97	Land North of Station Road	NC	5	0	5
100	Land South of Common Lane	NC	9	0	9
101	1 Fern Cottages, Nanny Lane	NC	1	0	1
102	RAF Church Fenton, Busk Lane, Church Fenton, Tadcaster, Leeds, North Yorkshire, LS24 9SE	NC	39	29	39
103	RAF Church Fenton, Busk Lane	NC	124	0	124
111	Spring Lodge Farm, Northfield Lane	NC	3	0	3
112	4 Manor Farm Cottage	NC	1	0	1
113	Manor Grange Equestrian, Cobcroft Lane	NC	1	0	1
114	Land West of Meadow View	NC	120	0	120
129	Land North of Main Road	NC	115	0	115
130	Bar Farm, 46 Main Road	NC	21	0	21
132	White House Farm & Manor Farm	NC	9	0	9
134	Land off Station Road	NC	3	0	3
136	Land off Oakwood, Main Street	NC	2	0	2
166	Roall Hall Farm,Roall Lane,	NC	1	0	1
167	The Old Vicarage,Main Street, , Kellington	NC	1	0	1
168	Hideaway,Wells Lane, Kellington	NC	2	0	2
169	Land on West side of Broach Lane	NC	4	0	4

170	Land Adjacent The Old Vicarage, Main Street	NC	2	0	2
172	Barn Rear Of Meadow Croft,Sweeming Lane,Little Fenton,Leeds	NC	2	0	2
173	The Courtyard, Sweeming Lane	NC	1	0	1
174	The Old Barn, Sweeming Lane	NC	2	0	2
175	Grove Farm, Sweeming Lane	NC	1	0	1
186	Land West of The Green	NC	35	0	35
190	Land North of York Road, North Duffield	NC	1	0	1
191	Lilac House, York Road	NC	1	0	1
192	Emmaus, Green Lane	NC	3	0	3
193	Land North of Green Lane	NC	9	0	9
194	Land West of Green Lane	NC	6	0	6
195	Land at Springfield House Farm	NC	4	0	4
198	Bridge Farm, Hull, Road, Osgodby	NC	1	0	1
199	Holly Lodge, Back Lane	NC	2	0	2
200	Tindalls Farm, Sand Lane	NC	4	0	4
201	Land East of St Leonards Avenue	NC	9	0	9
202	31 York Road, Riccall	NC	22	10	22
206	4 York Road, Riccall, York, North Yorkshire, YO19 6QG	NC	1	0	1
208	York House, York Road	NC	1	0	1
210	Tamwood, Station Road	NC	2	0	2
211	Jackadory, 37 York Road	NC	1	0	1
218	Old Hall Farm, Scarthingwell Lane	NC	2	0	2
219	Land East of Flaxley Road	NC	163	18	163
220	Phases 4A,4B,4C,4D,4E, Staynor Hall Development, Bawtry Road	NC	252	0	252
221	Phase 3E, 3F, 3G, 3K Staynor Hall, Abbots Road	NC	212	148	212
222	Portholme Road	NC	154	0	154
241	Access Selby, 8 - 10 Market Cross	NC	9	0	9
243	Brighthouse, 20 Market Cross	NC	1	0	1
244	Santander, 25 Market Cross	NC	1	0	1

246	Low Street - Persimmon	NC	249	241	249
247	Land South of Pasture Avenue	NC	50	0	50
248	Land South of Saxton Way	NC	292	207	292
249	Land off Hodgsons Lane	NC	270	0	270
250	Land West of Hodgsons Lane	MTI	150	0	150
262	Land South of Main Street	NC	14	0	14
263	Land North of Main Street	NC	8	0	8
264	North House Farm, Main Street	NC	8	1	8
265	Land Adjacent To Park Farm, Main Street	NC	1	0	1
278	Castle Farm, Castle Hills Road	NC	1	0	1
279	Moreby Hall, Moreby	NC	11	0	11
280	The Manor, The Green, Stillingfleet	NC	1	0	1
281	Plantation House, York Road	NC	2	0	2
282	Stillingfleet Service Station	NC	2	0	2
283	Fearndale, The Green	NC	2	0	2
284	Land East of Croft Cottages, York Road	NC	1	0	1
296	East End Cottage, Main Street	NC	3	0	3
297	Thorganby Methodist Church, Main Street	NC	5	0	5
298	Yew Tree Farm, Main Street	NC	6	0	6
299	NSDS Centre, Field Lane	NC	70	0	70
300	Land East of Linden Way	NC	276	132	276
307	Old Hall Farm, Scarthingwell Lane	NC	9	0	9
313	Poplar Farm, Selby Road	NC	8	2	8
314	Land at Chantry House, Doncaster Road	NC	1	0	1
315	Land At All Saints Court, All Saints Court	NC	5	0	5
316	Land West of Larth Close	NC	4	0	4
320	Village Hall, Main Street, Womersley	NC	4	0	4
321	Womersley C of E Primary School	NC	4	2	2
322	Grange Farm, Fulham Lane	NC	1	0	1
1	Land West of Northfield Avenue	RF	82	0	82
2	Therncroft, Malt Kiln Lane	RF	6	0	6

14	Land at Turnhead Farm	RF	26	0	26
21	Land rear of Morello Garth, Park Lane	H	15	0	15
42	Land North of Evergreen Way	RF	266	0	266
43	Land north of Mill Lane	RF	188	0	188
44	Land off St. Wilfred's Close	RF	20	0	20
59	Burn Airfield	RF	3000	0	1260
60	RAF Church Fenton, Church Fenton	RF	3000	0	1260
61	Land South of Escrick Road, Escrick.	RF	3000	0	1260
66	Land north of Beech Grove	RF	230	0	230
76	Land north of Mill Lane	RF	245	0	245
104	Land at Bon Accord Farm	RF	19	0	19
105	Land north of Cliffe Primary School, Main Street	RF	77	0	77
115	Land West of Kellington Lane	RF	1350	0	1225
131	Land east of Gateforth Lane	RF	290	0	290
139	Land South of Orchard End	RF	26	0	26
140	Land East of Mill Lane	RF	41	0	41
141	Land south of School Road	RF	32	0	32
149	Land to North of Weeland Road	RF	24	0	24
150	Land north of Wand Lane	RF	97	0	97
156	Land West of Main Street	RF	33	0	33
164	Land off Church Lane and Lunn Lane	RF	202	0	202
165	Land east of Manor Garth	RF	27	0	27
187	Land North of A163	RF	45	0	45
188	Land at Gothic Farm, Back Lane	RF	10	0	10
189	Land north of Gothic Farm, Back Lane	RF	101	0	101
196	Lake View Farm	RF	21	0	21
197	Land east of Sand Lane	RF	72	0	72
203	Land at Landing Lane	RF	180	0	180
223	Rigid Group Ltd, Denison Road	RF	330	0	330
224	Industrial Chemicals Ltd, Canal View, Bawtry Road	RF	450	0	450

225	Land at Cross Hills Lane	RF	1260	0	1260
226	Former Ousegate Maltings	RF	14	0	14
251	Land adjacent to Prospect Farm, Low Street	RF	300	0	300
288	Land at Hillcrest	RF	30	0	30
289	Central Area Car Park	RF	43	0	43
290	Land at Mill Lane	RF	248	0	248
291	Land at Station Road	RF	104	0	104
292	Wighill Lane	RF	17	0	17
301	Land South of Leeds Road	RF	127	0	127
302	Land at Swallowvale Leeds Road	RF	13	0	13
303	Land south of Leeds Road / north of Field Lane	RF	111	0	111
308	Land East of Bell Lane	RF	35	0	35

Table 4-3 – Selby District Employment Sites included in 2040 DM

Site Ref	Address	B1 (sqm)	B1a (sqm)	B1b (sqm)	B1c (sqm)	B2 (sqm)	B8 (sqm)	Other (A/C/D)
EMP/3	Sedalcol UK Ltd, Denison Road, Selby, YO8 8EF	0	0	0	0	0	990	0
EMP/5	Far Farm, Mill Lane, Ryther, Tadcaster,	0	0	0	0	0	0	1055
EMP/6	3A Lincoln Way, Sherburn In Elmet, Leeds	0	0	0	499	0	0	0
EMP/8	English Village Salads Brigg Lane	0	0	0	0	1000	0	0
EMP/13	Access Selby, 8 - 10 Market Cross, Selby, YO8 4JS	0	544	0	0	0	0	205
EMP/14	Green Lane Farm, Green Lane, Cliffe, Selby, North Yorkshire, YO8 6PG	0	0	0	0	0	1026	0
EMP/15	Leeds East Airport, Busk Lane, Church Fenton, Tadcaster, North Yorkshire, LS24 9SE	0	0	0	0	0	60000	0
EMP/16	St Gobain Glass UK Ltd, Goole,	0	0	0	0	119	0	0
EMP/18	Leeds East Airport, Busk Lane, Church Fenton, Tadcaster, North Yorkshire, S24 9SE	0	0	0	0	0	0	238
EMP/20	Scarthingwell Farm, Scarthingwell Lane, Towton, Tadcaster, North Yorkshire, LS24 9PF	0	0	0	0	0	0	171
EMP/27	Brocklesby, Unit 1, Long Lane, Great Heck, Goole	0	0	0	0	703	0	0
EMP/29	Eggborough Power Station, Selby Road, Eggborough, Goole, Selby,	0	0	0	0	0	0	435
EMP/31	Sedalcol UK Ltd, Denison Road, Selby, YO8 8EF	0	0	0	0	12460	0	0
EMP/32	Former NatWest Bank, The Crescent, Selby, YO8 4PE	0	0	0	0	0	0	390
EMP/34	Bay Horse Inn, Main Street, Great Heck, Goole, East Yorkshire, DN14 0BQ	0	0	0	0	0	0	59
EMP/36	Abbey Lodge, 10 Leeds Road, Selby, YO8 4HX	0	0	0	0	0	0	1540

EMP/38	ATS Euromaster, ATS Yorkshire Ltd, Canal Road, Selby, YO8 8AG	0	0	0	0	0	0	427
EMP/40	Land Off Lincoln Way	0	0	0	0	0	812	0
EMP/43	Highfield Nursing Home, Sarthingwell Park, Barkston Ash, Tadcaster, North Yorkshire, LS24 9PG	0	0	0	0	0	0	3544
EMP/44	Former Kellingley Colliery, Turvers Lane, Kellingley, Knottingley, West Yorkshire, WF11 8DT	0	0	0	362	1088	2176	0
EMP/45	Birchwood Lodge, Market Weighton Road, Barlby, Selby	0	0	0	145	0	0	0
EMP/49	Vivars Industrial Centre, Vivars Way, Selby, North Yorkshire	135	0	0	0	0	0	0
EMP/52	St Gobain Glass UK Ltd, Glassworks, Weeland Road, Eggborough	0	0	390	0	0	0	0
EMP/54	Railway Tavern, Station Road, Hensall, Selby	0	0	0	0	0	0	124
EMP/57	A19 Caravan Storage Limited, Hazel Old Lane, Hensall, Goole, East Yorkshire, DN14 0QA	0	0	0	0	0	6800	0
EMP/58	Now & Then Antiques,7 The Crescent, Selby,	0	0	0	0	0	0	115
EMP/61	Whitemoor Farm, Cliffe Common, Cliffe, Selby, North Yorkshire, YO8 6EG	0	0	0	0	0	447	0
EMP/62	Hagg Farm, Hagg Lane, Cawood,	0	0	0	0	0	590	0
EMP/67	Esterform Packaging, Moor Lane Trading Estate, Sherburn In Elmet, Leeds, North Yorkshire, LS25 6ES	0	0	0	0	4530	0	0
EMP/69	Staynor Hall Development, Bawtry Road, Selby	0	0	0	0	0	0	532
EMP/77	Austfield Farm, Austfield Lane, Hillam, Leeds, West Yorkshire, LS25 5NQ	0	0	0	0	0	0	800
EMP/78	Birchwood Lodge, Market Weighton Road, Barlby, Selby	0	0	0	0	0	383	0
EMP/2	Leeds East Airport, Busk Lane , Church Fenton, Tadcaster	0	4100	0	0	14720	14720	12125

Table 4-4 – Selby District Employment Sites included in 2040 DS1

Site Ref	Address	B1 (sqm)	B1a (sqm)	B1b (sqm)	B1c (sqm)	B2 (sqm)	B8 (sqm)	Other (A/C/D)
EMP_84	Land at ggborough Power Station	0	0	0	21.043	105,213	84,169	0
EMP_85	Olympia Park	0	0	0	12,387	24,774	0	24,480
EMP_86	Gascoigne Wood Interchange (former Gascoigne Wood mine site)	0	0	0	0	134,400	57,600	0
EMP_87	Burn	5,000	0	0	0	15,000	30,000	0
EMP_90_	East Common Lane HGV Park	0	0	0	0	0	5,325	0
EMP_89	Stillingfleet	20,000	0	0	0	0	0	NA

4.5.8. The estimated number of jobs given in Table 4-4 is calculated using data given in the Employment Densities Guide 3rd edition, 2015, which is summarised in Table 4-5.

Table 4-5 – Employment Densities

Land Use Type	Area per FTE (sqm)
B1 General	20
B1(a) General Office	11
B1(b) R&D Space	50
B1(c) Light Industry	47
B2 Industrial and Manufacturing	36
B8 Storage and Distribution	81
A1 Retail	19
A3 Restaurants & Cafes	18
A4 Food & Drinks	18
A5 Food & Drink Takeaway	18
C1 Hotels	Estimated based on jobs in Transport Assessments or similar existing sites
C2 Care Home	Estimated based on jobs in Transport Assessments or similar existing sites
D1 Non-Residential Institution/Health Clinic	36
D2 Leisure	120

4.6 INFRASTRUCTURE AND SERVICES

4.6.1. In addition to development sites, the Uncertainty Log also details supply assumptions. These can be categorised into:

- Changes to highway infrastructure in the FMA and
- Changes to services in the FMA (bus/rail).

4.6.2. An Uncertainty Log of transport improvement schemes was provided by Selby Council. Only schemes that were “Near certain” or “More than likely” were considered to be explicitly modelled. This is in line with production of a core scenario as defined in TAG M4.

4.6.3. A total of five highway schemes in the Selby district were taken forward from the Uncertainty Log for explicitly modelling in SATURN. These are listed in Table 4-6.

Table 4-6 – Selby District Highway Infrastructure Schemes and service

Name	Description	Uncertainty	Comment
Selby TCF	Selby TCF is a scheme which includes improvements around Selby Station (also called Selby Gateway scheme)	Committed	Included in 2040DM
Selby Place and Movement	This scheme includes improvement to the Selby town centre to influence	Not committed	Excluded from 2040 DM

Name	Description	Uncertainty	Comment
	place and movement within the town centre		
A19 Chapel Haddlesey	Increase the level of carriageway to account for flooding. This does not affect modelling of the road	completed	Included (but does not affect modelling)
A63/A162 Roundabout Improvements	Improvement to junction capacity	Not committed	Included in 2040 DS
A162/B1222	Improvements to roundabout capacity	Not committed	Included in 2040 DS
Transpenine Route upgrade	Improvement to railway line near York		Excluded as no impacts are anticipated from the scheme on highway and rail provision

4.6.4. There were no known changes to the bus service within the FMA.

5 REFERENCE DEMAND FORECASTING

5.1 INTRODUCTION

5.1.1. This chapter details the demand forecasting, including:

- Background growth;
- Development trip generation;
- Development trip distribution; and
- Core Scenario matrix totals.

5.1.2. TAG M4 describes a reference forecast as an intermediate step for producing forecasts prior to the application of variable demand modelling. It considers growth in trip ends over the forecasting period but does not consider changes in cost.

5.1.3. The process is summarised as follows and illustrated in Figure 5-1.

- Growth factors from NTEM and NTM were applied to the base year demand to develop the background matrix.
- Base year costs and demand were used to calibrate a deterrence function based on the base year trip length distribution.
- The outturn function was used to distribute development trips using a gravity model. This created the development trip matrix.
- The development trip matrix and the background matrix were merged, with the background growth reduced to account for the addition of development trips. Overall growth was controlled to NTEM values at district level in line with TAG M4 guidance.

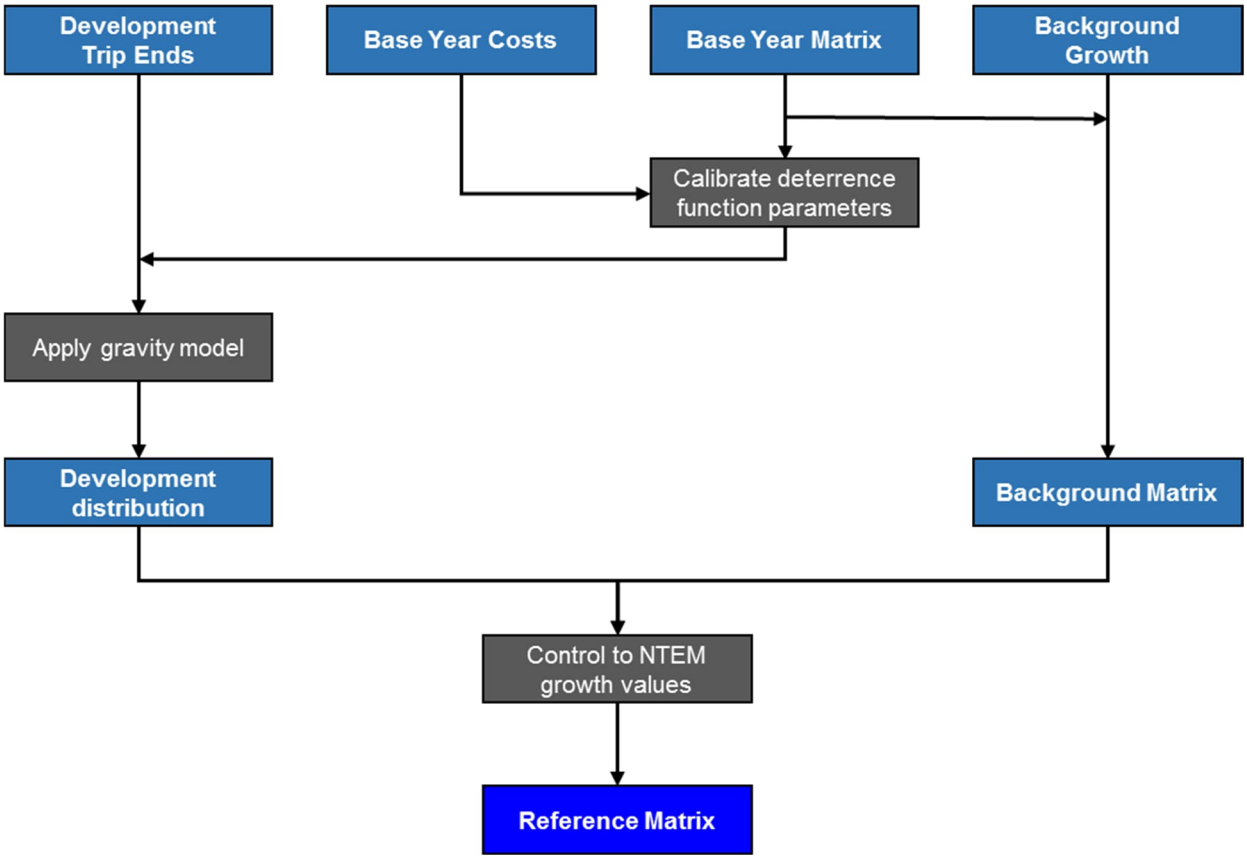
5.1.4. Each of the stages are detailed in the following sections.

5.1.5. The development trip ends were distributed using a Gravity Model developed within the CUBE suite.

5.1.6. The TAG compliant CUBE procedure attempts to reproduce the ‘distribution of trips by distance’ curve of the base year matrix, such that it yields what parameters would be needed to distribute the development trips as if they were in the base year matrix. Given the level of calibration and validation the base year matrices have undergone, this provides a level of confidence in the distribution of the development trips. CUBE optimises the gravity model parameters to minimise the overall differences between observed and modelled values, by time period. The gravity model then distributes development trips based on the cost of travel to other zones using the optimised parameters.

5.1.7. The CUBE process then balances background growth with the development trips, known as ‘constraining’. It is a requirement in TAG Unit M4 Section 7.3 that there is a need to control overall growth to TEMPro. This has been done at Local Authority District (LAD) level. CUBE subtracts the developments trips from the background growth (NTEM) at the aggregated level (i.e. Local Authority District), and then furnesses the base year matrices using these ‘adjusted’ growth factors to generate matrices with adjusted trip ends. This means when adding development trips to the furnessed background matrices (to create the final matrices), there is no double counting of trips.

Figure 5-1 – Reference Demand Methodology – to be updated



5.2 BACKGROUND GROWTH

5.2.1. TAG M4 defines a background assumption to be "an assumed change between the base year and the forecast year that is assumed to happen independent of the scheme."

5.2.2. Background demand changes occur due to various factors including demographic changes, GDP and fuel prices.

National Trip End Model

5.2.3. In line with TAG guidance the impact of changes to demographic data are accounted for by applying data from the DfT's National Trip End Model (NTEM) dataset.

5.2.4. Forecast trip ends were extracted from the NTEM version 7.2c to derive background car trip end growth factors for each demand segment. They consisted of origin and destination factors by mode (car driver, bus, rail), by time period (am peak, inter peak, pm peak) and by trip purpose (business, commuting, other).

5.2.5. The growth factors were applied at MSOA level, as the lowest spatial geography defined in NTEM, for zones within the FMA and aggregated to higher geographies corresponding to the zone definitions in the external areas.

5.2.6. A summary of the factors for Selby district overall are given in Table 5-1. These provide a high-level indication of the level of growth applied to the demand for each mode in the forecast matrix development including the trends for mode split in the forecast year.

5.2.7. It can be seen that:

- Car driver trip growth is around 10-12% in all time periods in 2040.
- Bus passenger demand decreases roughly 5-12% across the time periods, with it decreasing as low as 12% in the PM.
- Rail passenger demand is broadly flat across the time periods.

Table 5-1 – Summary of NTEM Growth Factors (2019-2040)

Year	Mode	AM Peak		Inter Peak		PM Peak	
		O	D	O	D	O	D
2040	Car	1.12	1.09	1.12	1.12	1.10	1.12
	Bus	0.96	0.91	0.92	0.93	0.88	0.93
	Rail	1.04	0.99	1.02	1.01	0.99	1.04

National Transport Model

5.2.8. Background LGV and HGV forecast growth was derived from the Road Traffic Forecasts (2018 – Reference scenario)[2] which are produced by the DfT from the National Transport Model (NTM).

5.2.9. The factors were applied at Government Region level. Table 5-2 summarises the values for Yorkshire and the Humber. A trend of increased growth for LGV's is predicted.

Table 5-2 – Summary of NTM Growth Factors

Year	LGVs	HGVs
2040	1.29	1.04

5.3 DEVELOPMENT TRIP GENERATION

5.3.1. Trip rates for each of the land uses were derived using the TRICS 7.8.4 database with groups of sites selected for residential and also different employment land uses. TRICS provides a consistent system for derivation of trip generation in this type of analysis through providing access to a large database of inbound & outbound transport surveys covering a wide variety of development types.

5.3.2. The trip rates have been agreed with NYCC and SDC.

5.3.3. Trip rates were derived for three vehicle types: car, LGV and HGV. The trip rates used are given by time period in Tables 5-3, 5-4 and 5-5.

[2] https://www.gov.uk/government/publications/road-traffic-forecasts-2018

Table 5-3 – AM Peak Trip Rates

		AM (08:00-09:00)					
		Car		LGV		OGV	
Land Use	Trip Rate Type	Arr	Dep	Arr	Dep	Arr	Dep
Residential (0-800 units)	avg per res unit	0.124	0.335	0.019	0.021	0.002	0.002
Residential (800+ units)	avg per res unit	0.133	0.305	0.008	0.012	0.000	0.000
A1 – Local Shops	ave per 100sqm GFA	6.348	6.224	1.203	1.328	0.166	0.124
A1 – Convenience Store	ave per 100sqm GFA	7.503	7.571	1.501	1.705	0.273	0.205
A1 – Food Superstore	ave per 100sqm GFA	2.028	1.588	0.124	0.114	0.028	0.028
A1 – Retail Park	ave per 100sqm GFA	1.479	0.977	0.120	0.091	0.004	0.008
A3 (0-0.5k sqm)	ave per 100sqm GFA	0.000	0.000	0.000	0.000	0.000	0.000
A3 (0.5k-1.5k sqm)	ave per 100sqm GFA	0.000	0.000	0.000	0.000	0.000	0.000
A4	ave per 100sqm GFA	0.000	0.000	0.000	0.000	0.000	0.000
A5	ave per 100sqm GFA	0.000	0.000	0.000	0.000	0.000	0.000
B1 General (0-10k sqm)	ave per 100sqm GFA	1.518	0.195	0.094	0.072	0.013	0.013
B1 General (10k+ sqm)	ave per 100sqm GFA	1.265	0.107	0.019	0.008	0.001	0.001
B1a	ave per 100sqm GFA	2.775	0.268	0.090	0.045	0.000	0.000
B1b	ave per 100sqm GFA	1.029	0.088	0.155	0.068	0.020	0.019
B1c	ave per 100sqm GFA	0.387	0.024	0.144	0.121	0.048	0.048
B2 (0-10k sqm)	ave per 100sqm GFA	0.320	0.034	0.045	0.036	0.037	0.027
B2 (10k+ sqm)	ave per 100sqm GFA	0.328	0.037	0.008	0.005	0.016	0.011
B8 (0-10k sqm)	ave per 100sqm GFA	0.221	0.036	0.105	0.069	0.052	0.058
B8 (10k-30k sqm)	ave per 100sqm GFA	0.094	0.022	0.025	0.022	0.046	0.044
B8 (30k+ sqm)	ave per 100sqm GFA	0.072	0.019	0.026	0.025	0.044	0.051
C1 Hotels	ave per 100sqm GFA	0.210	0.334	0.038	0.026	0.010	0.003
C1 Hotels	Ave per 1 employee	0.283	0.299	0.025	0.022	0.008	0.008

C2 Care Home	ave per 100sqm GFA	0.054	0.028	0.002	0.002	0.003	0.002
D1 (Education) (0-1k sqm)	ave per 100sqm GFA	7.079	4.906	0.186	0.212	0.027	0.027
D1 (Education) (1k+ sqm)	ave per 100sqm GFA	3.939	2.820	0.075	0.060	0.005	0.005
D1 Vet Clinic	ave per 100sqm GFA	3.035	1.480	0.074	0.074	0.000	0.000
D1 General Clinic	ave per 100sqm GFA	0.479	0.034	0.000	0.000	0.000	0.000
D2	ave per 100sqm GFA	0.575	0.657	0.021	0.000	0.000	0.000

Table 5-4 – Inter Peak Trip Rates

		IP (10:00-16:00)					
		Car		LGV		OGV	
Land Use	Trip Rate Type	Arr	Dep	Arr	Dep	Arr	Dep
Residential (0-800 units)	avg per res unit	0.143	0.138	0.019	0.020	0.002	0.002
Residential (800+ units)	avg per res unit	0.112	0.108	0.017	0.015	0.000	0.000
A1 – Local Shops	ave per 100sqm GFA	7.752	7.621	0.781	0.788	0.228	0.228
A1 – Convenience Store	ave per 100sqm GFA	5.059	5.025	0.762	0.762	0.045	0.045
A1 – Food Superstore	ave per 100sqm GFA	3.229	3.163	0.143	0.142	0.019	0.018
A1 – Retail Park	ave per 100sqm GFA	3.785	3.658	0.205	0.200	0.005	0.005
A3 (0-0.5k sqm)	ave per 100sqm GFA	2.657	2.292	0.185	0.202	0.009	0.009
A3 (0.5k-1.5k sqm)	ave per 100sqm GFA	1.168	1.022	0.100	0.104	0.028	0.032
A4	ave per 100sqm GFA	1.271	0.889	0.082	0.207	0.000	0.000
A5	ave per 100sqm GFA	14.444	13.889	3.611	3.333	0.000	0.000
B1 General (0-10k sqm)	ave per 100sqm GFA	0.412	0.407	0.090	0.089	0.013	0.013
B1 General (10k+ sqm)	ave per 100sqm GFA	0.113	0.172	0.012	0.012	0.002	0.002
B1a	ave per 100sqm GFA	0.478	0.601	0.075	0.078	0.018	0.018
B1b	ave per 100sqm GFA	0.390	0.396	0.120	0.128	0.031	0.035
B1c	ave per 100sqm GFA	0.129	0.129	0.121	0.101	0.036	0.036
B2 (0-10k sqm)	ave per 100sqm GFA	0.109	0.124	0.047	0.049	0.029	0.029
B2 (10k+ sqm)	ave per 100sqm GFA	0.103	0.118	0.020	0.020	0.015	0.010
B8 (0-10k sqm)	ave per 100sqm GFA	0.048	0.066	0.054	0.084	0.064	0.046
B8 (10k-30k sqm)	ave per 100sqm GFA	0.045	0.054	0.025	0.026	0.047	0.043
B8 (30k+ sqm)	ave per 100sqm GFA	0.034	0.042	0.019	0.025	0.037	0.037
C1 Hotels	ave per 100sqm GFA	0.180	0.184	0.021	0.018	0.006	0.006
C1 Hotels	Ave per 1 employee	0.186	0.188	0.015	0.014	0.003	0.003

C2 Care Home	ave per 100sqm GFA	0.057	0.065	0.009	0.009	0.001	0.001
D1 (Education) (0-1k sqm)	ave per 100sqm GFA	1.228	1.405	0.062	0.058	0.004	0.004
D1 (Education) (1k+ sqm)	ave per 100sqm GFA	0.702	0.746	0.028	0.029	0.003	0.003
D1 Vet Clinic	ave per 100sqm GFA	2.912	2.949	0.148	0.173	0.012	0.012
D1 General Clinic	ave per 100sqm GFA	0.536	0.553	0.034	0.040	0.000	0.000
D2	ave per 100sqm GFA	0.606	0.640	0.021	0.021	0.000	0.000

Table 5-5 – PM Peak Trip Rates

		PM (17:00-18:00)					
		Car		LGV		OGV	
Land Use	**Trip Rate Type**	**Arr**	**Dep**	**Arr**	**Dep**	**Arr**	**Dep**
Residential (0-800 units)	avg per res unit	0.299	0.150	0.026	0.013	0.001	0.001
Residential (800+ units)	avg per res unit	0.298	0.135	0.012	0.011	0.000	0.000
A1 – Local Shops	ave per 100sqm GFA	9.377	9.875	0.788	0.83	0.041	0.041
A1 – Convenience Store	ave per 100sqm GFA	7.435	7.435	1.228	1.228	0	0
A1 – Food Superstore	ave per 100sqm GFA	3.240	3.441	0.132	0.142	0.007	0.012
A1 – Retail Park	ave per 100sqm GFA	2.406	2.945	0.101	0.108	0.004	0.000
A3 (0-0.5k sqm)	ave per 100sqm GFA	2.832	1.207	0.139	0.093	0.000	0.000
A3 (0.5k-1.5k sqm)	ave per 100sqm GFA	1.045	0.626	0.104	0.084	0.021	0.021
A4	ave per 100sqm GFA	2.049	2.377	0.246	0.164	0.000	0.000
A5	ave per 100sqm GFA	6.845	6.250	0.000	0.298	0.000	0.000
B1 General (0-10k sqm)	ave per 100sqm GFA	0.294	1.611	0.023	0.064	0.001	0.004
B1 General (10k+ sqm)	ave per 100sqm GFA	0.058	0.910	0.004	0.010	0.001	0.001
B1a	ave per 100sqm GFA	0.515	2.732	0.045	0.067	0.000	0.000
B1b	ave per 100sqm GFA	0.271	1.300	0.039	0.068	0.000	0.010
B1c	ave per 100sqm GFA	0.000	0.194	0.072	0.144	0.000	0.000
B2 (0-10k sqm)	ave per 100sqm GFA	0.047	0.276	0.011	0.024	0.005	0.004
B2 (10k+ sqm)	ave per 100sqm GFA	0.054	0.367	0.007	0.013	0.009	0.007
B8 (0-10k sqm)	ave per 100sqm GFA	0.079	0.264	0.042	0.023	0.019	0.039
B8 (10k-30k sqm)	ave per 100sqm GFA	0.012	0.087	0.006	0.013	0.035	0.028
B8 (30k+ sqm)	ave per 100sqm GFA	0.021	0.095	0.014	0.013	0.038	0.027
C1 Hotels	ave per 100sqm GFA	0.262	0.228	0.032	0.019	0.000	0.000
C1 Hotels	Ave per 1 employee	0.274	0.267	0.027	0.017	0.000	0.002
C2 Care Home	ave per 100sqm GFA	0.029	0.041	0.003	0.005	0.000	0.000
D1 (Education) (0-1k sqm)	ave per 100sqm GFA	0.027	0.530	0.027	0.080	0.000	0.000

D1 (Education) (1k+ sqm)	ave per 100sqm GFA	0.241	0.407	0.006	0.010	0.000	0.000
D1 Vet Clinic	ave per 100sqm GFA	3.035	2.517	0.000	0.074	0.000	0.000
D1 General Clinic	ave per 100sqm GFA	0.444	0.410	0.000	0.000	0.000	0.000
D2	ave per 100sqm GFA	1.417	0.966	0.021	0.000	0.000	0.000

5.3.4. The outturn highway development trip generation for 2040 DM scenario for the AM, IP and PM peak hours is summarised in Table 5-6 to Table 5-8.

Table 5-6 – 2040 DM AM Development Trips (vehs)

	AM (08:00-09:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	299	807	46	51	5	5	349	863
Employment	664	167	79	65	71	71	814	303
Total	963	974	124	116	76	75	1163	1166

Table 5-7 – 2040 DM Inter Peak Development Trips (vehs)

	IP (10:00-16:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	344	331	46	47	4	5	394	384
Employment	301	315	69	77	70	63	441	455
Total	645	646	115	125	74	69	835	839

Table 5-8 – 2040 DM PM Peak Development Trips (vehs)

	PM (17:00-18:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	720	361	63	32	2	2	785	395
Employment	262	719	39	45	48	40	349	804
Total	982	1080	102	77	50	42	1134	1199

5.3.5. The outturn highway development trip generation for 2040 DM scenario for the AM, IP and PM peak hours is summarised in Table 5-9 to Table 5-11.

Table 5-9 – 2040 DS1 AM Development Trips (vehs)

	AM (08:00-09:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	1353	3318	130	163	9	8	1492	3490
Employment	3061	420	275	230	398	420	3734	1070
Total	4414	3738	405	393	406	428	5226	4560

Table 5-10 – 2040 DS1 Inter Peak Development Trips (vehs)

	IP (10:00-16:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	1300	1256	183	176	8	10	1490	1441
Employment	908	1066	273	318	351	331	1532	1715
Total	2207	2322	456	494	359	340	3022	3156

Table 5-11 – 2040 DS1 PM Peak Development Trips (vehs)

	PM (17:00-18:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	3124	1476	189	123	4	4	3316	1603
Employment	530	3267	143	177	314	229	987	3673
Total	3653	4743	332	300	319	233	4304	5276

5.4 DEVELOPMENT TRIP DISTRIBUTION

5.4.1. The location of each development was spatially allocated to the model zone structure and thus an existing zone number was assigned to each development. The base model included dummy zones in locations where developments were expected to be allocated as well as some additional extra dummy zones.

5.4.2. The trip distribution applied to the development trips was undertaken using a gravity model approach. A tanner function or log normal curve was calibrated against the trip distance distributions from the calibrated base year models by mode, time period and trip purpose. The formulations are as follows, where c_{ij} is the cost of travel between zones i and j (in this case distance) and x_1, x_2 or μ, σ parameters to be calibrated.

- Tanner $$f(c_{ij} : x_1, x_2) = c_{ij}^{x_1} exp\left(c_{ij}^{x_2}\right)$$
- Log Normal $$f(c_{ij} : \mu, \sigma) = \frac{1}{c_{ij}\sigma\sqrt{2\pi}} exp\left(-\frac{(\ln(c_{ij}) - \mu)^2}{2\sigma^2}\right)$$

5.4.3. The outturn parameters and R^2 statistics are presented in Table 5-12.

Table 5-12 – Gravity Model Calibration Summary

Mode	Time Period	User Class	Function	Parameters*		R^2
				p1	p2	
Highway	AM Peak	Car Business	LogNormal	1.4428101	1.5223545	0.99851
		Car Commute	LogNormal	1.2680641	1.5720547	0.999783
		Car Other	LogNormal	0.8790917	1.059556	0.999551
		LGV	LogNormal	1.9594631	0.9240508	0.999771

		HGV	LogNormal	1.2691947	1.2923867	0.989647
	Inter Peak	Car Business	LogNormal	1.3390699	1.20021	0.997293
		Car Commute	LogNormal	1.2852683	1.3182351	0.99976
		Car Other	LogNormal	1.0081974	1.0743983	0.999748
		LGV	LogNormal	1.877947	0.9585308	0.999805
		HGV	LogNormal	1.3279192	1.394782	0.997553
	PM Peak	Car Business	LogNormal	1.4915853	1.4518217	0.998771
		Car Commute	LogNormal	1.3020157	1.5876933	0.999712
		Car Other	LogNormal	1.1094358	1.1729821	0.999809
		LGV	LogNormal	1.994973	0.9534422	0.999768
		HGV	LogNormal	1.1762434	1.395188	0.986112

**If Tanner then p1=x1, p2=x2*
**If Log normal then p1=mu, p2=sigma*

5.5 CORE SCENARIO REFERENCE MATRIX TOTALS

5.5.1. As described in Section 5.1, the resultant development trip matrix and background matrix were merged, with the background growth reduced to account for the addition of development trips. Overall growth was controlled to NTEM values at district level in line with TAG M4 guidance.

5.5.2. The Core scenario matrix totals are summarised in Section 6 alongside, and compared against, the post-variable demand matrix totals.

6 SUPPLY FORECASTING

6.1 INTRODUCTION

6.1.1. The changes to the network supply in the forecast years is summarised by coding of future schemes, making changes to the external area fixed speed and updating parameters for generalised costs.

6.1.2. This chapter describes each of those areas including:

- scheme coding;
- speed forecasting;
- generalised cost parameters;
- toll assumptions;
- fare and parameter assumptions; and
- network checks.

6.2 DO MINIMUM SCHEME CODING

6.2.1. The Do Minimum network coding was based on the validated base year networks with the addition of committed and more than likely highway schemes.

6.2.2. The identification and locations of such schemes was described in Section 4.6. The access junction of the committed / proposed developments were coded using information from the development log/ transport assessments where available. Where the information was not available, the access junctions were coded a simple priority junction.

6.2.3. Do Minimum scheme coding in SATURN was based on the coding manual used to develop the base year networks. This provided consistency in coding values and parameters across the network such as saturation flows and speed flow curves.

6.2.4. Section 6.7 below references the checks undertaken including signal timings.

6.3 FUTURE YEAR SPEED FORECASTING

6.3.1. Outside of the highway model simulation area, the buffer area (see Figure 2-4) is coded with speed flow curves and so the speed/flow relationship, in respect of increases in future travel demand and correspondingly increased congestion, is represented.

6.3.2. Beyond the buffer area, the base year coding approach for the external area was to apply a default 50mph speed on all external links. Given this approach, a factor was derived for each year to be applied to all external area links using data from the Road Traffic Forecasts (2018 – Reference scenario)[3] which are produced by the DfT from the National Transport Model (NTM).

6.3.3. The factors were based on the average change for weekday 12-hour speeds on motorways and A roads between 2018 and the forecast years, with outturn values of:

[3] https://www.gov.uk/government/publications/road-traffic-forecasts-2018

- 2040: 0.96; i.e. adjusted to 48mph.

6.4 FUTURE YEAR GENERALISED COST PARAMETERS

6.4.1. Within the SDSM, the cost of a trip through the network is calculated as a combination of two elements: the cost of the road user's time (value of time) during the journey and the cost of operating the vehicle (vehicle operating cost) over the travelled distance.

6.4.2. The highway assignment has two parameters defined for each user class to calculate generalised cost. These parameters combine modelled journey times, distances and any tolls (where relevant) into a standard unit of generalised time.

6.4.3. Forecast year generalised cost parameters for the highway model have been derived from data in the DfT's TAG Databook for Nov 2021 (v1.17) which is consistent with the version used for the generalised costs in the base year models. These are listed in Table 6-1.

6.4.4. It is noted that an updated TAG Databook was issued at the end of May 2022 beyond the time for the updated values to be incorporated into these demonstration forecasting runs however it is expected that they would be a minor change.

Table 6-1 – Highway Assignment Generalised Cost Parameters (2019-2040)

Year	User Class	AM Peak		Inter Peak		PM Peak	
		PPM	PPK	PPM	PPK	PPM	PPK
2019	Car Business	30.92	12.78	31.68	12.78	31.36	12.78
	Car Commuting	20.73	6.27	21.07	6.27	20.81	6.27
	Car Other	14.31	6.27	15.24	6.27	14.98	6.27
	LGV	22.41	13.65	22.41	13.65	22.41	13.65
	HGV	51.32	43.99	51.32	44.36	51.32	46.09
2040	Car Business	40.11	9.92	41.10	9.92	40.69	9.92
	Car Commuting	26.90	4.20	27.33	4.20	26.99	4.20
	Car Other	18.56	4.20	19.77	4.20	19.43	4.20
	LGV	29.07	11.76	29.07	11.76	29.07	11.76
	HGV	66.58	40.00	66.58	40.30	66.58	41.70

6.5 FUTURE YEAR TOLL ASSUMPTIONS

6.5.1. There are no toll charges in the SDSTM base year highway model.

6.6 FORECAST YEAR NETWORK CHECKS

6.6.1. The following logic checks were undertaken on the fixed demand forecast network assignments prior to running variable demand modelling:

- Convergence statistics;
- Overall network statistics;
- Changes in traffic flow between base and Do Minimum;

- Changes in delay between base and Do Minimum.

6.6.2. In particular, checks also identified if there were locations with large changes in delay (possibly linked to VOC) that may be adversely impacting model convergence. These cases can occur due to the sensitivity of local network parameters to additional travel demand.

6.6.3. For example, signal timings can only be coded as fixed timings in SATURN but may actually be on a dynamic system. By default, the base year timings were carried over into the forecast networks however the fixed highway assignments were reviewed to check if there were any significant localised impacts of inappropriate allocations.

6.6.4. This was initially reviewed prior to variable demand modelling since the highway network convergence can impact on the demand model stability, and subsequently when the initial variable demand runs had been undertaken. Furthermore, if there are cost changes in the forecast year highway network attributed to large delays this will have an impact on the resultant variable demand outputs.

6.6.5. As a result of these checks adjustments were made to the green timings at some signalised junctions. Typical examples were junctions with one or more entry arms under-capacity and one or more entry arms over capacity which could be resolved to a more stable solution through redistribution of green times. These were reviewed by time period with more locations identified in the PM peak followed by the AM peak and inter peak in line with the respective levels of congestion. There were a small number of changes to GAP parameter – carried across all time periods at some locations.

7 VARIABLE DEMAND FORECASTING

7.1 INTRODUCTION

7.1.1. This chapter details the application and impacts of variable demand modelling in the forecast years including:

- Variable demand model methodology;
- Variable demand model convergence;
- Variable demand forecast matrix totals; and
- Impacts of variable demand modelling.

7.1.2. It refers to TAG Unit M2 'Variable Demand Modelling' throughout.

7.2 VARIABLE DEMAND MODEL METHODOLOGY

7.2.1. The variable demand forecasts have been developed using the Selby Variable Demand Model (SVDM). The Selby Variable Demand Model Report (VDMR) provides a detailed documentation of the SVDM including the specification and methodologies which is summarised as follows.

7.2.2. The variable demand process employed a pivot-point model which used incremental cost changes to derive changes in demand from a reference trip matrix. It had been calibrated to predict the traveller responses of:

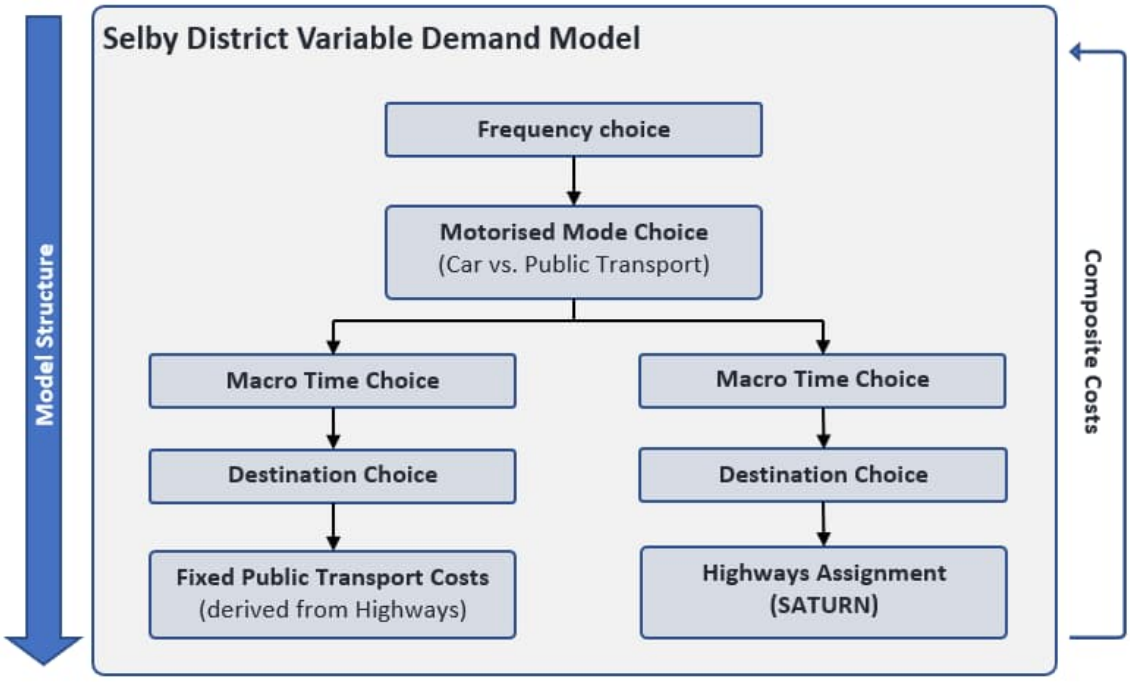
- Mode choice (between highway and public transport),
- Time of day choice (macro and/or micro time choice),
- Destination choice (a change of origin and/or destination); and
- Route choice.

7.2.3. It does not predict change in travel demand for LGVs or HGVs which were assumed to be of fixed demand (in accordance with TAG M2) but susceptible to re-routeing at the assignment stage.

7.2.4. The modelled choice responses and hierarchy are illustrated in Figure 7-1.

- An acceptable level of calibration in the realism testing was achieved without **frequency choice** being utilised therefore this was not invoked.
- It is advised in TAG M2 that it is almost always desirable to include a **mode choice** response and this was included.
- It is noted that **micro time choice** is not enabled in the SVDM since there is limited evidence on this choice response within the study area.
- Mode specific **destination choice** responses for highway and public transport were included.
- The **route choice** was undertaken in the highway assignment model.
- The **sub-mode** choice for public transport (between bus and rail) is not undertaken as the absence of a PT model means that the modal split between bus and rail within public transport is not modelled and is therefore not undertaken within the VDM process.

Figure 7-1 – SVDM Structure and Hierarchy



7.2.5. The variable demand was applied to trips which interact (wholly within, to or from) an Area of Influence which is illustrated in Figure 7-2 – Impacts of VDM Sector System as sectors 1 to 7.

7.2.6. Following a review of the specified study area in relation to the existing model coverage and the likely uses of the new transport model, it was deemed appropriate to define the extent of the variable demand model study area in line with the FMA definition used for the assignment models.

7.2.7. In particular, this includes areas of detailed representation of highway network, PT service provision, zone density and validation in the highway and PT models. Beyond this area network coverage and zone representation are at an increasingly aggregate level with decreasing detail further from the model study area and fixed speed coding in the external areas.

7.2.8. Cost damping has been applied; the requirement for which was established during the base year realism testing. The Area of Influence covers a large geographical area which necessarily includes a component of longer distance trips. This is in line with TAG M2 which states that cost damping may be required due to the 'sensitivity of demand responses to changes in generalised cost [reducing] with increasing trip length'.

7.2.9. The specification of SDSDM was considered appropriate for this demonstration forecasting purpose and has been developed in line with the latest TAG guidance.

7.3 VARIABLE DEMAND MODEL CONVERGENCE

7.3.1. Convergence of the variable demand model is defined by the %GAP, in this context referring to the demand/supply gap. This is in line with TAG M2 guidance and formulation. It measures how far the current flow is from the equilibrium point and would therefore be zero in a perfect model.

7.3.2. The SVDM convergence criteria takes account of TAG M2 guidance which says *"0.1% can be achieved in many cases, although in more problematic systems this may be nearer to 0.2%. Where the convergence level, as measured by the %GAP, is over 0.2% remedial steps should be taken to improve the convergence, by increasing the assignment accuracy."*

7.3.3. Section 6 detailed checking the forecast year networks and this included reference to improving stability of the highway assignment models and consequently the variable demand model convergence. This was necessary given the level of congestion in the base year networks, and consequently even more so in the future years.

7.3.4. The conference statistics are set out in Table 7-1. It can be seen that the VDM models converged quickly within 4 demand/supply loops and the convergence gap calculated from the realism tests were well within the TAG M2 recommended criterion of 0.1%.

Table 7-1 – Variable Demand Model Convergence

Year	Scenario	Number of Loops	Total GAP%
2040 DM	Core	4	0.06784
2040 DS1	Forecast	4	0.07067
2040 DS2	Forecast	4	0.0636
2040 DS3	Forecast	4	0.05489
2040 DS4	Forecast	4	0.09789

7.4 VARIABLE DEMAND FORECAST MATRIX TOTALS

7.4.1. The core scenario forecast reference demand and post-variable demand modelling person trip totals for 2040 are summarised in Tables below.

7.4.2. In 2040 it can be seen that the changes are:

- Small changes in Car across all periods, with a much larger decrease in PT.
- Across all modes a small reduction in the peak period (AM and PM) and increase in the inter-peak and off-peak period trips. This is attributed to time choice for (non-discretionary) trips transferring to travel at less congested times of the day;
- Overall mode shift from PT to highway across all periods, attributed to the future trend of reduced car operating costs, reflected in highway assignment PPK parameters;
- Slightly greater response in Other trips, attributed to greater flexibility for discretionary travel.

7.4.3. The results for all the modelled scenarios are summarised in the tables below. Please note the "reference matrix" is in these tables refers to pre-vdm matrix.

Table 7-2 – Reference Demand Core 2040 DM (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	Reference	41,133	1,460	179,914	13,444	326,767	18,289	547,814	33,194	581,008
	DM	41,218	1,258	179,668	11,396	328,574	14,951	549,460	27,606	577,066
IP	Reference	61,512	2,068	120,818	4,666	853,654	41,718	1,035,985	48,452	1,084,437
	DM	62,109	1,708	122,482	4,021	862,588	34,211	1,047,179	39,940	1,087,119
PM	Reference	32,641	1,444	175,592	10,044	387,792	14,794	596,025	26,283	622,308
	DM	32,408	1,246	176,245	8,688	388,695	12,051	597,348	21,985	619,333
OP	Reference	33,682	1,179	136,705	6,616	343,106	17,742	513,492	25,537	539,029
	DM	34,179	994	139,699	5,601	348,435	14,356	522,313	20,951	543,263
Total	Reference	168,968	6,152	613,029	34,771	1,911,319	92,544	2,693,316	133,466	2,826,782
	DM	169,913	5,206	618,094	29,706	1,928,293	75,570	2,716,300	110,482	2,826,782
Changes: Do Minimum – Reference										
AM	DM - Ref	0.2%	-13.9%	-0.1%	-15.2%	0.6%	-18.2%	0.3%	-16.8%	-0.7%
IP	DM - Ref	1.0%	-17.4%	1.4%	-13.8%	1.0%	-18.0%	1.1%	-17.6%	0.2%
PM	DM - Ref	-0.7%	-13.7%	0.4%	-13.5%	0.2%	-18.5%	0.2%	-16.4%	-0.5%
OP	DM - Ref	1.5%	-15.6%	2.2%	-15.4%	1.6%	-19.1%	1.7%	-18.0%	0.8%
Total	DM - Ref	0.6%	-15.4%	0.8%	-14.6%	0.9%	-18.3%	0.9%	-17.2%	0.0%

Table 7-3 – Reference Demand 2040 DS1 (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	Reference	42,512	1,460	188,082	13,444	344,607	18,289	575,201	33,194	608,395
	DS1	42,547	1,255	187,613	11,415	346,130	14,970	576,289	27,641	603,930
IP	Reference	64,033	2,068	125,490	4,666	901,877	41,718	1,091,400	48,452	1,139,853
	DS1	64,733	1,709	127,449	4,034	911,705	34,309	1,103,887	40,052	1,143,939
PM	Reference	34,083	1,444	183,281	10,044	410,518	14,794	627,882	26,283	654,165
	DS1	33,773	1,244	183,648	8,709	410,564	12,078	627,985	22,031	650,016
OP	Reference	35,084	1,179	142,472	6,616	365,800	17,742	543,357	25,537	568,894
	DS1	35,610	994	145,618	5,611	371,205	14,385	552,432	20,990	573,423
Total	Reference	175,712	6,152	639,325	34,771	2,022,803	92,544	2,837,840	133,466	2,971,307
	DS1	176,662	5,202	644,327	29,769	2,039,604	75,743	2,860,593	110,714	2,971,307
Changes: Do something – Reference										
AM	DS1 - Ref	0.1%	-14.1%	-0.2%	-15.1%	0.4%	-18.1%	0.2%	-16.7%	-0.7%
IP	DS1 - Ref	1.1%	-17.4%	1.6%	-13.6%	1.1%	-17.8%	1.1%	-17.3%	0.4%
PM	DS1 - Ref	-0.9%	-13.9%	0.2%	-13.3%	0.0%	-18.4%	0.0%	-16.2%	-0.6%
OP	DS1 - Ref	1.5%	-15.7%	2.2%	-15.2%	1.5%	-18.9%	1.7%	-17.8%	0.8%
Total	DS1 - Ref	0.5%	-15.4%	0.8%	-14.4%	0.8%	-18.2%	0.8%	-17.0%	0.0%

Reference Demand 2040 DS2 (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	Reference	42,225	1,460	186,339	13,444	340,518	18,289	569,082	33,194	602,275
	DS2	42,268	1,256	185,940	11,413	342,115	14,967	570,323	27,636	597,959
IP	Reference	63,700	2,068	124,894	4,666	894,139	41,718	1,082,733	48,452	1,131,185
	DS2	64,367	1,709	126,740	4,029	903,641	34,278	1,094,749	40,016	1,134,765
PM	Reference	33,795	1,444	181,764	10,044	405,602	14,794	621,161	26,283	647,444
	DS2	33,510	1,245	182,234	8,705	405,953	12,070	621,697	22,020	643,717
OP	Reference	34,816	1,179	141,479	6,616	361,244	17,742	537,539	25,537	563,076
	DS2	35,339	994	144,576	5,608	366,646	14,377	546,561	20,979	567,540
Total	Reference	174,537	6,152	634,475	34,771	2,001,503	92,544	2,810,515	133,466	2,943,981
	DS2	175,485	5,204	639,490	29,755	2,018,356	75,691	2,833,331	110,651	2,943,981
Changes: Do Something – Reference										
AM	DS2 - Ref	0.1%	-14.0%	-0.2%	-15.1%	0.5%	-18.2%	0.2%	-16.7%	-0.7%
IP	DS2 - Ref	1.0%	-17.4%	1.5%	-13.6%	1.1%	-17.8%	1.1%	-17.4%	0.3%
PM	DS2 - Ref	-0.8%	-13.8%	0.3%	-13.3%	0.1%	-18.4%	0.1%	-16.2%	-0.6%
OP	DS2 - Ref	1.5%	-15.6%	2.2%	-15.2%	1.5%	-19.0%	1.7%	-17.8%	0.8%
Total	DS2 - Ref	0.5%	-15.4%	0.8%	-14.4%	0.8%	-18.2%	0.8%	-17.1%	0.0%

Reference Demand 2040 DS3 (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	Reference	42,263	1,460	186,544	13,444	340,963	18,289	569,769	33,194	602,963
	DS3	42,316	1,257	186,153	11,418	342,634	14,971	571,103	27,646	598,749
IP	Reference	63,749	2,068	124,966	4,666	895,084	41,718	1,083,798	48,452	1,132,251
	DS3	64,414	1,709	126,840	4,031	904,604	34,285	1,095,858	40,025	1,135,883
PM	Reference	33,831	1,444	181,934	10,044	406,172	14,794	621,936	26,283	648,219
	DS3	33,539	1,245	182,371	8,708	406,431	12,073	622,341	22,026	644,368
OP	Reference	34,851	1,179	141,594	6,616	361,710	17,742	538,155	25,537	563,692
	DS3	35,371	994	144,676	5,610	367,093	14,380	547,141	20,985	568,125
Total	Reference	174,694	6,152	635,037	34,771	2,003,928	92,544	2,813,659	133,466	2,947,125
	DS3	175,640	5,205	640,041	29,767	2,020,762	75,710	2,836,443	110,682	2,947,125
Changes: Do Something – Reference										
AM	DS3 - Ref	0.1%	-13.9%	-0.2%	-15.1%	0.5%	-18.1%	0.2%	-16.7%	-0.7%
IP	DS3 - Ref	1.0%	-17.4%	1.5%	-13.6%	1.1%	-17.8%	1.1%	-17.4%	0.3%
PM	DS3 - Ref	-0.9%	-13.8%	0.2%	-13.3%	0.1%	-18.4%	0.1%	-16.2%	-0.6%
OP	DS3 - Ref	1.5%	-15.6%	2.2%	-15.2%	1.5%	-18.9%	1.7%	-17.8%	0.8%
Total	DS3 - Ref	0.5%	-15.4%	0.8%	-14.4%	0.8%	-18.2%	0.8%	-17.1%	0.0%

Reference Demand 2040 DS4 (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	Reference	42,275	1,460	186,616	13,444	341,249	18,289	570,140	33,194	603,333
	DS4	42,220	1,354	185,489	12,412	340,832	17,090	568,541	30,856	599,397
IP	Reference	63,775	2,068	125,038	4,666	895,798	41,718	1,084,611	48,452	1,133,064
	DS4	64,269	1,891	126,399	4,364	900,867	38,795	1,091,536	45,051	1,136,586
PM	Reference	33,857	1,444	182,066	10,044	406,701	14,794	622,624	26,283	648,907
	DS4	33,485	1,336	181,826	9,368	405,075	13,678	620,386	24,381	644,767
OP	Reference	34,883	1,179	141,670	6,616	362,407	17,742	538,959	25,537	564,497
	DS4	35,296	1,091	144,181	6,122	365,872	16,488	545,349	23,701	569,050
Total	Reference	174,791	6,152	635,389	34,771	2,006,154	92,544	2,816,334	133,466	2,949,801
	DS4	175,270	5,672	637,895	32,265	2,012,647	86,051	2,825,812	123,989	2,949,801
Changes: Do Something – Reference										
AM	DS4 - Ref	-0.1%	-7.3%	-0.6%	-7.7%	-0.1%	-6.6%	-0.3%	-7.0%	-0.7%
IP	DS4 - Ref	0.8%	-8.6%	1.1%	-6.5%	0.6%	-7.0%	0.6%	-7.0%	0.3%
PM	DS4 - Ref	-1.1%	-7.5%	-0.1%	-6.7%	-0.4%	-7.5%	-0.4%	-7.2%	-0.6%
OP	DS4 - Ref	1.2%	-7.4%	1.8%	-7.5%	1.0%	-7.1%	1.2%	-7.2%	0.8%
Total	DS4 - Ref	0.3%	-7.8%	0.4%	-7.2%	0.3%	-7.0%	0.3%	-7.1%	0.0%

7.5 IMPACTS OF VARIABLE DEMAND MODELLING

7.5.1. Further impacts of variable demand modelling are analysed in this section in terms of:

- Car trip length distribution; and
- Car sector trip ends.

7.5.2. The previous section presented the overall pattern including time of day and mode transfer.

Trip Length Distribution

7.5.3. The car trip length distribution for the loop 1 (reference demand) assignments and post-variable demand modelling assignments are compared in Table 7-5. It can be seen that

- There are increases in trip length for business commute and other attributed to reducing car operating costs, hence potential for longer travel, referenced above in Section 4.4;
- Commute has a slight lower increase in the more congested periods, noting that Commute is doubly constrained for trip distribution;
- Overall, this leads to a net increase in trip length for car trips.

Table 7-4 – Impacts of VDM on Car Average Trip Length- 2040 DM

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040 DM	AM	Business	48.22	51.77	7.4%
		Commute	20.37	21.29	4.5%
		Other	13.08	14.61	11.7%
	IP	Business	45.03	48.62	8.0%
		Commute	19.64	20.92	6.5%
		Other	15.05	17.05	13.2%
	PM	Business	45.84	48.18	5.1%
		Commute	22.87	23.90	4.5%
		Other	16.18	18.09	11.8%

Table 7-5 – Impacts of VDM on Car Average Trip Length- 2040 DS1

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040 DS1	AM	Business	47.27	50.86	7.6%
		Commute	20.13	20.88	3.7%
		Other	12.82	14.25	11.1%
	IP	Business	43.75	47.25	8.0%
		Commute	19.38	20.52	5.9%
		Other	14.59	16.48	12.9%
	PM	Business	44.57	46.93	5.3%
		Commute	22.50	23.37	3.9%
		Other	15.68	17.50	11.6%

Table 7-6 – Impacts of VDM on Car Average Trip Length- 2040 DS2

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040	AM	Business	47.43	50.99	7.5%
		Commute	20.15	20.94	3.9%
		Other	12.85	14.29	11.2%
	IP	Business	43.90	47.41	8.0%
		Commute	19.39	20.56	6.1%
		Other	14.65	16.56	13.0%
	PM	Business	44.76	47.10	5.2%
		Commute	22.54	23.45	4.0%
		Other	15.75	17.58	11.6%

Table 7-7 – Impacts of VDM on Car Average Trip Length- 2040 DS3

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040	AM	Business	47.44	51.03	7.6%
		Commute	20.13	20.92	3.9%
		Other	12.88	14.33	11.3%
	IP	Business	43.86	47.38	8.0%
		Commute	19.38	20.55	6.0%
		Other	14.63	16.54	13.1%
	PM	Business	44.75	47.12	5.3%
		Commute	22.52	23.43	4.1%
		Other	15.74	17.59	11.7%

Table 7-8 – Impacts of VDM on Car Average Trip Length- 2040 DS4

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040	AM	Business	47.41	51.00	7.6%
		Commute	20.16	20.95	3.9%
		Other	12.86	14.32	11.3%
	IP	Business	43.87	47.41	8.1%
		Commute	19.39	20.55	6.0%
		Other	14.64	16.57	13.1%
	PM	Business	44.76	47.13	5.3%
		Commute	22.54	23.45	4.0%
		Other	15.75	17.60	11.7%

7.5.4. The changes in car sector trip ends from variable demand modelling are illustrated in tables below. The sectors are illustrated in Figure 7-2. The diagrams show a normalised impact of trip-end sectoral changes resultant from VDM. It can be seen that:

- The changes for Commute are small attributed to the distribution being doubly constrained. The VDM impacts indicate to a small mode shift from PT to highway.

- For Business and Other, there is a general trend – to varying magnitudes and most observable in the later forecast year – of a reduction in demand to the central sectors in Selby and increases for sectors adjacent Selby district. This is attributed to the level of congestion and delay in and around Selby and consequently the impact from destination choice. The influence of reducing car operating costs on travel distance has been referred to in the previous sections.

Figure 7-2 – Impacts of VDM Sector System

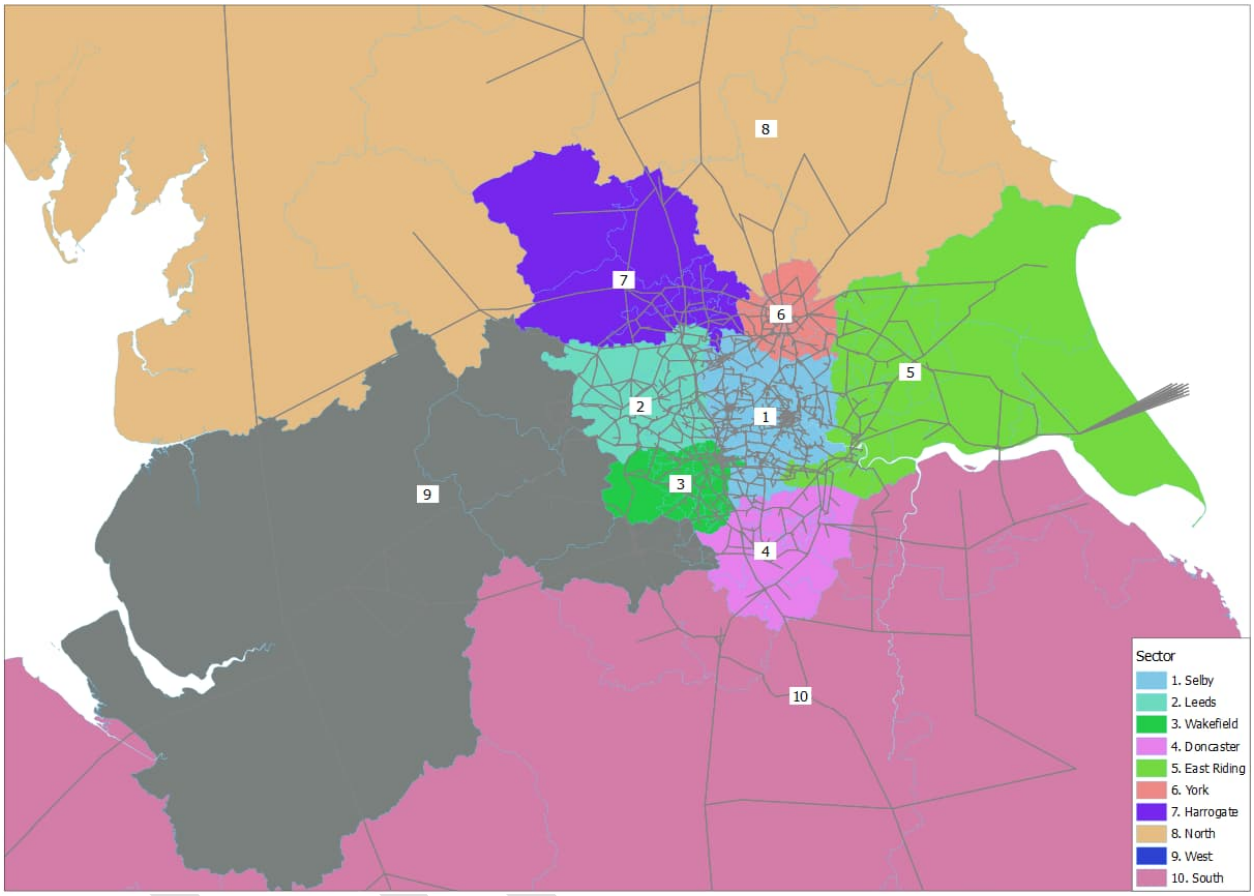


Table 7-5 – Impacts of VDM on Car Trip Ends 2040 DM AM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5751	5730	-0.4%	30381	30267	-0.4%	51717	51887	0.3%
2	5691	5719	0.5%	28200	28331	0.5%	43726	44209	1.1%
3	4383	4368	-0.3%	24310	24175	-0.6%	38872	38913	0.1%
4	2302	2322	0.9%	11771	11806	0.3%	24596	24796	0.8%
5	4919	4937	0.4%	20147	19959	-0.9%	34120	34334	0.6%
6	3930	3936	0.1%	18317	18387	0.4%	31344	31443	0.3%
7	2006	2013	0.3%	7957	7911	-0.6%	12619	12671	0.4%
8	1751	1766	0.9%	3717	3703	-0.4%	4487	4691	4.5%
9	1596	1604	0.5%	3713	3677	-1.0%	5272	5414	2.7%
10	1667	1685	1.1%	2447	2497	2.1%	4508	4712	4.5%

Table 7-6 – Impacts of VDM on Car Trip Ends 2040 DM AM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5537	5328	-3.8%	27994	27903	-0.3%	52239	52054	-0.4%
2	5838	5752	-1.5%	30972	31016	0.1%	45292	45599	0.7%
3	4445	4317	-2.9%	24637	24536	-0.4%	38555	38310	-0.6%
4	2107	2082	-1.2%	10702	10708	0.1%	23945	23908	-0.2%
5	4359	4324	-0.8%	17171	17064	-0.6%	32510	32519	0.0%
6	4385	4261	-2.8%	24447	24460	0.1%	33753	33724	-0.1%
7	2035	2061	1.3%	8443	8427	-0.2%	12202	12371	1.4%
8	1893	2174	14.8%	2553	2555	0.1%	4167	4883	17.2%
9	1537	1663	8.2%	2601	2608	0.3%	4549	4979	9.5%
10	1860	2118	13.9%	1439	1434	-0.3%	4049	4721	16.6%

Table 7-7 – Impacts of VDM on Car Trip Ends 2040 DM Inter Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	7968	8001	0.4%	18888	19089	1.1%	118830	118718	-0.1%
2	8065	8156	1.1%	17820	18208	2.2%	113231	114586	1.2%
3	6607	6670	1.0%	16885	17184	1.8%	100174	100900	0.7%
4	3309	3323	0.4%	7970	8071	1.3%	62171	62402	0.4%
5	7344	7394	0.7%	13037	13277	1.8%	93426	94066	0.7%
6	6848	6942	1.4%	14868	15118	1.7%	90886	91602	0.8%
7	2724	2743	0.7%	4709	4763	1.2%	31657	31955	0.9%
8	2541	2623	3.2%	1551	1584	2.1%	14326	16179	12.9%
9	2183	2234	2.4%	2225	2278	2.4%	17137	18419	7.5%
10	2558	2657	3.9%	1398	1443	3.2%	16205	18152	12.0%

Table 7-8 – Impacts of VDM on Car Trip Ends 2040 DM Inter Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	9276	9137	-1.5%	21786	22057	1.2%	135282	135986	0.5%
2	7743	7640	-1.3%	16633	16966	2.0%	109256	109631	0.3%
3	6549	6483	-1.0%	16754	17045	1.7%	98564	99006	0.4%
4	3347	3275	-2.2%	8246	8358	1.4%	61656	61565	-0.1%
5	7068	7066	0.0%	12964	13191	1.8%	91006	91306	0.3%
6	6663	6595	-1.0%	13165	13381	1.6%	89301	90048	0.8%
7	2605	2649	1.7%	4150	4181	0.7%	30516	30822	1.0%
8	2438	2861	17.3%	1665	1705	2.5%	13161	15543	18.1%
9	2017	2240	11.1%	2390	2460	2.9%	14886	16401	10.2%
10	2441	2797	14.6%	1598	1669	4.5%	14414	16671	15.7%

Table 7-9 – Impacts of VDM on Car Trip Ends 2040 DM PM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	4145	4059	-2.1%	25348	25332	-0.1%	55702	54650	-1.9%
2	4723	4668	-1.2%	30305	30497	0.6%	54193	54434	0.4%
3	3653	3572	-2.2%	23879	23887	0.0%	46092	45580	-1.1%
4	1784	1770	-0.8%	10400	10481	0.8%	27652	27701	0.2%
5	3454	3401	-1.5%	17483	17547	0.4%	39969	39689	-0.7%
6	3609	3559	-1.4%	23955	24100	0.6%	42617	42131	-1.1%
7	1529	1527	-0.1%	7985	8012	0.3%	14539	14701	1.1%
8	1404	1457	3.8%	3040	3080	1.3%	7203	8219	14.1%
9	1284	1289	0.4%	3602	3654	1.4%	8238	8836	7.3%
10	1656	1707	3.1%	2640	2700	2.3%	8914	10079	13.1%

Table 7-10 – Impacts of VDM on Car Trip Ends 2040 DM PM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5445	5281	-3.0%	35601	35692	0.3%	67841	67233	-0.9%
2	4146	4092	-1.3%	24565	24748	0.7%	49061	49007	-0.1%
3	3636	3561	-2.1%	24113	24163	0.2%	45577	45222	-0.8%
4	1794	1780	-0.8%	11222	11346	1.1%	27400	27447	0.2%
5	4006	3935	-1.8%	19757	19888	0.7%	41775	41690	-0.2%
6	3394	3320	-2.2%	16867	17016	0.9%	40404	40239	-0.4%
7	1494	1503	0.6%	7335	7327	-0.1%	14460	14581	0.8%
8	1242	1338	7.7%	3365	3349	-0.5%	6345	7214	13.7%
9	1002	1041	3.9%	3475	3420	-1.6%	6470	6892	6.5%
10	1083	1160	7.1%	2338	2342	0.2%	5784	6494	12.3%

Table 7-5 – Impacts of VDM on Car Trip Ends 2040 DS1 AM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6789	6735	-0.8%	36889	36645	-0.7%	66301	66267	-0.1%
2	5733	5755	0.4%	28398	28499	0.4%	44064	44524	1.0%
3	4488	4468	-0.5%	24866	24712	-0.6%	40118	40127	0.0%
4	2322	2341	0.8%	11841	11873	0.3%	24803	25007	0.8%
5	4992	5010	0.3%	20610	20416	-0.9%	34712	34951	0.7%
6	3953	3959	0.1%	18553	18596	0.2%	31751	31783	0.1%
7	2015	2021	0.3%	7968	7920	-0.6%	12665	12716	0.4%
8	1767	1783	0.9%	3756	3743	-0.4%	4572	4782	4.6%
9	1622	1627	0.4%	3751	3712	-1.0%	5442	5583	2.6%
10	1693	1710	1.0%	2495	2540	1.8%	4673	4885	4.5%

Table 7-6 – Impacts of VDM on Car Trip Ends 2040 DS1 AM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6546	6186	-5.5%	33990	33800	-0.6%	66795	65959	-1.3%
2	5894	5827	-1.1%	31506	31507	0.0%	45760	46145	0.8%
3	4506	4395	-2.5%	25005	24876	-0.5%	39256	39078	-0.5%
4	2123	2109	-0.7%	10765	10769	0.0%	24090	24094	0.0%
5	4436	4423	-0.3%	17515	17405	-0.6%	33148	33276	0.4%
6	4448	4299	-3.3%	25101	25080	-0.1%	34664	34564	-0.3%
7	2049	2085	1.8%	8477	8454	-0.3%	12267	12462	1.6%
8	1911	2201	15.2%	2624	2622	-0.1%	4237	4968	17.3%
9	1559	1695	8.7%	2657	2662	0.2%	4648	5098	9.7%
10	1901	2188	15.1%	1488	1482	-0.4%	4236	4980	17.6%

Table 7-7 – Impacts of VDM on Car Trip Ends 2040 DS1 Inter Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	10007	10055	0.5%	22588	22915	1.4%	159424	158999	-0.3%
2	8125	8237	1.4%	17959	18383	2.4%	114218	115870	1.4%
3	6705	6783	1.2%	17042	17375	2.0%	102321	103260	0.9%
4	3329	3348	0.6%	8005	8118	1.4%	62495	62790	0.5%
5	7471	7535	0.9%	13412	13679	2.0%	95180	96095	1.0%
6	6918	7022	1.5%	15066	15358	1.9%	92299	93066	0.8%
7	2738	2761	0.9%	4715	4777	1.3%	31784	32141	1.1%
8	2575	2663	3.4%	1569	1605	2.3%	14601	16537	13.3%
9	2211	2269	2.6%	2244	2302	2.6%	17429	18777	7.7%
10	2589	2694	4.1%	1421	1469	3.4%	16517	18558	12.4%

Table 7-8 – Impacts of VDM on Car Trip Ends 2040 DS1 Inter Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	11320	11057	-2.3%	25527	25932	1.6%	175722	175497	-0.1%
2	7806	7742	-0.8%	16750	17115	2.2%	110212	110944	0.7%
3	6659	6626	-0.5%	16912	17232	1.9%	100923	101678	0.7%
4	3364	3303	-1.8%	8279	8404	1.5%	61926	61931	0.0%
5	7190	7231	0.6%	13375	13627	1.9%	92718	93417	0.8%
6	6728	6684	-0.6%	13318	13578	1.9%	90667	91639	1.1%
7	2616	2674	2.2%	4156	4193	0.9%	30638	31031	1.3%
8	2468	2915	18.1%	1681	1725	2.7%	13457	15956	18.6%
9	2049	2287	11.6%	2410	2485	3.1%	15268	16878	10.5%
10	2468	2847	15.4%	1615	1689	4.6%	14736	17122	16.2%

Table 7-9 – Impacts of VDM on Car Trip Ends 2040 DS1 PM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5227	5062	-3.2%	31126	31009	-0.4%	74298	71993	-3.1%
2	4791	4732	-1.2%	30755	30898	0.5%	54888	55177	0.5%
3	3716	3635	-2.2%	24188	24165	-0.1%	47057	46571	-1.0%
4	1808	1796	-0.7%	10469	10542	0.7%	27920	28011	0.3%
5	3533	3482	-1.4%	17873	17913	0.2%	40894	40719	-0.4%
6	3666	3607	-1.6%	24482	24580	0.4%	43415	42955	-1.1%
7	1540	1540	0.0%	8011	8027	0.2%	14605	14797	1.3%
8	1420	1475	3.9%	3102	3136	1.1%	7306	8360	14.4%
9	1300	1305	0.4%	3649	3697	1.3%	8356	8963	7.3%
10	1684	1741	3.4%	2671	2727	2.1%	9104	10343	13.6%

Table 7-10 – Impacts of VDM on Car Trip Ends 2040 DS1 PM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6558	6258	-4.6%	41739	41683	-0.1%	86292	84245	-2.4%
2	4186	4140	-1.1%	24734	24882	0.6%	49512	49550	0.1%
3	3745	3674	-1.9%	24589	24619	0.1%	47291	47007	-0.6%
4	1816	1806	-0.6%	11287	11404	1.0%	27669	27768	0.4%
5	4078	4014	-1.6%	20244	20353	0.5%	42620	42648	0.1%
6	3421	3356	-1.9%	17093	17207	0.7%	40869	40791	-0.2%
7	1500	1513	0.9%	7344	7331	-0.2%	14507	14666	1.1%
8	1254	1359	8.4%	3400	3379	-0.6%	6450	7358	14.1%
9	1020	1062	4.1%	3511	3448	-1.8%	6639	7082	6.7%
10	1107	1194	7.8%	2386	2387	0.1%	5995	6775	13.0%

Table 7-5 – Impacts of VDM on Car Trip Ends 2040 DS2 AM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6551	6506	-0.7%	35444	35247	-0.6%	62814	62837	0.0%
2	5726	5749	0.4%	28336	28446	0.4%	44018	44476	1.0%
3	4482	4462	-0.4%	24803	24653	-0.6%	40064	40067	0.0%
4	2319	2338	0.8%	11828	11860	0.3%	24768	24968	0.8%
5	4980	4996	0.3%	20578	20384	-0.9%	34599	34829	0.7%
6	3944	3949	0.1%	18457	18510	0.3%	31477	31553	0.2%
7	2013	2019	0.3%	7968	7920	-0.6%	12656	12706	0.4%
8	1764	1780	0.9%	3741	3728	-0.4%	4558	4765	4.6%
9	1617	1623	0.4%	3746	3708	-1.0%	5403	5543	2.6%
10	1691	1707	1.0%	2482	2529	1.9%	4655	4864	4.5%

Table 7-6 – Impacts of VDM on Car Trip Ends 2040 DS2 AM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6349	6015	-5.3%	32815	32655	-0.5%	63767	63086	-1.1%
2	5885	5812	-1.2%	31355	31368	0.0%	45681	46042	0.8%
3	4500	4382	-2.6%	24930	24809	-0.5%	39198	38987	-0.5%
4	2119	2101	-0.9%	10762	10766	0.0%	24057	24043	-0.1%
5	4419	4400	-0.4%	17484	17375	-0.6%	33009	33103	0.3%
6	4425	4297	-2.9%	24843	24838	0.0%	34075	34062	0.0%
7	2045	2079	1.7%	8476	8456	-0.2%	12250	12438	1.5%
8	1907	2196	15.2%	2586	2586	0.0%	4218	4946	17.3%
9	1553	1686	8.5%	2651	2656	0.2%	4613	5053	9.5%
10	1885	2161	14.7%	1481	1476	-0.3%	4144	4848	17.0%

Table 7-7 – Impacts of VDM on Car Trip Ends 2040 DS2 Inter Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	9738	9776	0.4%	22139	22415	1.2%	152972	152506	-0.3%
2	8117	8223	1.3%	17924	18334	2.3%	114092	115652	1.4%
3	6699	6772	1.1%	17018	17339	1.9%	102224	103083	0.8%
4	3326	3344	0.5%	8001	8112	1.4%	62463	62735	0.4%
5	7458	7519	0.8%	13401	13658	1.9%	94966	95815	0.9%
6	6899	7000	1.5%	15008	15281	1.8%	91630	92456	0.9%
7	2735	2758	0.8%	4715	4774	1.3%	31762	32104	1.1%
8	2571	2658	3.4%	1561	1595	2.2%	14560	16477	13.2%
9	2207	2263	2.5%	2242	2299	2.5%	17386	18713	7.6%
10	2585	2689	4.0%	1417	1465	3.3%	16475	18490	12.2%

Table 7-8 – Impacts of VDM on Car Trip Ends 2040 DS2 Inter Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	11050	10809	-2.2%	25062	25409	1.4%	169258	169184	0.0%
2	7798	7722	-1.0%	16719	17074	2.1%	110093	110717	0.6%
3	6652	6609	-0.6%	16889	17201	1.8%	100810	101460	0.6%
4	3361	3297	-1.9%	8276	8398	1.5%	61899	61872	0.0%
5	7178	7210	0.4%	13363	13607	1.8%	92529	93132	0.7%
6	6711	6667	-0.7%	13268	13509	1.8%	90025	90976	1.1%
7	2614	2669	2.1%	4155	4191	0.8%	30613	30983	1.2%
8	2463	2905	17.9%	1673	1716	2.6%	13399	15868	18.4%
9	2044	2278	11.5%	2409	2482	3.1%	15212	16797	10.4%
10	2464	2836	15.1%	1611	1685	4.6%	14692	17042	16.0%

Table 7-9 – Impacts of VDM on Car Trip Ends 2040 DS2 PM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5017	4875	-2.8%	30090	30010	-0.3%	70390	68528	-2.6%
2	4780	4722	-1.2%	30628	30787	0.5%	54777	55051	0.5%
3	3707	3624	-2.2%	24122	24109	-0.1%	46943	46419	-1.1%
4	1803	1790	-0.7%	10466	10541	0.7%	27872	27944	0.3%
5	3519	3466	-1.5%	17848	17896	0.3%	40705	40482	-0.5%
6	3647	3595	-1.4%	24266	24386	0.5%	43003	42583	-1.0%
7	1537	1537	0.0%	8011	8030	0.2%	14593	14779	1.3%
8	1416	1471	3.9%	3071	3107	1.2%	7279	8320	14.3%
9	1297	1302	0.4%	3643	3692	1.3%	8330	8932	7.2%
10	1675	1730	3.3%	2664	2721	2.1%	9036	10241	13.3%

Table 7-10 – Impacts of VDM on Car Trip Ends 2040 DS2 PM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6325	6069	-4.0%	40473	40474	0.0%	82093	80551	-1.9%
2	4179	4130	-1.2%	24683	24842	0.6%	49446	49449	0.0%
3	3735	3661	-2.0%	24534	24570	0.1%	47165	46831	-0.7%
4	1811	1799	-0.7%	11275	11394	1.0%	27620	27696	0.3%
5	4068	4001	-1.6%	20219	20334	0.6%	42499	42487	0.0%
6	3414	3349	-1.9%	17013	17143	0.8%	40655	40588	-0.2%
7	1499	1511	0.8%	7344	7333	-0.2%	14498	14648	1.0%
8	1251	1353	8.2%	3387	3368	-0.6%	6415	7309	13.9%
9	1015	1055	4.0%	3507	3446	-1.7%	6592	7025	6.6%
10	1101	1184	7.5%	2374	2376	0.1%	5944	6696	12.7%

Table 7-5 – Impacts of VDM on Car Trip Ends 2040 DS3 AM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6575	6538	-0.6%	35616	35435	-0.5%	63078	63136	0.1%
2	5726	5749	0.4%	28318	28426	0.4%	44029	44490	1.0%
3	4485	4464	-0.5%	24828	24672	-0.6%	40096	40096	0.0%
4	2321	2340	0.8%	11833	11864	0.3%	24798	24999	0.8%
5	4986	5002	0.3%	20603	20404	-1.0%	34663	34896	0.7%
6	3943	3951	0.2%	18450	18508	0.3%	31481	31586	0.3%
7	2012	2019	0.3%	7965	7918	-0.6%	12656	12708	0.4%
8	1763	1780	0.9%	3745	3732	-0.3%	4559	4768	4.6%
9	1620	1626	0.4%	3743	3706	-1.0%	5431	5573	2.6%
10	1692	1708	1.0%	2487	2533	1.8%	4666	4876	4.5%

Table 7-6 – Impacts of VDM on Car Trip Ends 2040 DS3 AM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6378	6024	-5.6%	33102	32948	-0.5%	64127	63367	-1.2%
2	5878	5808	-1.2%	31283	31298	0.0%	45606	45980	0.8%
3	4502	4384	-2.6%	24950	24826	-0.5%	39228	39024	-0.5%
4	2122	2106	-0.8%	10761	10764	0.0%	24082	24079	0.0%
5	4425	4417	-0.2%	17502	17391	-0.6%	33082	33215	0.4%
6	4418	4297	-2.7%	24807	24807	0.0%	34034	34062	0.1%
7	2043	2078	1.7%	8468	8448	-0.2%	12235	12427	1.6%
8	1906	2197	15.2%	2594	2594	0.0%	4216	4946	17.3%
9	1554	1688	8.6%	2639	2644	0.2%	4629	5074	9.6%
10	1897	2179	14.9%	1482	1476	-0.4%	4218	4954	17.4%

Table 7-7 – Impacts of VDM on Car Trip Ends 2040 DS3 Inter Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	9788	9819	0.3%	22218	22507	1.3%	153976	153390	-0.4%
2	8112	8219	1.3%	17909	18321	2.3%	113957	115527	1.4%
3	6701	6777	1.1%	17025	17355	1.9%	102236	103139	0.9%
4	3327	3346	0.6%	8002	8114	1.4%	62478	62764	0.5%
5	7462	7526	0.8%	13409	13671	2.0%	95070	95966	0.9%
6	6897	6997	1.4%	15001	15272	1.8%	91602	92428	0.9%
7	2734	2756	0.8%	4713	4772	1.3%	31742	32086	1.1%
8	2570	2656	3.3%	1563	1597	2.2%	14544	16465	13.2%
9	2207	2263	2.5%	2240	2296	2.5%	17386	18720	7.7%
10	2585	2690	4.0%	1418	1466	3.4%	16481	18508	12.3%

Table 7-8 – Impacts of VDM on Car Trip Ends 2040 DS3 Inter Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	11100	10844	-2.3%	25135	25500	1.4%	170221	169980	-0.1%
2	7794	7719	-1.0%	16707	17062	2.1%	109994	110639	0.6%
3	6653	6613	-0.6%	16896	17216	1.9%	100811	101518	0.7%
4	3362	3299	-1.9%	8277	8401	1.5%	61912	61904	0.0%
5	7183	7218	0.5%	13372	13621	1.9%	92625	93279	0.7%
6	6709	6664	-0.7%	13263	13500	1.8%	90000	90954	1.1%
7	2613	2668	2.1%	4154	4189	0.8%	30603	30976	1.2%
8	2461	2904	18.0%	1675	1718	2.6%	13387	15862	18.5%
9	2044	2279	11.5%	2407	2481	3.1%	15217	16811	10.5%
10	2465	2840	15.2%	1612	1687	4.6%	14704	17071	16.1%

Table 7-9 – Impacts of VDM on Car Trip Ends 2040 DS3 PM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5046	4892	-3.1%	30329	30232	-0.3%	70907	68840	-2.9%
2	4774	4718	-1.2%	30568	30727	0.5%	54649	54946	0.5%
3	3710	3627	-2.2%	24139	24118	-0.1%	47001	46475	-1.1%
4	1806	1793	-0.7%	10466	10539	0.7%	27908	27993	0.3%
5	3526	3475	-1.4%	17862	17905	0.2%	40809	40620	-0.5%
6	3643	3592	-1.4%	24237	24357	0.5%	42963	42550	-1.0%
7	1536	1536	0.0%	8004	8023	0.2%	14581	14772	1.3%
8	1415	1471	3.9%	3077	3113	1.2%	7277	8323	14.4%
9	1297	1302	0.4%	3633	3681	1.3%	8335	8943	7.3%
10	1679	1735	3.3%	2665	2722	2.1%	9067	10293	13.5%

Table 7-10 – Impacts of VDM on Car Trip Ends 2040 DS3 PM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6350	6079	-4.3%	40618	40591	-0.1%	82528	80771	-2.1%
2	4178	4131	-1.1%	24668	24828	0.6%	49416	49444	0.1%
3	3738	3666	-1.9%	24554	24582	0.1%	47218	46899	-0.7%
4	1813	1802	-0.6%	11280	11397	1.0%	27647	27740	0.3%
5	4072	4006	-1.6%	20238	20351	0.6%	42554	42569	0.0%
6	3414	3347	-2.0%	17007	17143	0.8%	40646	40582	-0.2%
7	1498	1512	0.9%	7341	7331	-0.1%	14497	14653	1.1%
8	1250	1353	8.2%	3391	3372	-0.5%	6415	7313	14.0%
9	1016	1058	4.1%	3505	3444	-1.7%	6609	7050	6.7%
10	1104	1188	7.7%	2378	2379	0.1%	5967	6737	12.9%

Table 7-5 – Impacts of VDM on Car Trip Ends 2040 DS4 AM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6589	6529	-0.9%	35631	35305	-0.9%	63241	62786	-0.7%
2	5725	5726	0.0%	28328	28249	-0.3%	44013	44006	0.0%
3	4483	4449	-0.8%	24835	24570	-1.1%	40071	39792	-0.7%
4	2320	2330	0.5%	11834	11800	-0.3%	24773	24776	0.0%
5	4983	4990	0.2%	20579	20320	-1.3%	34631	34706	0.2%
6	3951	3933	-0.5%	18510	18431	-0.4%	31730	31449	-0.9%
7	2013	2017	0.2%	7965	7909	-0.7%	12654	12674	0.2%
8	1764	1779	0.8%	3750	3731	-0.5%	4561	4749	4.1%
9	1617	1623	0.3%	3742	3703	-1.0%	5409	5540	2.4%
10	1691	1704	0.7%	2487	2516	1.2%	4660	4850	4.1%

Table 7-6 – Impacts of VDM on Car Trip Ends 2040 DS4 AM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6381	6028	-5.5%	32973	32692	-0.9%	64002	62855	-1.8%
2	5878	5796	-1.4%	31309	31155	-0.5%	45602	45539	-0.1%
3	4500	4374	-2.8%	24966	24732	-0.9%	39190	38724	-1.2%
4	2121	2097	-1.1%	10763	10710	-0.5%	24065	23871	-0.8%
5	4427	4401	-0.6%	17479	17308	-1.0%	33057	33012	-0.1%
6	4437	4273	-3.7%	24984	24833	-0.6%	34586	34154	-1.2%
7	2046	2078	1.6%	8468	8421	-0.6%	12248	12395	1.2%
8	1908	2188	14.7%	2609	2596	-0.5%	4218	4909	16.4%
9	1553	1682	8.4%	2633	2622	-0.4%	4617	5026	8.9%
10	1888	2161	14.5%	1476	1465	-0.7%	4157	4840	16.4%

Table 7-7 – Impacts of VDM on Car Trip Ends 2040 DS4 Inter Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	9798	9811	0.1%	22244	22455	0.9%	154192	152917	-0.8%
2	8112	8182	0.9%	17915	18205	1.6%	113921	114449	0.5%
3	6700	6756	0.8%	17031	17278	1.4%	102213	102462	0.2%
4	3327	3333	0.2%	8003	8071	0.9%	62472	62344	-0.2%
5	7461	7507	0.6%	13401	13609	1.6%	95025	95543	0.5%
6	6912	6959	0.7%	15040	15217	1.2%	92183	92040	-0.2%
7	2735	2753	0.7%	4713	4759	1.0%	31752	32014	0.8%
8	2572	2654	3.2%	1566	1593	1.7%	14559	16398	12.6%
9	2208	2263	2.5%	2239	2285	2.1%	17389	18659	7.3%
10	2586	2683	3.8%	1418	1458	2.8%	16482	18430	11.8%

Table 7-8 – Impacts of VDM on Car Trip Ends 2040 DS4 Inter Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	11111	10831	-2.5%	25171	25443	1.1%	170401	169326	-0.6%
2	7793	7695	-1.3%	16712	16945	1.4%	109970	109635	-0.3%
3	6651	6594	-0.9%	16901	17136	1.4%	100778	100822	0.0%
4	3362	3288	-2.2%	8277	8354	0.9%	61907	61491	-0.7%
5	7183	7200	0.2%	13363	13560	1.5%	92598	92886	0.3%
6	6722	6631	-1.4%	13296	13448	1.1%	90567	90642	0.1%
7	2614	2663	1.9%	4154	4180	0.6%	30615	30904	0.9%
8	2464	2895	17.5%	1678	1716	2.3%	13416	15801	17.8%
9	2046	2275	11.2%	2406	2474	2.8%	15236	16761	10.0%
10	2464	2831	14.9%	1612	1674	3.9%	14700	16988	15.6%

Table 7-9 – Impacts of VDM on Car Trip Ends 2040 DS4 PM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5064	4904	-3.2%	30285	30098	-0.6%	71238	68922	-3.3%
2	4772	4699	-1.5%	30590	30591	0.0%	54620	54443	-0.3%
3	3708	3618	-2.4%	24156	24038	-0.5%	46946	46165	-1.7%
4	1805	1787	-1.0%	10467	10490	0.2%	27879	27788	-0.3%
5	3526	3467	-1.7%	17845	17822	-0.1%	40787	40450	-0.8%
6	3657	3580	-2.1%	24385	24360	-0.1%	43308	42480	-1.9%
7	1537	1535	-0.1%	8004	7997	-0.1%	14584	14739	1.1%
8	1418	1470	3.7%	3090	3109	0.6%	7292	8297	13.8%
9	1296	1299	0.3%	3629	3660	0.9%	8319	8891	6.9%
10	1678	1729	3.0%	2661	2706	1.7%	9054	10226	12.9%

Table 7-10 – Impacts of VDM on Car Trip Ends 2040 DS4 PM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6364	6082	-4.4%	40692	40553	-0.3%	82873	80789	-2.5%
2	4180	4118	-1.5%	24677	24671	0.0%	49421	49020	-0.8%
3	3740	3657	-2.2%	24564	24488	-0.3%	47212	46608	-1.3%
4	1814	1797	-0.9%	11282	11338	0.5%	27640	27553	-0.3%
5	4073	3998	-1.8%	20220	20262	0.2%	42549	42402	-0.3%
6	3418	3334	-2.5%	17057	17061	0.0%	40822	40395	-1.0%
7	1499	1510	0.7%	7342	7322	-0.3%	14496	14616	0.8%
8	1253	1352	7.9%	3395	3369	-0.8%	6436	7296	13.4%
9	1017	1056	3.8%	3504	3443	-1.7%	6614	7027	6.2%
10	1103	1184	7.3%	2379	2364	-0.6%	5962	6694	12.3%

8 CORE SCENARIO ASSIGNMENT RESULTS

8.1 INTRODUCTION

8.1.1. This chapter details the outputs from the forecast assignments for the 2040 DM model run including assignment stability, network performance and congestion indicators. Convergence is reported for the forecast to demonstrate stability of the models that have been developed. Comparisons are made between base and do minimum scenarios for the forecast year with respect to metrics including distance, time, and travel speed.

8.1.2. The outputs are divided into the following sub-sections:

- Highway model assignment convergence;
- Highway network statistics – vehicle hours, kilometres, delays etc. across the simulation area network; and
- Highway assignment impacts – traffic flow difference plots, journey time and traffic flow Volume over capacity plots.

8.1.3. These results are summarised for the following model runs in the subsequent sections of this chapter

- 2040 DM
- 2040 DS1
- 2040 DS2
- 2040 DS3
- 2040 DS4

8.2 DEFINITION OF VARIOUS PARAMETERS USED FOR REPORTING

8.2.1. This section summarises the definition of various parameters outlined in section **Error! Reference source not found.Error! Reference source not found.** used for reporting in the subsequent sections of this chapter for reference.

Highway Model Assignment Convergence

8.2.2. An assignment model is considered to be converged if there is no significant change in travel costs across all the routes between successive iterations. Convergence limits “modelled noise”, reducing errors and allowing the true impacts of forecast model tests to be established.

8.2.3. TAG recommends several criteria to be applied for all highway assignments to achieve a final solution, i.e. route choice, flows and delays produced from the model are deemed stable. It recommends that the model should continue until, for at least 98% of cases, the percentage of link flow or cost differences changes by no more than 1% on four successive iterations.

8.2.4. Stability indicator % Flow indicates the link flows differing by <1% between Assignment & Simulation.

8.2.5. Stability indicator % Delays indicates the turn delays differing by <1% between Assignment & Simulation.

Highway Network Statistics

8.2.6. The results present the strategic impact on the wider network performance, including:

- Transient queues (pcus)
  Queues that occur at junctions operating within their designed capacity; for example vehicles stopping momentarily at a give-way line, or during one traffic signal cycle.
- Over-capacity queues (pcus)
  Queues that occur due to there being more traffic than there is network capacity to deal with; for example traffic held for more than one cycle at a traffic signal junction.
- Link Cruise Time (pcu-hrs)
- Total travel time (pcu-hrs)
  Total journey time of all vehicles within the model during the modelled time period
- Total travel distance (km)
  Total distance travelled across the network by all vehicles in the model during the modelled time period
- Average journey speed (kph)
- Total assigned trips (pcus);
  The total number of vehicles travelling on the network in the modelled time period.

8.2.7. For all time periods, all but one of the indicators is expected to increase through the forecast modelled years, expected given the increased travel demand (and limited supply interventions). The exception to this is average speed, which is expected to decrease through the forecast modelled years, attributed to increased congestion.

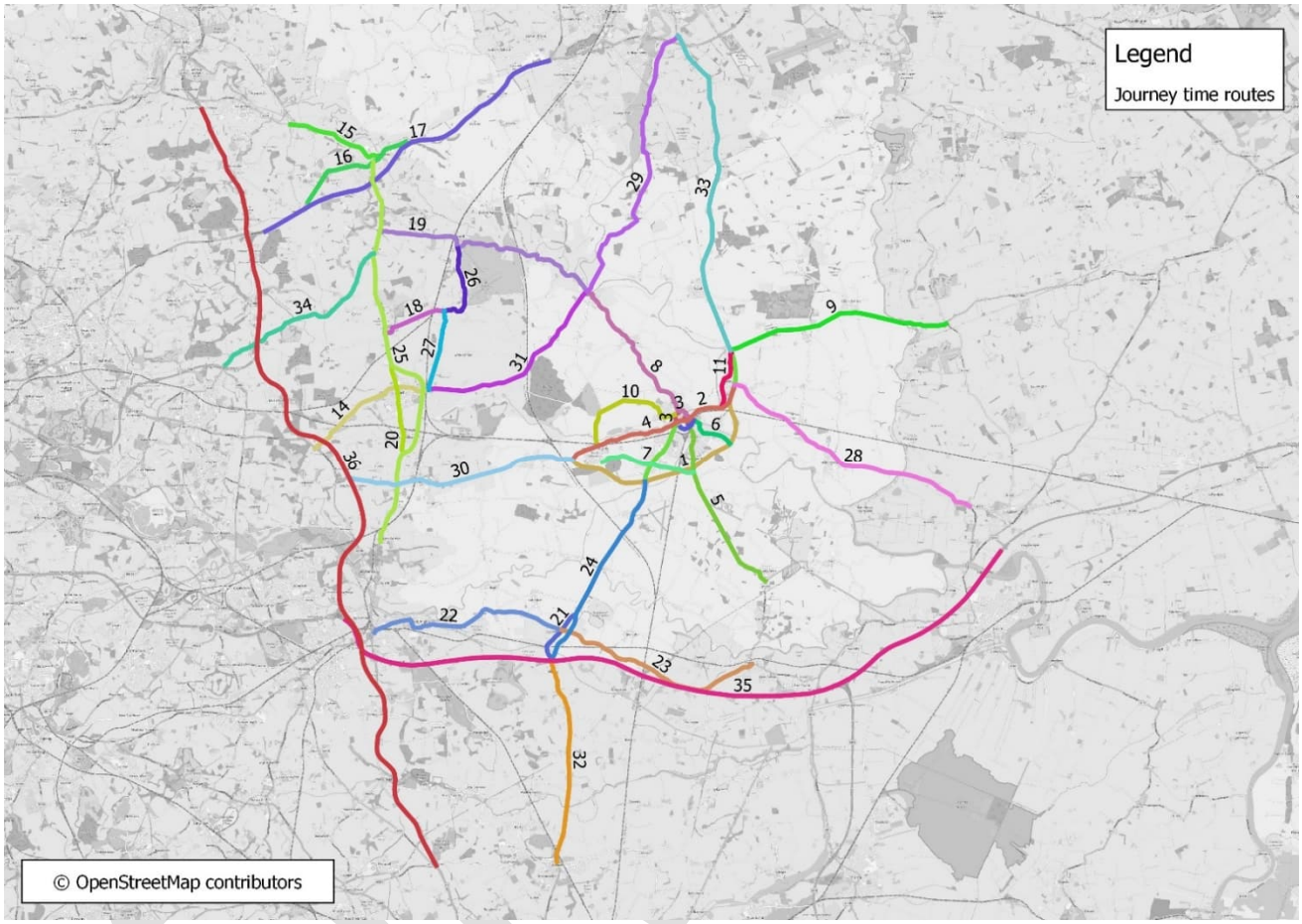
Highway Assignment Impacts

8.2.8. In addition to the above, the results also include the following

- Change in Journey time
  Journey times have been extracted for the various forecasting scenarios using the journey routes defined on the base year. Please note Route 6EB and Route 13 WB will be reported as blank in the forecast year as these links are converted to oneway in the forecast year as part of the Selby TCF scheme.
  Error! Reference source not found. shows the various journey time routes included in the assessment.
- traffic flow difference plots and
  The traffic difference plots compare the traffic flow for each of the 2040 DS scenarios against the 2040 DM showing the change in the traffic flow. In these plots the link which are predicted to experience an increase in traffic flows are highlighted on green whilst the links predicted to experience a decrease in traffic are highlighted don blue.
- VoC plots for each of the scenario runs.
  Two VoC assessments have been produced namely;
  Link VoC which highlights links on the network which are over 70% VoC and
  Junction VoC which highlights junctions where any arm is over 70% VoC.
  The figures for traffic flow difference and VoC make use of a graduated scale which categorises the results into difference segments which are presented in the respective legend.

8.2.9. For the 2040 DM model run, the change in journey time is reported and compared against the 2019 base year model whilst the change in journey time for 2040 DS model runs is reported and compared against the 2040 DM.

Figure 8-1 – Journey Time Routes



8.2.10. SATURN is a strategic modelling software, which assigns traffic on the model network based on land use changes and the VOC values calculated by SATURN are indicative of their operational capacity.

8.2.11. For a more accurate operational assessment of these junctions, industry standard software (e.g. JUNCTIONS 10 for priority controlled junction and LINSIG for signal controlled junctions) would need to be used. This software enables finer detail on factors such as junction layouts, lane utilisation and signal operation to be modelled and would be used as part of the junction design process.

8.2.12. JUNCTIONS 10 calculates the capacity of each of arm of a junction in terms of Ratio of Flow to Capacity (RFC). It is normally accepted that any arm which is reported to have an RFC value of 0.85 or lower can confidently be considered to have adequate capacity to accommodate the predicted traffic demand.

8.2.13. LINSIG is a software tool which models the effect of traffic signals on the highway network by measuring the capacity of each lane of a junction in terms of Degree of Saturation (DoS). It is

normally accepted that any arm which is reported to have a DoS value of 90% or lower can confidently be considered to have adequate capacity to accommodate the predicted traffic demand.

8.2.14. Both RFC and DOS measure the volume over capacity for an arm or a turn of a junction and are hence comparable to the VOC reported in SATURN.

8.2.15. For priority-controlled junction it is normally accepted that a VOC value of 0.85 or lower can confidently be considered to have adequate capacity to accommodate the predicted traffic demand.

8.2.16. For a signalised junction it is normally accepted that any arm which is reported to have a VOC value of 90% or lower can confidently be considered to have adequate capacity to accommodate the predicted traffic demand.

8.3 RESULTS FOR 2040DM

8.3.1. This section summarises the results for 2040 DM model run for the parameter outlined in section 8.1.2

8.3.2. The convergence results for 2040 DM are summarised in Table 8-1**Error! Reference source not found.**. The core scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 8-1 – Core Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (d) / (Gap (%)	% Flow	% Delays
2040 DM	AM	47	0.0037	99.6	99.5
		48	0.0056	99.6	99.5
		49	0.0051	99.1	99.6
		50	0.0048	99.2	99.5
	IP	14	0.00062	99.1	99.9
		15	0.00053	99.3	99.9
		16	0.00048	99.5	99.9
		17	0.00042	99.5	100
	PM	62	0.0035	99.6	99.3
		63	0.0039	99.5	99.4
		64	0.0045	99.5	99.3
		65	0.007	99.7	99.3

Highway Network Statistics

8.3.3. A comparison of the network statistics between the model base year and modelled forecast years is provided in Tables 8-2 to 8-4 respectively by time period.

8.3.4. For all time periods, all but one of the indicators is forecast to increase through the modelled year, expected given the increased travel demand (and limited supply interventions). The exception to this

is average speed, which is forecast to decrease through the modelled years, attributed to increased congestion.

Table 8-2 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2019	2040DM	% Change
Transient Queues (pcu-hrs)	1140	2122	86.2%
Overcapacity Queues (pcu-hrs)	52.9	544	
Link Cruise Time (pcu-hrs)	12326	16489	33.8%
Total Travel Time (pcu-hrs)	13518	19156	41.7%
Travel Distance (pcu-kms)	1032129	1319250	27.8%
Average Journey Speed (kph)	76.4	69	-9.9%
Total Assigned Trips (pcus)	125441.1	145258.7	15.8%

Table 8-3 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2019	2040DM	% Change
Transient Queues (pcu-hrs)	699	1054	50.6%
Overcapacity Queues (pcu-hrs)	0	18	
Link Cruise Time (pcu-hrs)	9732	12467	28.1%
Total Travel Time (pcu-hrs)	10431	13538	29.8%
Travel Distance (pcu-kms)	857791	1063815	24.0%
Average Journey Speed (kph)	82	79	-4.4%
Total Assigned Trips (pcus)	97539.8	113024.3	15.9%

Table 8-4 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2019	2040DM	% Change
Transient Queues (pcu-hrs)	1207	2311	91.5%
Overcapacity Queues (pcu-hrs)	5	641	
Link Cruise Time (pcu-hrs)	12610	16920	34.2%
Total Travel Time (pcu-hrs)	13822	19873	43.8%
Travel Distance (pcu-kms)	1048040	1342632	28.1%
Average Journey Speed (kph)	75.8	68	-10.9%
Total Assigned Trips (pcus)	122215.6	141497.5	15.8%

8.4 HIGHWAY ASSIGNMENT IMPACTS

8.4.1. Highway assignment impacts are quantified through comparison of forecast model outputs for:

- Journey time routes.
- Traffic flow plots.
- VoC plots for each of the scenario runs.

Journey Time Routes

8.4.2. Comparisons of travel times on a subset of the local network journey time routes between the base year 2019 and forecast 2040 DM are presented in tables below by time period.

8.4.3. There are increases in travel time between the base year and 2040 forecast. This is reflective of larger delays in the network due to increased demand and congestion and is the general trend across the network.

Table 8-5 – Journey Time Routes, 2040 DM compared with 2019 Base

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2019	2040DM	% Change	2019	2040DM	% Change	2019	2040	% Change
1 EB	08:01	09:04	13%	07:31	07:56	6%	08:02	09:57	24%
1 WB	07:54	09:39	22%	07:28	07:51	5%	07:56	09:32	20%
2 NB	14:43	16:45	14%	14:09	14:47	4%	15:08	17:55	18%
2 SB	15:07	19:23	28%	14:08	15:01	6%	14:47	18:42	27%
3 ACW	05:57	05:49	-2%	06:03	06:09	2%	07:12	06:38	-8%
3 CW	06:32	07:18	12%	06:15	06:45	8%	07:26	07:53	6%
4 EB	13:20	14:39	10%	12:58	13:23	3%	13:54	15:49	14%
4 WB	13:57	16:35	19%	13:00	13:39	5%	13:32	16:19	21%
5 NB	10:28	11:27	9%	08:50	09:19	5%	10:01	11:39	16%
5 SB	08:55	09:01	1%	08:20	08:14	-1%	09:10	09:16	1%
6 EB	04:19	00:00		04:12	00:00		04:39	00:00	
6 WB	04:44	05:29	16%	04:38	05:21	15%	04:56	05:48	18%
7 WB	05:16	05:29	4%	05:09	05:13	1%	05:18	05:32	4%
7 EB	05:29	05:48	6%	05:13	05:16	1%	05:17	05:36	6%
8 NB	09:40	09:56	3%	09:38	09:45	1%	09:48	10:06	3%
8 SB	10:32	11:16	7%	10:25	10:44	3%	11:25	11:58	5%
9 WB	08:12	08:28	3%	08:05	08:11	1%	08:12	08:26	3%
9 EB	08:00	08:03	1%	07:56	07:57	0%	08:01	08:04	1%

10 EB	06:35	06:51	4%	06:27	06:33	2%	06:23	06:33	3%
10 WB	06:23	06:30	2%	06:21	06:27	2%	06:25	06:33	2%
11 SB	04:04	04:13	4%	04:01	04:01	0%	04:02	04:05	1%
11 NB	04:06	04:43	15%	03:59	04:02	1%	04:02	04:33	13%
12 NB	03:19	03:24	3%	03:19	03:22	1%	03:31	03:49	8%
12 SB	03:09	03:09	0%	03:09	03:10	0%	03:17	03:19	1%
13 EB	02:30	02:39	6%	02:42	02:51	6%	03:05	03:20	8%
13 WB	02:43	00:00		02:41	00:00		02:47	00:00	
14 EB	07:47	08:41	12%	07:23	07:32	2%	07:51	08:28	8%
14 WB	07:51	08:01	2%	07:34	07:34	0%	07:57	08:02	1%
15 EB	07:29	08:31	14%	07:14	07:28	3%	07:37	09:02	19%
15 WB	07:34	08:06	7%	07:11	07:18	1%	07:37	08:11	7%
16 WB	07:08	07:32	6%	06:46	06:52	2%	07:08	07:39	7%
16 EB	07:30	08:37	15%	07:00	07:15	4%	07:27	08:56	20%
17 EB	09:25	10:36	12%	08:39	09:08	6%	09:26	12:27	32%
17 WB	08:57	09:53	10%	08:45	09:06	4%	09:16	09:57	7%
18 EB	03:26	03:28	1%	03:25	03:26	0%	03:28	03:29	1%
18 WB	03:30	03:41	5%	03:25	03:27	1%	03:28	03:30	1%
19 EB	10:33	10:52	3%	10:33	10:36	1%	10:37	11:07	5%
19 WB	10:54	12:49	18%	10:43	10:48	1%	10:44	11:16	5%
20 SB	05:45	05:55	3%	05:41	05:44	1%	06:03	06:04	0%
20 NB	06:01	06:06	1%	05:45	05:49	1%	06:01	06:04	1%
21 NB	04:05	04:11	3%	03:35	03:39	2%	03:40	03:59	9%
21 SB	04:09	04:24	6%	03:36	03:40	1%	03:42	03:50	3%
22 EB	10:12	12:30	23%	10:07	11:15	11%	10:57	14:53	36%
22 WB	10:11	18:43	84%	09:56	11:03	11%	10:34	14:38	39%
23 EB	08:35	08:37	0%	08:21	08:23	0%	08:39	08:41	1%
23 WB	08:38	08:36	0%	08:24	08:25	0%	08:35	08:35	0%
24 NB	07:48	08:59	15%	07:18	08:05	11%	07:52	10:27	33%
24 SB	07:44	10:36	37%	07:23	07:52	7%	07:48	08:19	7%

25 NB	16:32	18:06	10%	15:21	16:00	4%	15:29	17:01	10%
25 SB	14:59	16:47	12%	14:57	15:31	4%	15:56	17:33	10%
26 NB	03:56	04:04	4%	03:55	04:01	3%	03:56	04:02	3%
26 SB	04:03	04:12	4%	04:02	04:07	2%	04:02	04:14	5%
27 NB	03:29	03:35	3%	03:29	03:32	2%	03:30	03:34	2%
27 SB	03:27	03:30	2%	03:24	03:27	1%	03:25	03:31	3%
28 EB	09:25	09:21	-1%	09:17	09:13	-1%	10:02	09:26	-6%
28 WB	09:55	10:29	6%	09:21	09:34	2%	09:44	10:25	7%
29 NB	13:15	20:10	52%	12:36	13:21	6%	12:53	18:14	42%
29 SB	13:03	21:16	63%	12:54	14:49	15%	14:18	22:49	60%
30 WB	09:45	12:29	28%	08:48	09:11	4%	09:10	10:35	16%
30 EB	08:57	10:56	22%	08:42	09:25	8%	10:04	13:36	35%
31 EB	07:40	07:45	1%	07:33	07:38	1%	07:43	08:03	4%
31 WB	07:29	07:42	3%	07:23	07:24	0%	07:27	07:30	1%
32 SB	07:39	07:41	0%	07:38	07:37	0%	08:00	07:50	-2%
32 NB	08:00	08:24	5%	07:41	07:44	1%	07:46	07:51	1%
33 NB	14:52	18:12	22%	11:21	13:12	16%	12:06	15:47	31%
33 SB	12:20	17:34	43%	11:55	14:52	25%	15:49	20:20	29%
34 EB	07:51	08:12	5%	07:46	07:53	2%	08:05	08:48	9%
34 WB	07:46	07:49	1%	07:37	07:39	0%	07:40	07:46	1%
35 EB	17:16	17:50	3%	17:12	17:39	3%	17:35	18:43	6%
35 WB	17:28	18:26	6%	17:09	17:37	3%	17:06	17:36	3%
36 NB	23:04	25:27	10%	21:42	22:25	3%	22:14	24:11	9%
36 SB	21:20	22:17	4%	21:40	22:16	3%	22:09	23:07	4%

Traffic difference plots

8.4.4. The following plots show the difference in traffic flow between the 2040 DM and 2019 Base year for the AM, IP and PM peak hours.

Figure 8-2 - Demand Flow Difference 2040DM – 2019 Base (AM)

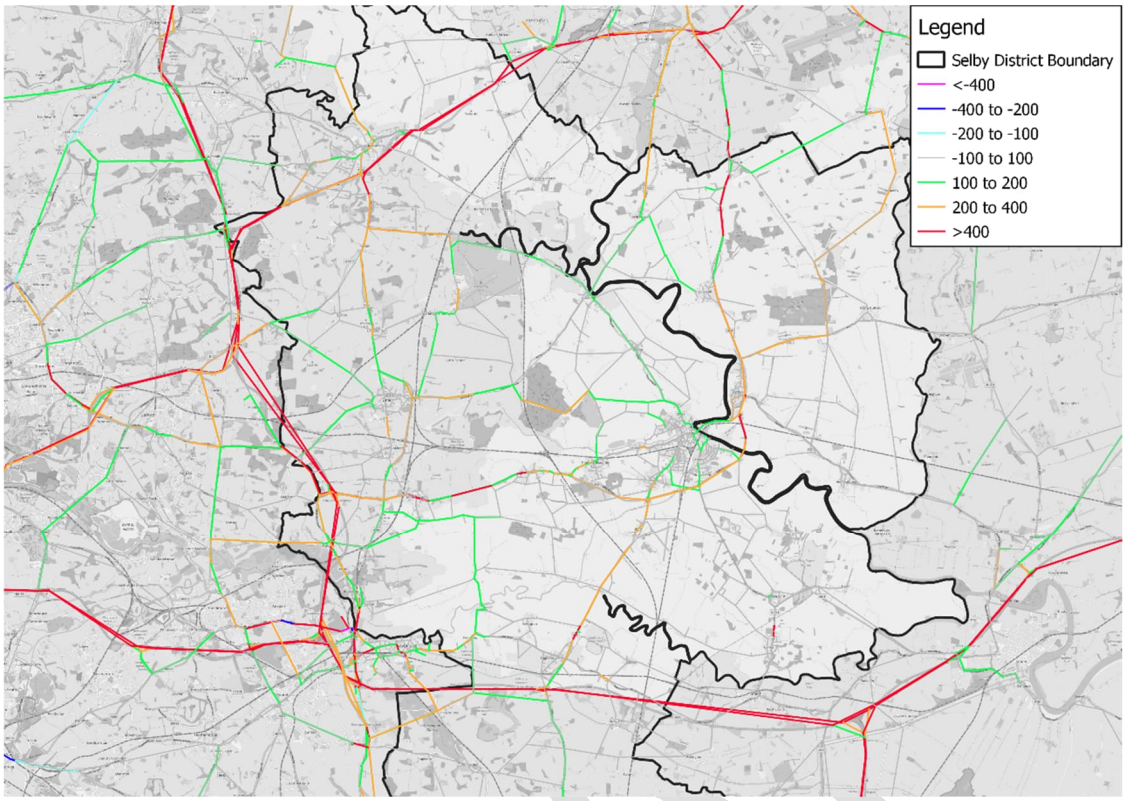


Figure 8-3 - Demand Flow Difference 2040DM – 2019 Base (IP)

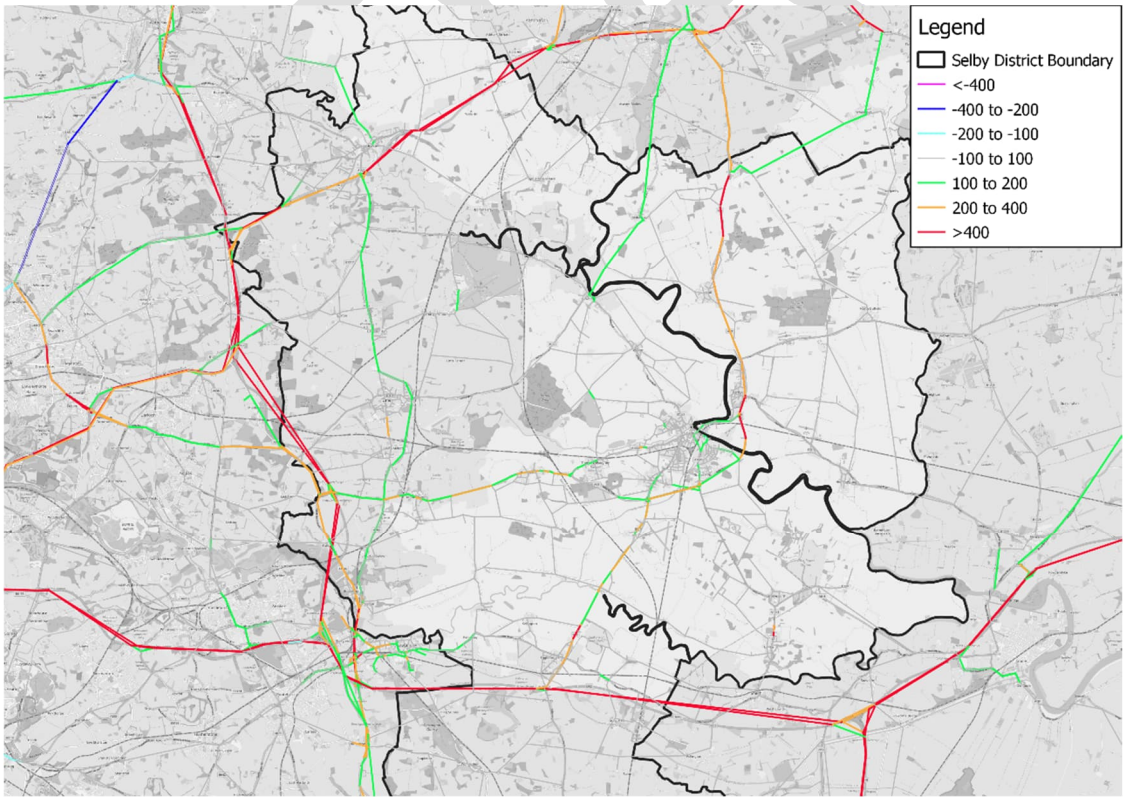
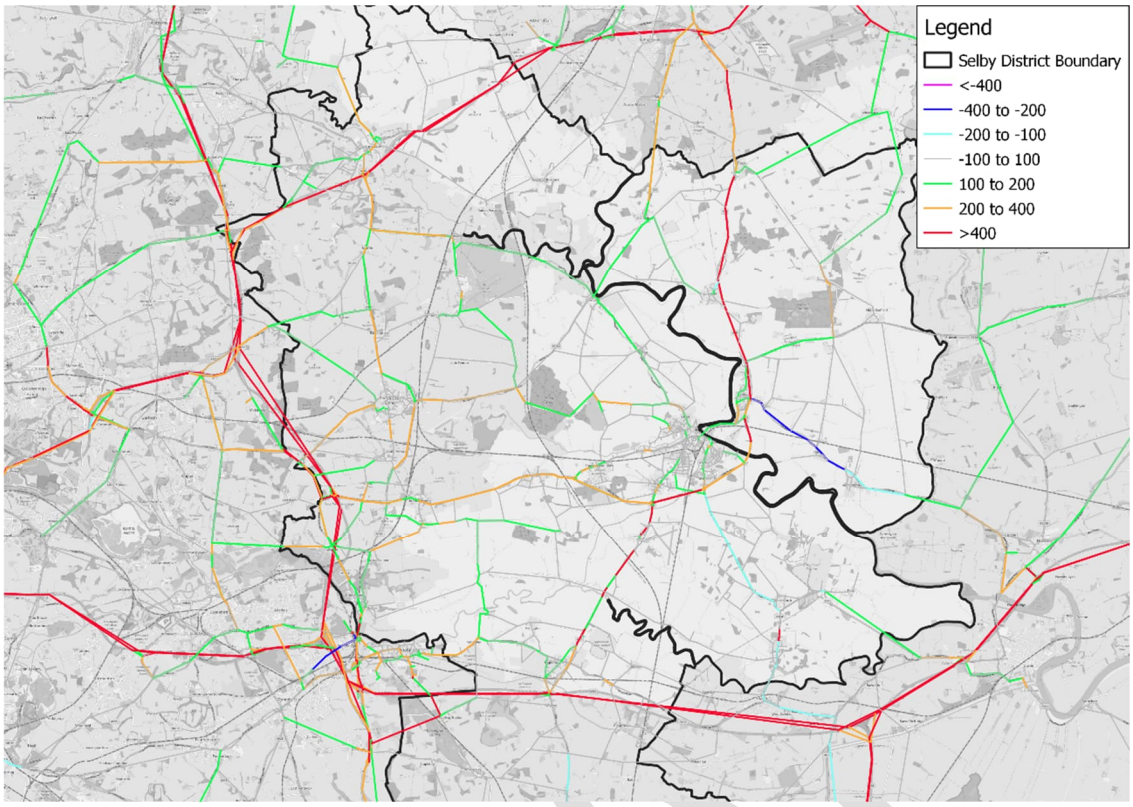


Figure 8-4 - Demand Flow Difference 2040DM – 2019 Base (PM)



Volume over capacity assessment- Link

8.4.5. The following figures show the link VoC plots for 2040 DM for the AM, IP and PM peak hours.

Figure 8-5 - Link VOC 2040 DM (AM)

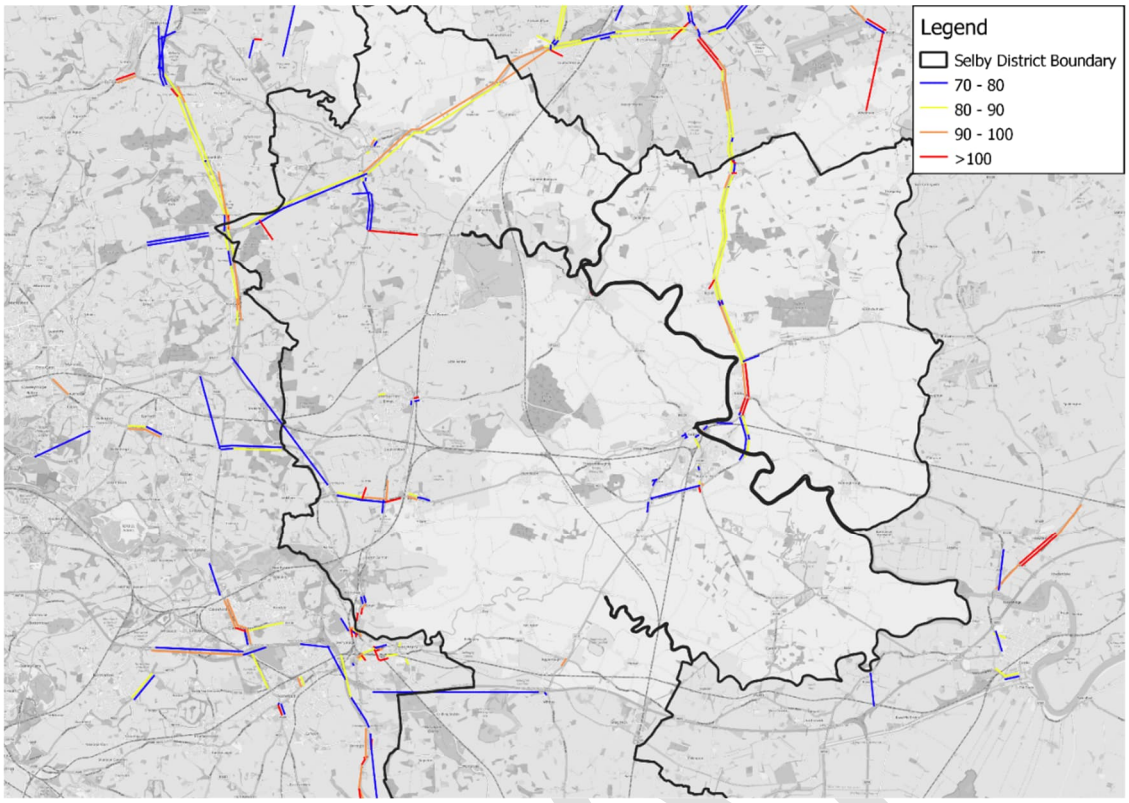


Figure 8-6 - Link VOC 2040 DM (IP)

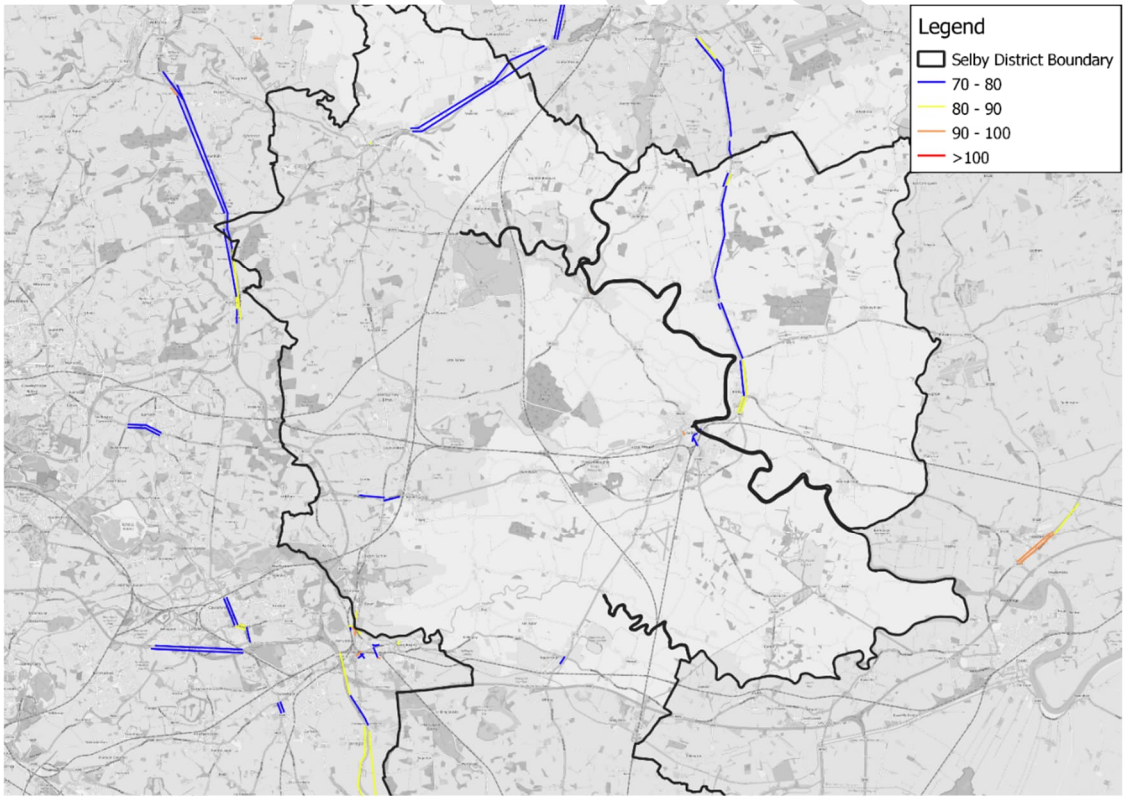
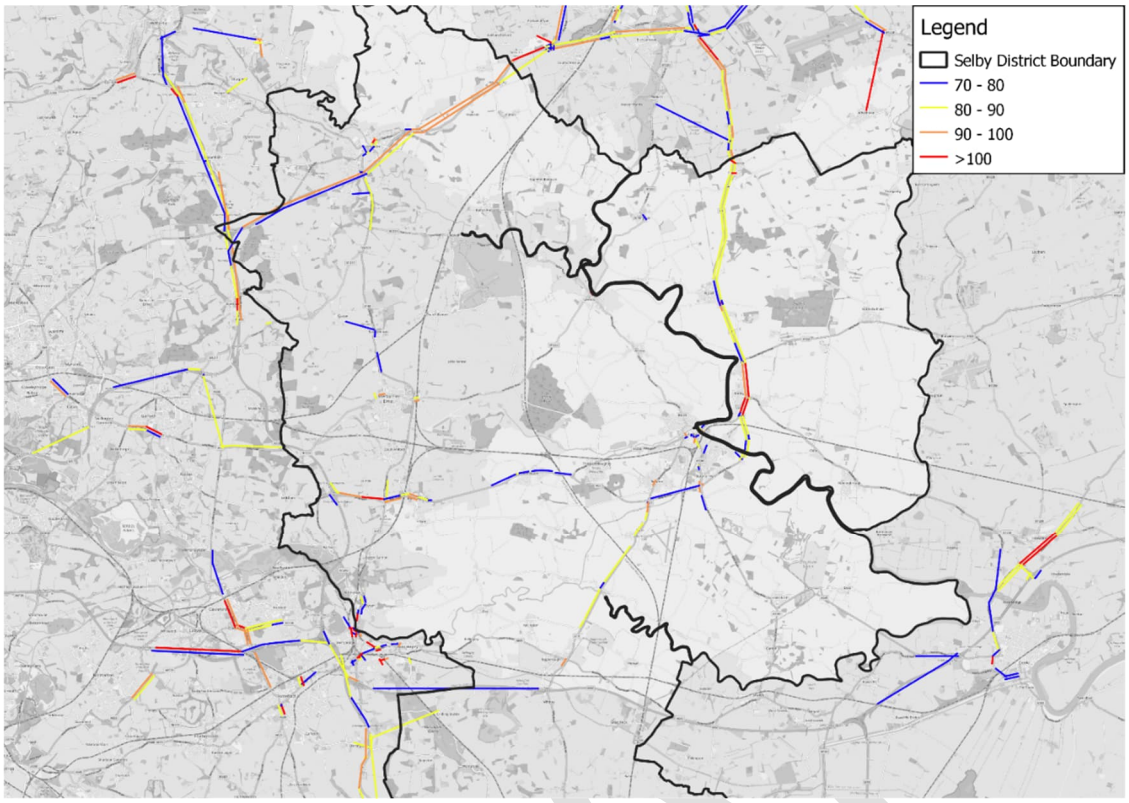


Figure 8-7 - Link VOC 2040 DM (PM)



Volume over capacity assessment - Junction

8.4.6. The following figures show the junction VoC plots for 2040 DM for the AM, IP and PM peak hours based on the maximum VoC at any turn at the junction

Figure 8-8 - Turn VOC 2040 DM (AM)

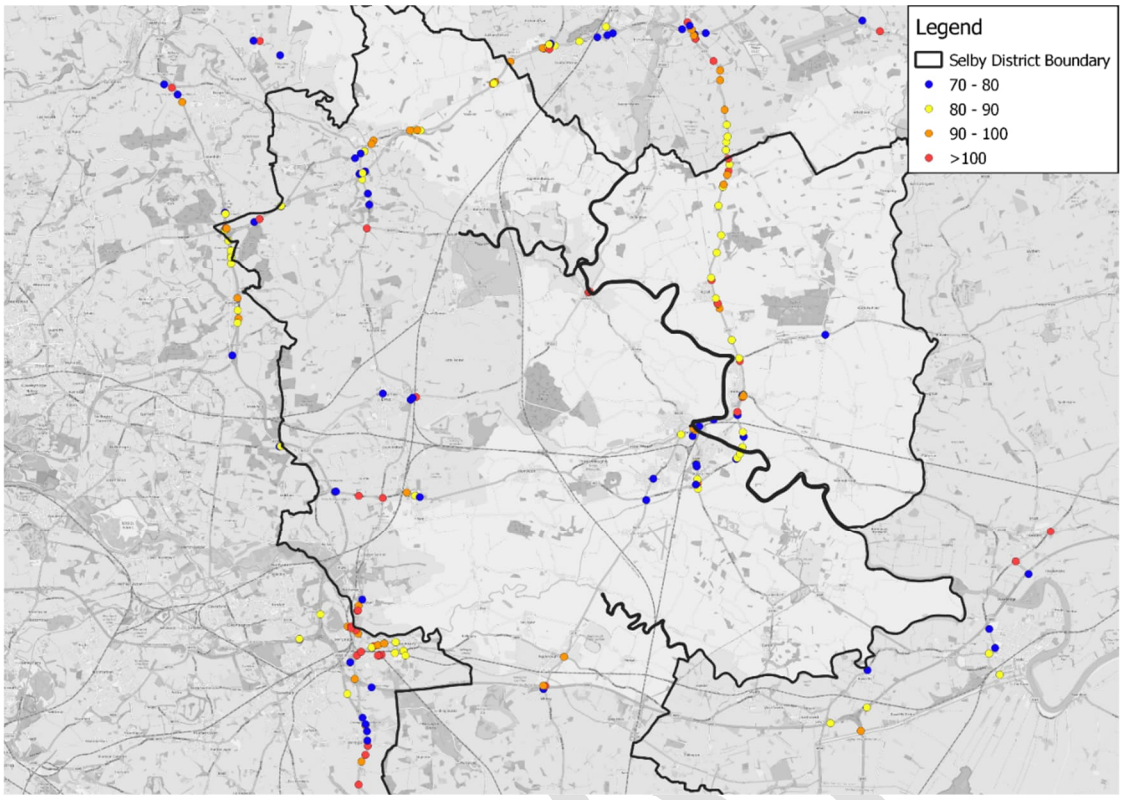


Figure 8-9 - Turn VOC 2040 DM(IP)

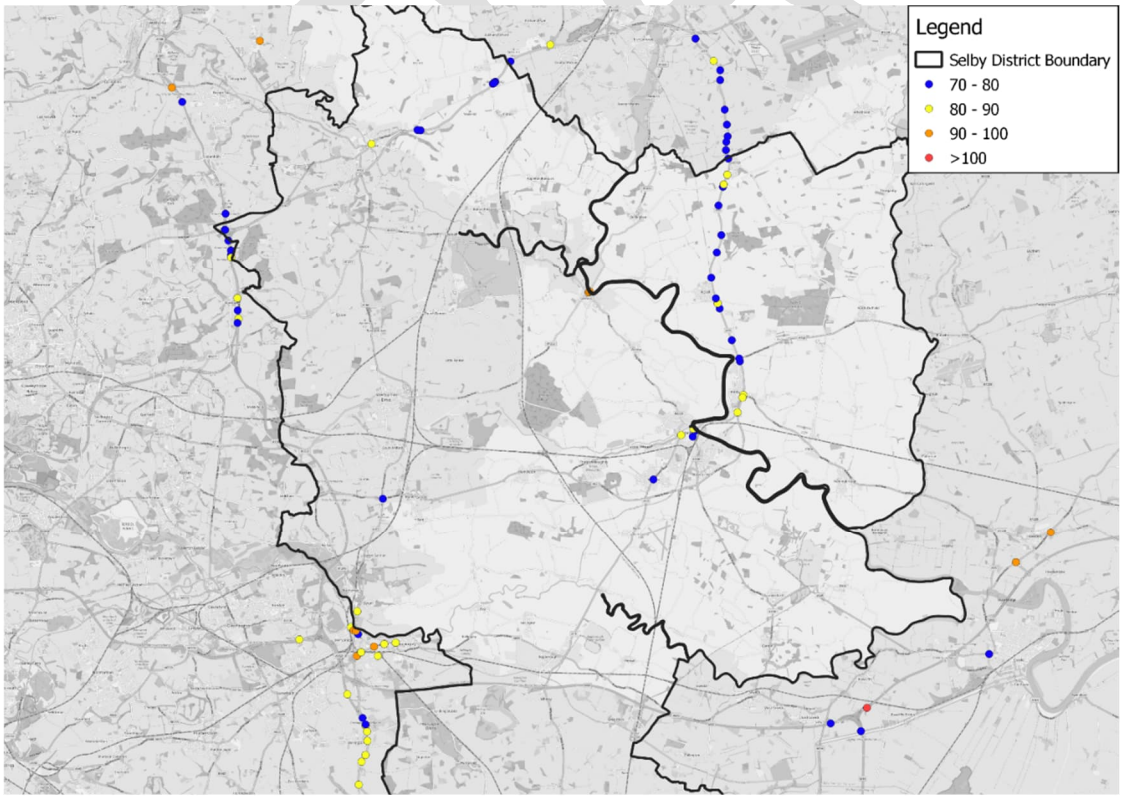
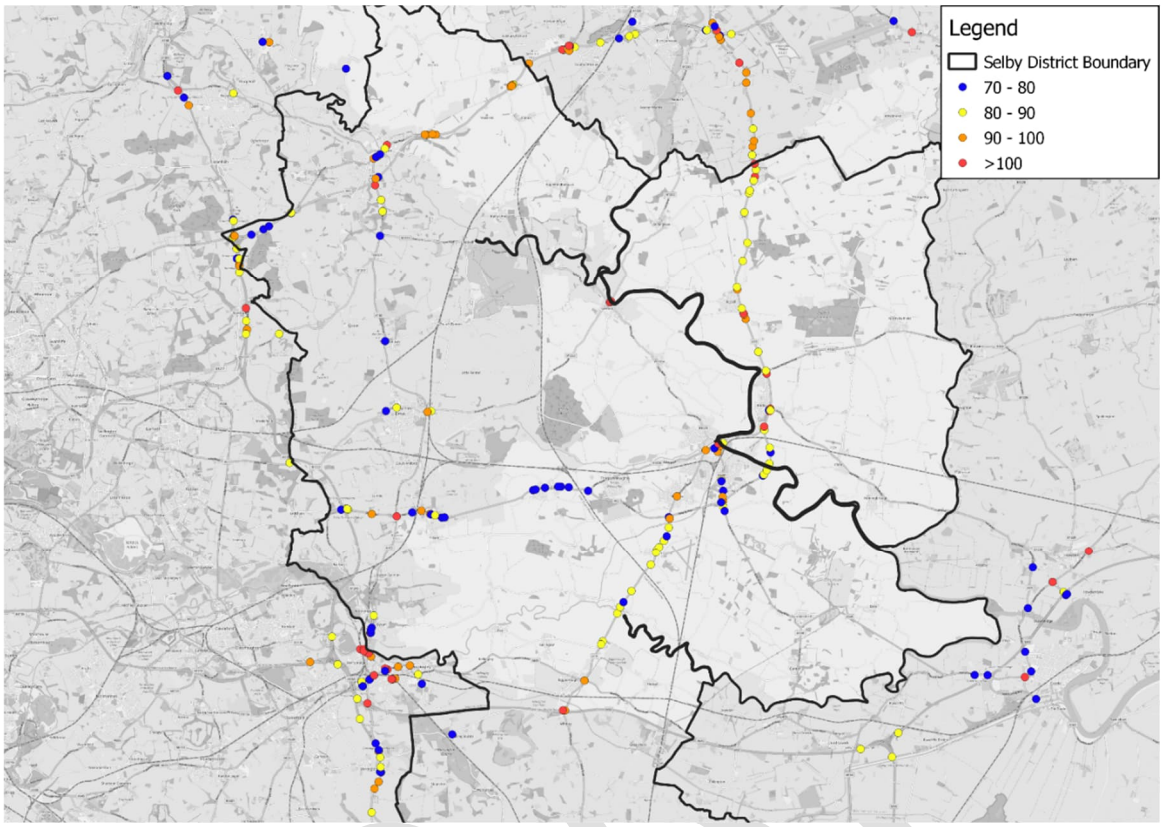


Figure 8-10 - Turn VOC 2040 DM (PM)



8.5 RESULTS FOR 2040 DS1

8.5.1. This section summarises the results for 2040 DM model run for the parameter outlined in section 8.1.2

8.5.2. The convergence results are summarised in **Table 8-6 Error! Reference source not found.**. The core scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 8-6 – Core Scenario Highway Assignment Convergence Statistics, 2040 DS1

Year	Time Period	Loop	Proximity	Stability	Stability
			Delta (d) /	% Flow	% Delays
2040 DS1	AM	73	0.0047	98.8	99.4
		74	0.0044	99	99.5
		75	0.0042	99.3	99.5
		76	0.0043	99.4	99.6
	IP	23	0.00072	99.2	99.8
		24	0.00066	99.4	99.8
		25	0.00068	99.1	99.8
		26	0.00065	99.3	99.8

	PM	50	0.0064	99.4	99
		51	0.0059	99.1	98.8
		52	0.0069	99.2	98.9
		53	0.0044	99.3	99

Highway Network Statistics

8.5.3. A comparison of the network statistics between the 2040DS1 and 2040DMforecast years is provided in the following tables by time period.

8.5.4. For all time periods, all but one of the indicators is forecast to increase through the modelled year, expected given the increased travel demand (and limited supply interventions). The exception to this is average speed, which is forecast to decrease through the modelled years, attributed to increased congestion.

Table 8-7 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2040DM	2040DS1	% Change
Transient Queues (pcu-hrs)	2122	2803	32.1%
Overcapacity Queues (pcu-hrs)	544	1019	
Link Cruise Time (pcu-hrs)	16489	18133	10.0%
Total Travel Time (pcu-hrs)	19156	21955	14.6%
Travel Distance (pcu-kms)	1319250	1409791	6.9%
Average Journey Speed (kph)	69	64	-6.8%
Total Assigned Trips (pcus)	145259	153632	5.8%

Table 8-8 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2040DM	2040DS1	% Change
Transient Queues (pcu-hrs)	1054	1415	34.3%
Overcapacity Queues (pcu-hrs)	18	142	
Link Cruise Time (pcu-hrs)	12467	13696	9.9%
Total Travel Time (pcu-hrs)	13538	15253	12.7%
Travel Distance (pcu-kms)	1063815	1137852	7.0%
Average Journey Speed (kph)	79	75	-5.1%
Total Assigned Trips (pcus)	113024	119961	6.1%

Table 8-9 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2040DM	2040DS1	% Change
Transient Queues (pcu-hrs)	2311	3124	35.2%
Overcapacity Queues (pcu-hrs)	641	1467	
Link Cruise Time (pcu-hrs)	16920	18551	9.6%
Total Travel Time (pcu-hrs)	19873	23143	16.5%
Travel Distance (pcu-kms)	1342632	1431946	6.7%
Average Journey Speed (kph)	68	62	-8.4%
Total Assigned Trips (pcus)	141498	150317	6.2%

8.6 HIGHWAY ASSIGNMENT IMPACTS

8.6.1. Highway assignment impacts are quantified through comparison of forecast model outputs for:

- Journey time routes;
- Traffic flow plots;
- VoC plots for each of the scenario runs .

Journey Time Routes

8.6.2. Comparisons of travel times on a subset of the local network journey time routes between 2040 DS1 and forecast 2040 DM are presented in Tables 8-8 to 8-10 by time period.

8.6.3. There are increases in travel time between the 2040 DS1 and 2040 DM forecast. This is reflective of larger delays in the network due to increased demand and congestion and is the general trend across the network.

Table 8-10 – Journey Time Routes, 2040

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2040DM	2040DS1	% Change	2040DM	2040DS1	% Change	2040DM	2040DS1	% Change
1 EB	09:04	11:00	21%	07:56	09:50	24%	09:57	12:49	29%
1 WB	09:39	12:05	25%	07:51	09:56	27%	09:32	14:02	47%
2 NB	16:45	19:39	17%	14:47	17:33	19%	17:55	21:37	21%
2 SB	19:23	23:54	23%	15:01	18:11	21%	18:42	27:26	47%
3 ACW	05:49	06:47	17%	06:09	06:39	8%	06:38	08:15	24%
3 CW	07:18	08:04	11%	06:45	07:40	14%	07:53	10:36	34%
4 EB	14:39	17:06	17%	13:23	15:27	15%	15:49	18:33	17%
4 WB	16:35	20:09	22%	13:39	16:37	22%	16:19	22:21	37%

5 NB	11:27	14:08	23%	09:19	10:27	12%	11:39	14:42	26%
5 SB	09:01	09:34	6%	08:14	08:46	6%	09:16	09:24	2%
6 EB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
6 WB	05:29	05:59	9%	05:21	05:45	8%	05:48	06:43	16%
7 WB	05:29	05:59	9%	05:13	05:24	4%	05:32	06:07	11%
7 EB	05:48	06:55	19%	05:16	05:32	5%	05:36	05:50	4%
8 NB	09:56	10:05	2%	09:45	09:57	2%	10:06	10:13	1%
8 SB	11:16	12:11	8%	10:44	11:48	10%	11:58	14:20	20%
9 WB	08:28	08:31	1%	08:11	08:18	1%	08:26	08:30	1%
9 EB	08:03	08:07	1%	07:57	08:00	1%	08:04	08:06	0%
10 EB	06:51	06:59	2%	06:33	06:37	1%	06:33	06:38	1%
10 WB	06:30	06:43	3%	06:27	06:32	1%	06:33	08:22	28%
11 SB	04:13	04:25	5%	04:01	04:07	2%	04:05	04:11	3%
11 NB	04:43	05:19	13%	04:02	04:07	2%	04:33	04:53	7%
12 NB	03:24	03:39	7%	03:22	03:43	10%	03:49	04:27	17%
12 SB	03:09	03:22	7%	03:10	03:19	5%	03:19	03:38	10%
13 EB	02:39	03:03	15%	02:51	03:40	28%	03:20	04:49	45%
13 WB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
14 EB	08:41	12:27	43%	07:32	07:39	2%	08:28	09:37	14%
14 WB	08:01	08:46	9%	07:34	07:47	3%	08:02	10:43	33%
15 EB	08:31	09:04	6%	07:28	07:38	2%	09:02	08:56	-1%
15 WB	08:06	08:23	3%	07:18	07:23	1%	08:11	08:49	8%
16 WB	07:32	07:48	4%	06:52	06:56	1%	07:39	09:09	20%
16 EB	08:37	09:12	7%	07:15	07:25	2%	08:56	08:55	0%
17 EB	10:36	11:41	10%	09:08	09:15	1%	12:27	13:14	6%
17 WB	09:53	10:09	3%	09:06	09:14	2%	09:57	10:44	8%
18 EB	03:28	03:43	7%	03:26	03:27	0%	03:29	03:33	2%
18 WB	03:41	04:05	11%	03:27	03:28	0%	03:30	03:38	4%
19 EB	10:52	11:14	3%	10:36	10:44	1%	11:07	11:50	6%
19 WB	12:49	15:58	25%	10:48	10:57	1%	11:16	11:42	4%

20 SB	05:55	06:04	3%	05:44	05:49	1%	06:04	06:14	3%
20 NB	06:06	06:21	4%	05:49	05:54	1%	06:04	06:13	2%
21 NB	04:11	04:56	18%	03:39	03:49	4%	03:59	04:33	14%
21 SB	04:24	05:44	30%	03:40	03:49	4%	03:50	04:04	6%
22 EB	12:30	13:04	5%	11:15	11:20	1%	14:53	14:54	0%
22 WB	18:43	15:44	-16%	11:03	11:22	3%	14:38	15:39	7%
23 EB	08:37	08:49	2%	08:23	08:28	1%	08:41	08:58	3%
23 WB	08:36	08:43	1%	08:25	08:30	1%	08:35	08:38	1%
24 NB	08:59	12:53	43%	08:05	09:29	17%	10:27	14:46	41%
24 SB	10:36	12:51	21%	07:52	09:21	19%	08:19	11:11	34%
25 NB	18:06	20:08	11%	16:00	16:31	3%	17:01	18:35	9%
25 SB	16:47	17:27	4%	15:31	16:02	3%	17:33	18:26	5%
26 NB	04:04	04:10	2%	04:01	04:06	2%	04:02	04:13	5%
26 SB	04:12	04:39	11%	04:07	04:12	2%	04:14	04:21	3%
27 NB	03:35	03:30	-2%	03:32	03:35	1%	03:34	03:42	4%
27 SB	03:30	03:42	6%	03:27	03:30	1%	03:31	03:29	-1%
28 EB	09:21	09:29	1%	09:13	09:22	2%	09:26	09:42	3%
28 WB	10:29	10:58	5%	09:34	10:03	5%	10:25	10:57	5%
29 NB	20:10	27:50	38%	13:21	15:59	20%	18:14	22:27	23%
29 SB	21:16	25:30	20%	14:49	17:50	20%	22:49	30:44	35%
30 WB	12:29	13:32	8%	09:11	09:36	5%	10:35	10:59	4%
30 EB	10:56	12:55	18%	09:25	10:01	6%	13:36	16:36	22%
31 EB	07:45	07:59	3%	07:38	07:51	3%	08:03	08:52	10%
31 WB	07:42	08:21	8%	07:24	07:34	2%	07:30	07:58	6%
32 SB	07:41	07:41	0%	07:37	07:39	0%	07:50	07:55	1%
32 NB	08:24	08:36	2%	07:44	07:46	0%	07:51	07:55	1%
33 NB	18:12	23:45	30%	13:12	14:58	13%	15:47	16:59	8%
33 SB	17:34	19:28	11%	14:52	16:56	14%	20:20	22:58	13%
34 EB	08:12	08:24	2%	07:53	07:58	1%	08:48	09:24	7%
34 WB	07:49	07:59	2%	07:39	07:41	0%	07:46	07:48	1%

35 EB	17:50	18:00	1%	17:39	17:45	1%	18:43	18:58	1%
35 WB	18:26	18:41	1%	17:37	17:43	1%	17:36	17:44	1%
36 NB	25:27	26:08	3%	22:25	22:32	1%	24:11	24:48	3%
36 SB	22:17	22:27	1%	22:16	22:23	1%	23:07	23:41	2%

Traffic difference plots

8.6.4. The following plots show the difference in traffic flow between the2040 DS1 and 2040 DM for the AM, IP and PM peak hours.

Figure 8-11 - Demand Flow Difference 2040 DS1-DM (AM)

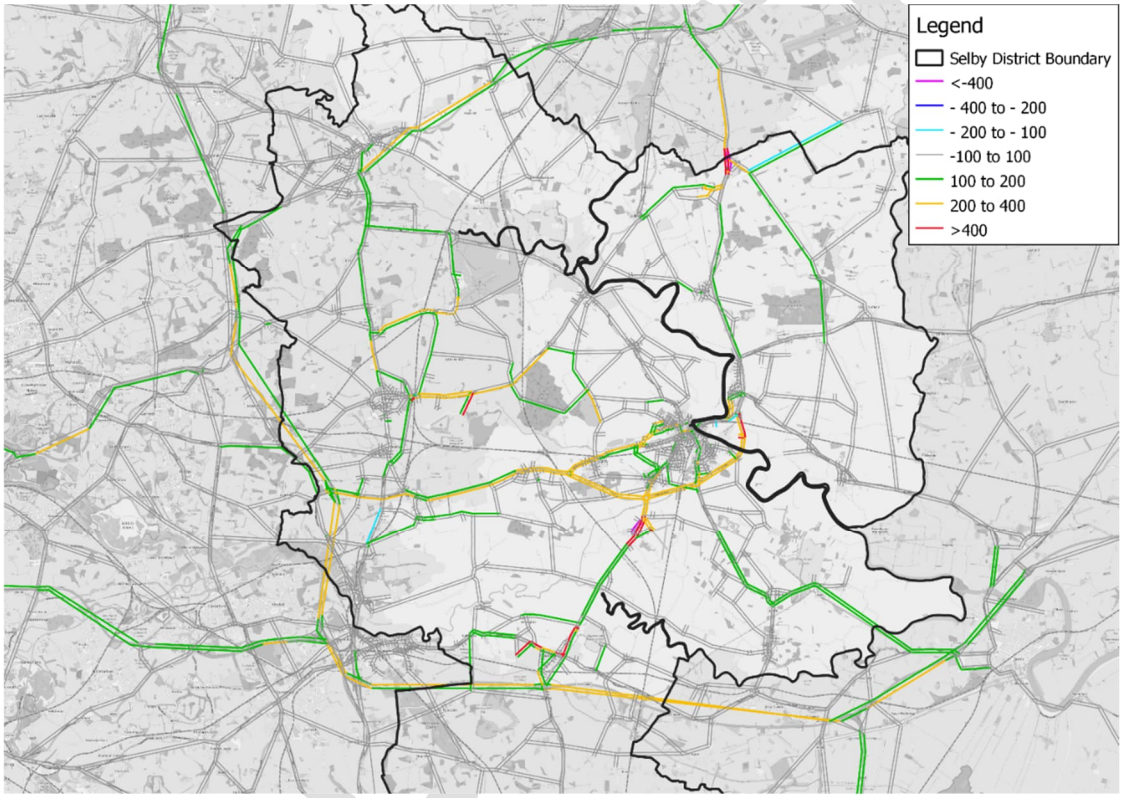


Figure 8-12 - Demand Flow Difference 2040 DS1-DM (IP)

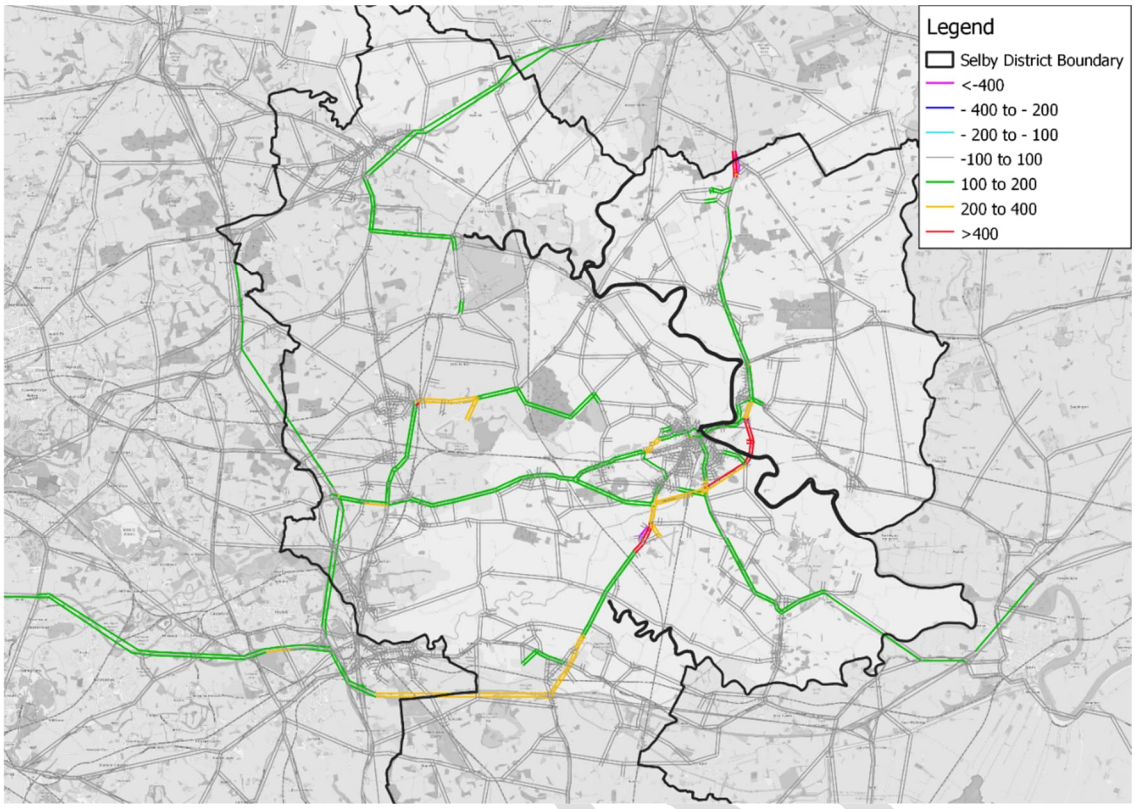
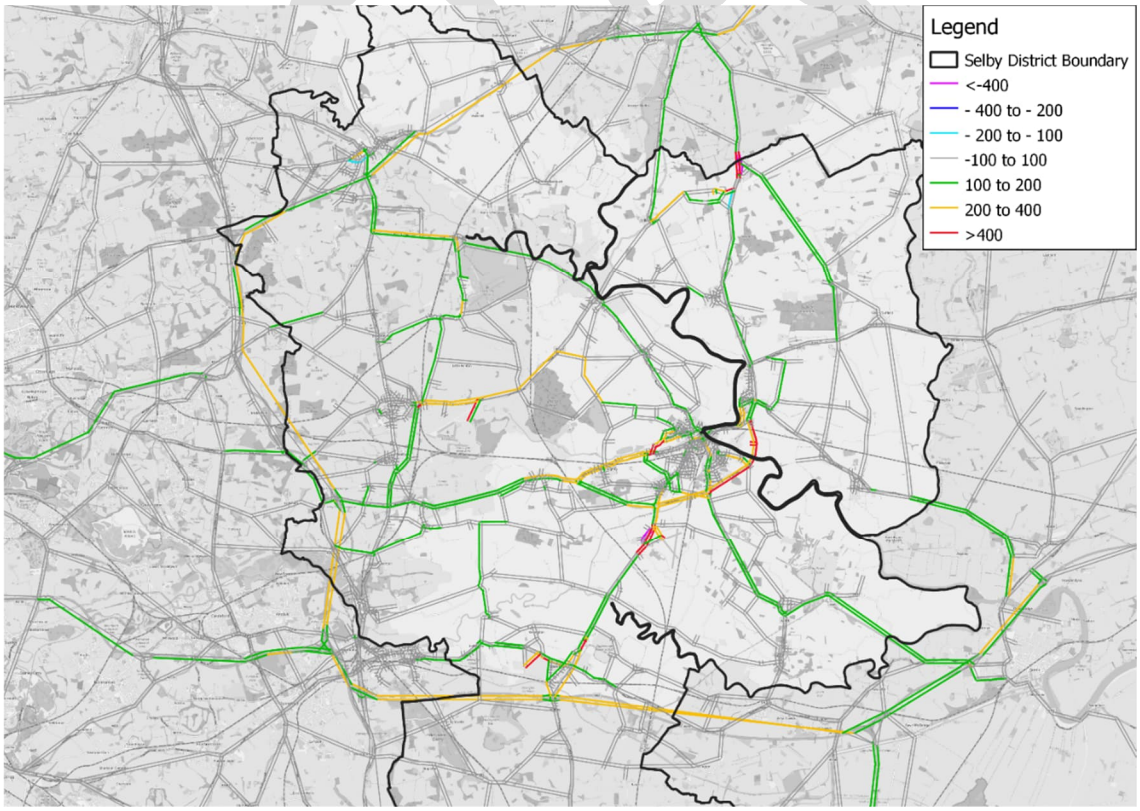


Figure 8-13 - Demand Flow Difference 2040 DS1-DM (PM)



Volume over capacity assessment- Link

8.6.5. The following figures show the link VoC plots for 2040 DS1 for the AM, IP and PM peak hours

Figure 8-14 - Link VOC 2040 DS1 (AM)

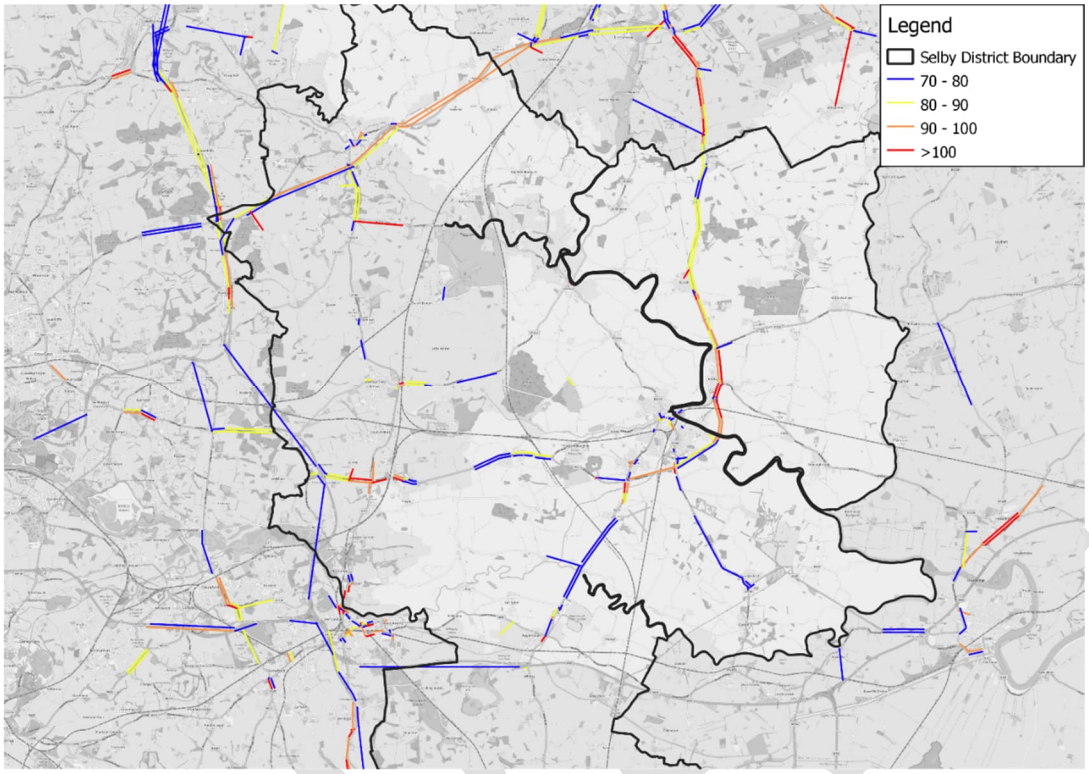


Figure 8-15 - Link VOC 2040 DS1 (IP)

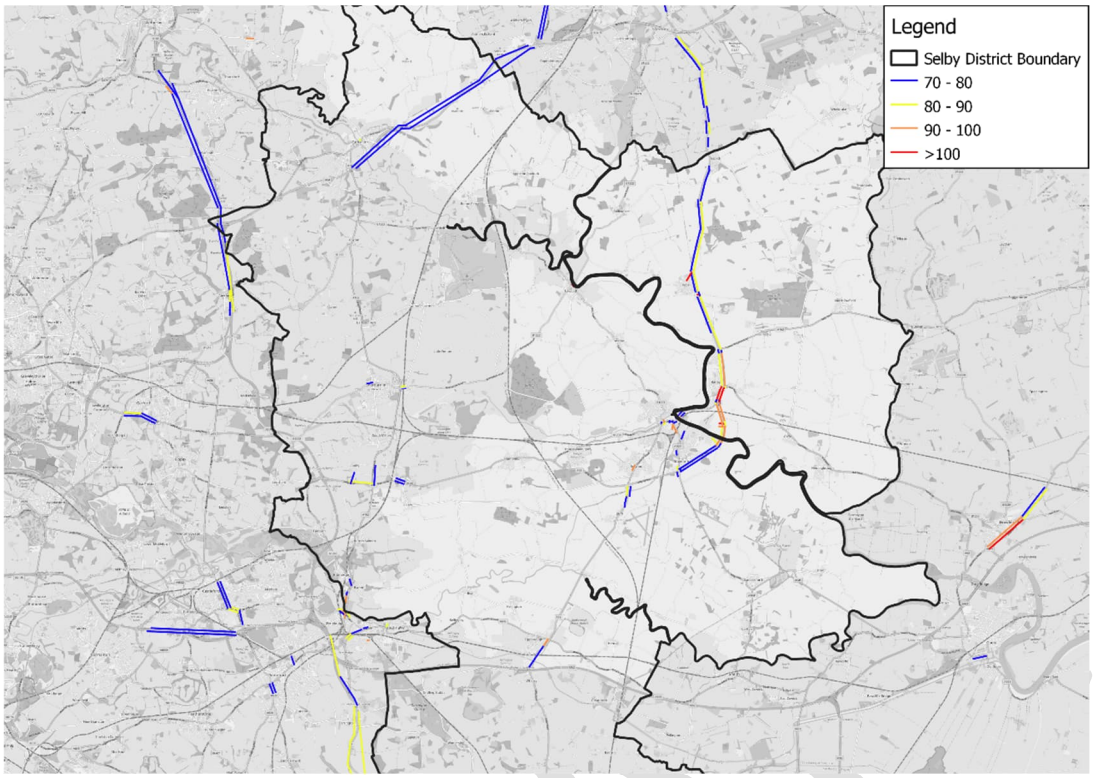
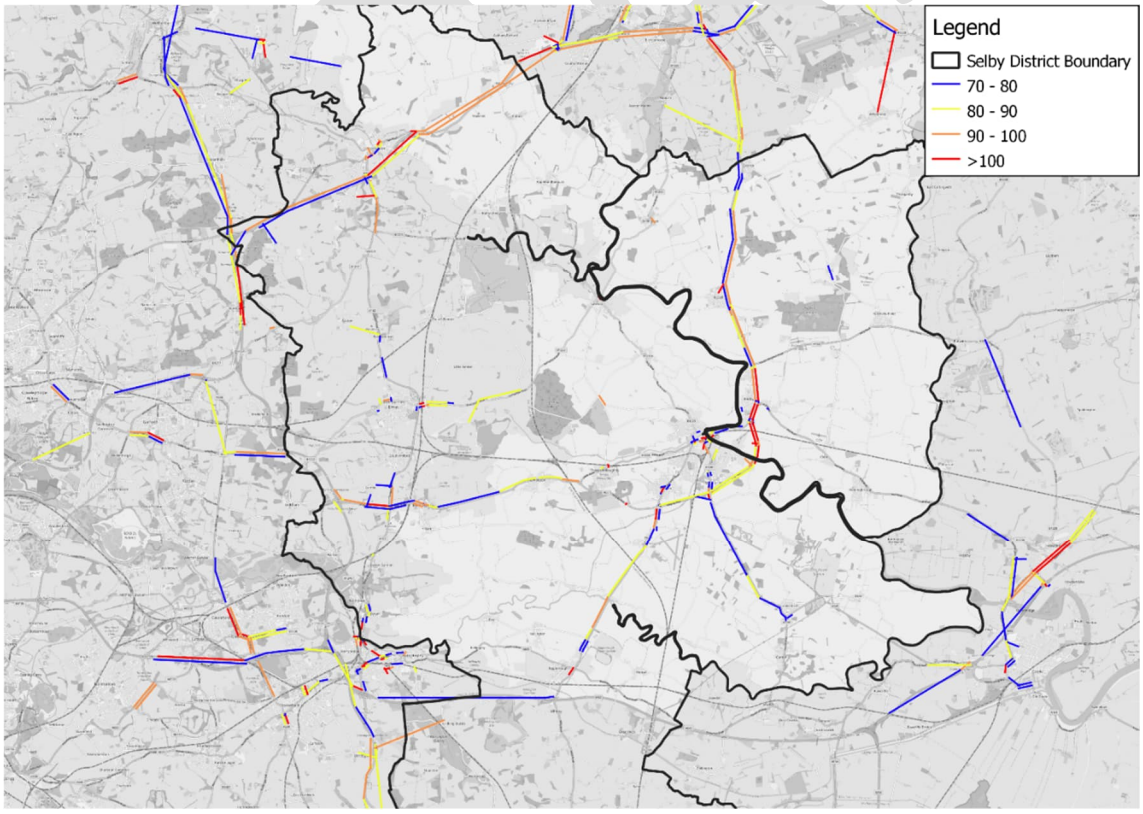


Figure 8-16 - Link VOC 2040 DS1 (PM)



Volume over capacity assessment- Junction

8.6.6. The following figures show the junction VoC plots for 2040 DS1 for the AM, IP and PM peak hours based on the maximum VoC at any turn at the junction

Figure 8-17 - Turn VOC 2040 DS1 (AM)

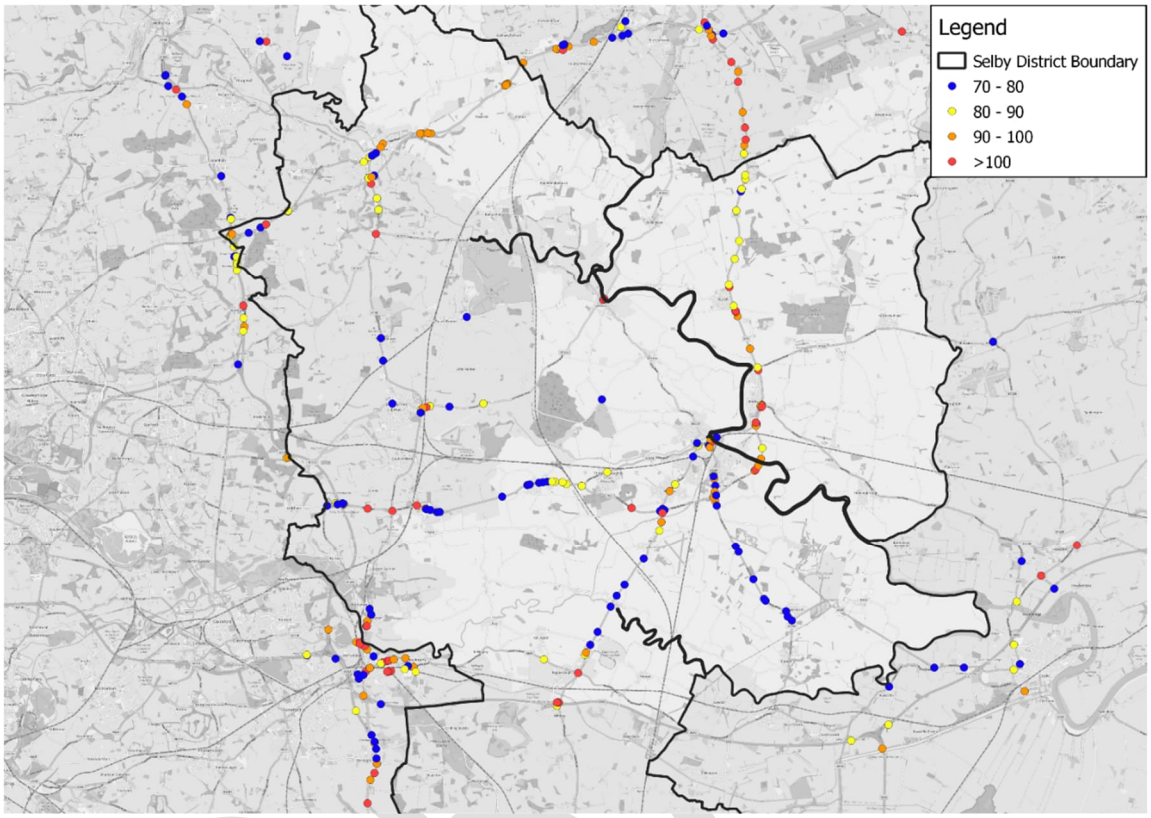


Figure 8-18 - Turn VOC 2040 DS1 (IP)

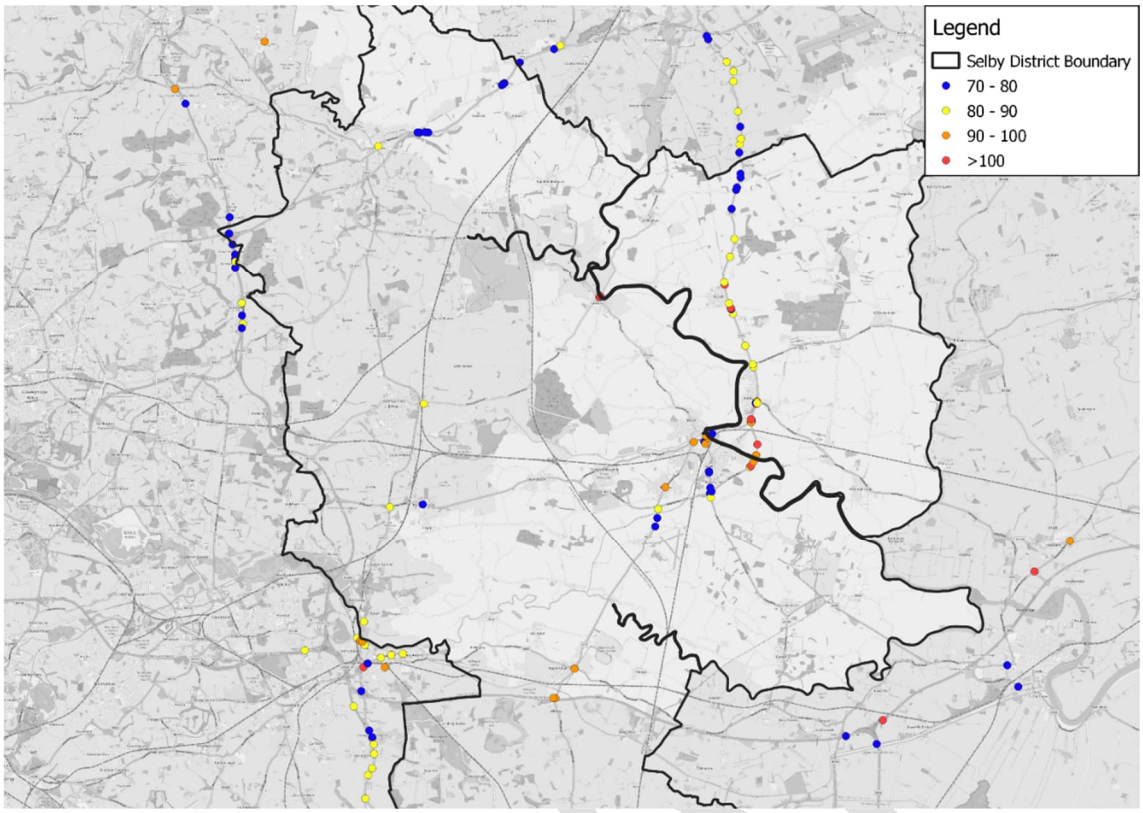
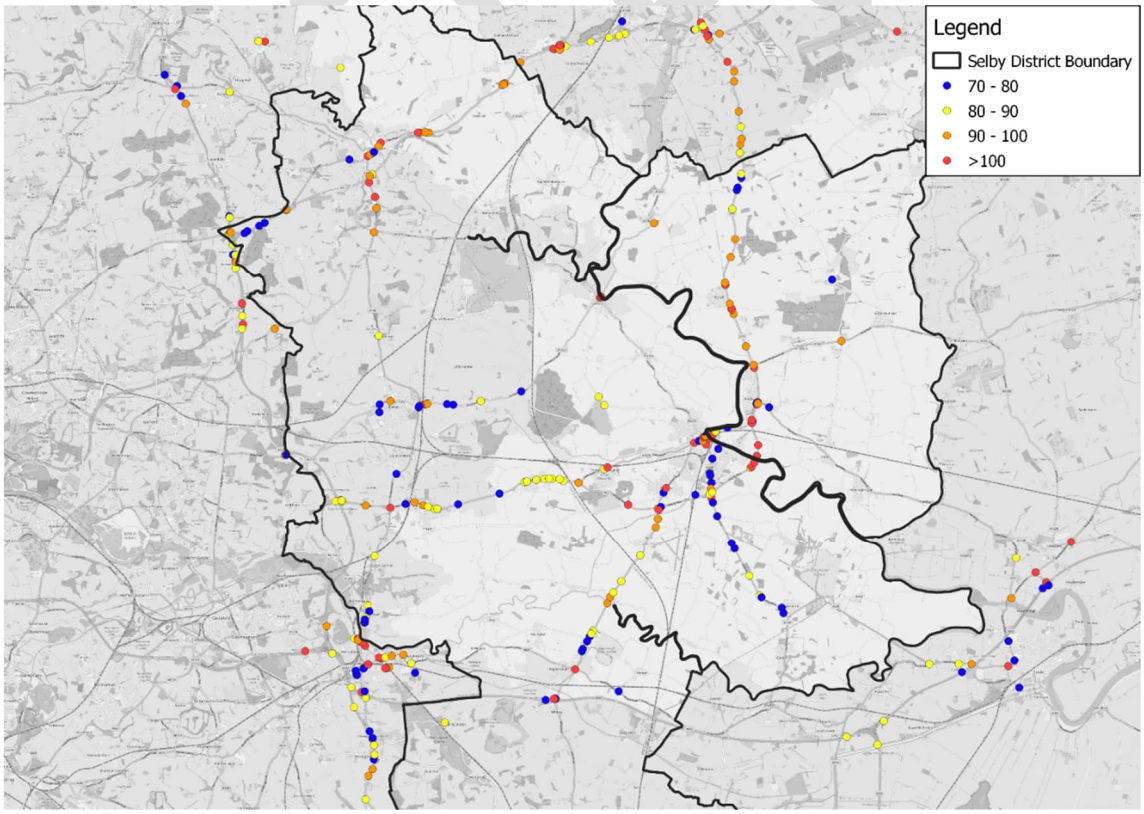


Figure 8-19 - Turn VOC 2040 DS1 (PM)



8.7 RESULTS FOR 2040 DS2

8.7.1. This section summarises the results for 2040 DS2 model run for the parameter outlined in section 8.1.2

8.7.2. The convergence results are summarised in the **Error! Reference source not found.**. The core scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 8-11 – Core Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (d) / (Gap (%)	% Flow	% Delays
2040 DS2	AM	59	0.0036	99.4	99.3
		60	0.0038	99.4	99.4
		61	0.0047	99.4	99.4
		62	0.0046	99.2	99.4
	IP	21	0.00036	99.1	99.9
		22	0.00024	99.5	100
		23	0.00033	99.3	99.9
		24	0.00021	99.4	100
	PM	37	0.006	99.2	99.1
		38	0.0057	99.3	99.1
		39	0.0053	99.4	99
		40	0.0068	99.3	99

Highway Network Statistics

8.7.3. A comparison of the network statistics between the 2040 DS2 and 2040 DM is provided in following tables by time period.

8.7.4. For all time periods, all but one of the indicators is forecast to increase through the modelled year, expected given the increased travel demand (and limited supply interventions). The exception to this is average speed, which is forecast to decrease through the modelled years, attributed to increased congestion.

Table 8-12 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2040DM	2040DS2	% Change
Transient Queues (pcu-hrs)	2122	2602	22.6%
Overcapacity Queues (pcu-hrs)	544	816	49.9%
Link Cruise Time (pcu-hrs)	16489	17772	7.8%
Total Travel Time (pcu-hrs)	19156	21190	10.6%
Travel Distance (pcu-kms)	1319250	1390438	5.4%
Average Journey Speed (kph)	69	66	-4.7%
Total Assigned Trips (pcus)	145259	151858	4.5%

Table 8-13 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2040DM	2040DS2	% Change
Transient Queues (pcu-hrs)	1054	1305	23.9%
Overcapacity Queues (pcu-hrs)	18	90	403.5%
Link Cruise Time (pcu-hrs)	12467	13456	7.9%
Total Travel Time (pcu-hrs)	13538	14852	9.7%
Travel Distance (pcu-kms)	1063815	1123675	5.6%
Average Journey Speed (kph)	79	76	-3.7%
Total Assigned Trips (pcus)	113024	118839	5.1%

Table 8-14 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2040DM	2040DS2	% Change
Transient Queues (pcu-hrs)	2311	2875	24.4%
Overcapacity Queues (pcu-hrs)	641	1172	82.8%
Link Cruise Time (pcu-hrs)	16920	18191	7.5%
Total Travel Time (pcu-hrs)	19873	22238	11.9%
Travel Distance (pcu-kms)	1342632	1412142	5.2%
Average Journey Speed (kph)	68	64	-6.0%
Total Assigned Trips (pcus)	141498	148526	5.0%

8.8 HIGHWAY ASSIGNMENT IMPACTS

8.8.1. Highway assignment impacts are quantified through comparison of forecast model outputs for:

- Journey time routes;
- Traffic flow plots;
- VoC plots for each of the scenario runs .

Journey Time Routes

8.8.2. Comparisons of travel times on a subset of the local network journey time routes between 2040 DS2 and forecast 2040 DM are presented in tables below by time period.

8.8.3. There are increases in travel time between the base year and 2040 forecast. This is reflective of larger delays in the network due to increased demand and congestion and is the general trend across the network, whilst noting the checks on convergence and traffic signal timings that were referred to in Section 6.7.

Table 8-15 – Journey Time Routes, 2040 DS2

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2040DM	2040DS2	% Change	2040DM	2040DS2	% Change	2040DM	2040DS2	% Change
1 EB	09:04	10:33	16%	07:56	09:08	15%	09:57	12:32	26%
1 WB	09:39	11:28	19%	07:51	09:34	22%	09:32	12:53	35%
2 NB	16:45	18:34	11%	14:47	16:23	11%	17:55	20:34	15%
2 SB	19:23	22:55	18%	15:01	17:26	16%	18:42	25:50	38%
3 ACW	05:49	06:32	12%	06:09	06:19	3%	06:38	09:17	40%
3 CW	07:18	07:52	8%	06:45	07:29	11%	07:53	12:01	52%
4 EB	14:39	16:34	13%	13:23	14:44	10%	15:49	17:44	12%
4 WB	16:35	19:28	17%	13:39	16:00	17%	16:19	21:13	30%
5 NB	11:27	13:29	18%	09:19	10:09	9%	11:39	13:54	19%
5 SB	09:01	10:20	15%	08:14	08:42	5%	09:16	09:37	4%
6 EB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
6 WB	05:29	05:58	9%	05:21	05:40	6%	05:48	06:24	11%
7 WB	05:29	05:48	6%	05:13	05:22	3%	05:32	06:00	9%
7 EB	05:48	06:49	18%	05:16	05:28	4%	05:36	06:13	11%
8 NB	09:56	10:08	2%	09:45	09:55	2%	10:06	10:37	5%
8 SB	11:16	11:55	6%	10:44	11:36	8%	11:58	15:50	32%

9 WB	08:28	08:36	2%	08:11	08:16	1%	08:26	08:26	0%
9 EB	08:03	08:07	1%	07:57	08:00	1%	08:04	08:05	0%
10 EB	06:51	06:57	1%	06:33	06:36	1%	06:33	06:39	1%
10 WB	06:30	06:41	3%	06:27	06:30	1%	06:33	08:08	24%
11 SB	04:13	04:22	3%	04:01	04:05	1%	04:05	04:08	1%
11 NB	04:43	04:49	2%	04:02	04:05	1%	04:33	04:47	5%
12 NB	03:24	03:35	5%	03:22	03:38	8%	03:49	04:17	12%
12 SB	03:09	03:25	9%	03:10	03:17	4%	03:19	03:36	9%
13 EB	02:39	02:50	7%	02:51	03:32	24%	03:20	04:14	27%
13 WB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
14 EB	08:41	12:11	40%	07:32	07:38	1%	08:28	08:50	4%
14 WB	08:01	08:28	6%	07:34	07:46	3%	08:02	10:43	33%
15 EB	08:31	09:00	6%	07:28	07:37	2%	09:02	10:01	11%
15 WB	08:06	08:22	3%	07:18	07:22	1%	08:11	08:37	5%
16 WB	07:32	07:46	3%	06:52	06:56	1%	07:39	08:15	8%
16 EB	08:37	09:08	6%	07:15	07:25	2%	08:56	09:56	11%
17 EB	10:36	11:10	5%	09:08	09:12	1%	12:27	12:56	4%
17 WB	09:53	10:05	2%	09:06	09:11	1%	09:57	10:23	4%
18 EB	03:28	03:40	6%	03:26	03:27	0%	03:29	03:33	2%
18 WB	03:41	04:02	9%	03:27	03:28	0%	03:30	03:37	3%
19 EB	10:52	11:09	3%	10:36	10:42	1%	11:07	11:31	4%
19 WB	12:49	14:56	17%	10:48	10:51	0%	11:16	11:19	0%
20 SB	05:55	06:02	2%	05:44	05:49	1%	06:04	06:13	3%
20 NB	06:06	06:21	4%	05:49	05:54	1%	06:04	06:11	2%
21 NB	04:11	04:51	16%	03:39	03:47	4%	03:59	04:29	12%
21 SB	04:24	05:40	28%	03:40	03:48	4%	03:50	04:01	5%
22 EB	12:30	13:12	6%	11:15	11:19	1%	14:53	14:54	0%
22 WB	18:43	17:42	-5%	11:03	11:21	3%	14:38	14:45	1%
23 EB	08:37	08:46	2%	08:23	08:28	1%	08:41	08:56	3%
23 WB	08:36	08:41	1%	08:25	08:30	1%	08:35	08:38	1%

24 NB	08:59	11:03	23%	08:05	08:51	9%	10:27	12:24	19%
24 SB	10:36	11:56	13%	07:52	08:30	8%	08:19	10:04	21%
25 NB	18:06	19:37	8%	16:00	16:26	3%	17:01	17:59	6%
25 SB	16:47	17:21	3%	15:31	15:58	3%	17:33	18:25	5%
26 NB	04:04	04:10	2%	04:01	04:06	2%	04:02	04:15	5%
26 SB	04:12	04:37	10%	04:07	04:11	2%	04:14	04:20	2%
27 NB	03:35	03:31	-2%	03:32	03:35	1%	03:34	03:43	4%
27 SB	03:30	03:41	5%	03:27	03:30	1%	03:31	03:30	-1%
28 EB	09:21	09:28	1%	09:13	09:25	2%	09:26	09:47	4%
28 WB	10:29	11:33	10%	09:34	10:01	5%	10:25	11:00	6%
29 NB	20:10	21:57	9%	13:21	14:29	8%	18:14	21:10	16%
29 SB	21:16	23:31	11%	14:49	16:18	10%	22:49	28:00	23%
30 WB	12:29	12:44	2%	09:11	09:28	3%	10:35	10:52	3%
30 EB	10:56	12:17	12%	09:25	09:50	4%	13:36	15:37	15%
31 EB	07:45	07:55	2%	07:38	07:50	3%	08:03	08:40	8%
31 WB	07:42	08:08	6%	07:24	07:32	2%	07:30	07:41	2%
32 SB	07:41	07:41	0%	07:37	07:39	0%	07:50	07:53	1%
32 NB	08:24	08:35	2%	07:44	07:45	0%	07:51	07:54	1%
33 NB	18:12	19:11	5%	13:12	13:22	1%	15:47	15:38	-1%
33 SB	17:34	17:29	0%	14:52	15:14	2%	20:20	20:38	1%
34 EB	08:12	08:20	2%	07:53	07:57	1%	08:48	09:15	5%
34 WB	07:49	07:58	2%	07:39	07:40	0%	07:46	07:48	1%
35 EB	17:50	17:57	1%	17:39	17:44	0%	18:43	18:55	1%
35 WB	18:26	18:39	1%	17:37	17:42	0%	17:36	17:42	1%
36 NB	25:27	25:53	2%	22:25	22:31	0%	24:11	24:36	2%
36 SB	22:17	22:26	1%	22:16	22:22	0%	23:07	23:28	2%

Traffic difference plots

8.8.4. The following plots show the difference in traffic flow between 2040 DS2 and 2040 DM for the AM, IP and PM peak hours.

Figure 8-20 - Demand Flow Difference 2040 DS2-DM (AM)

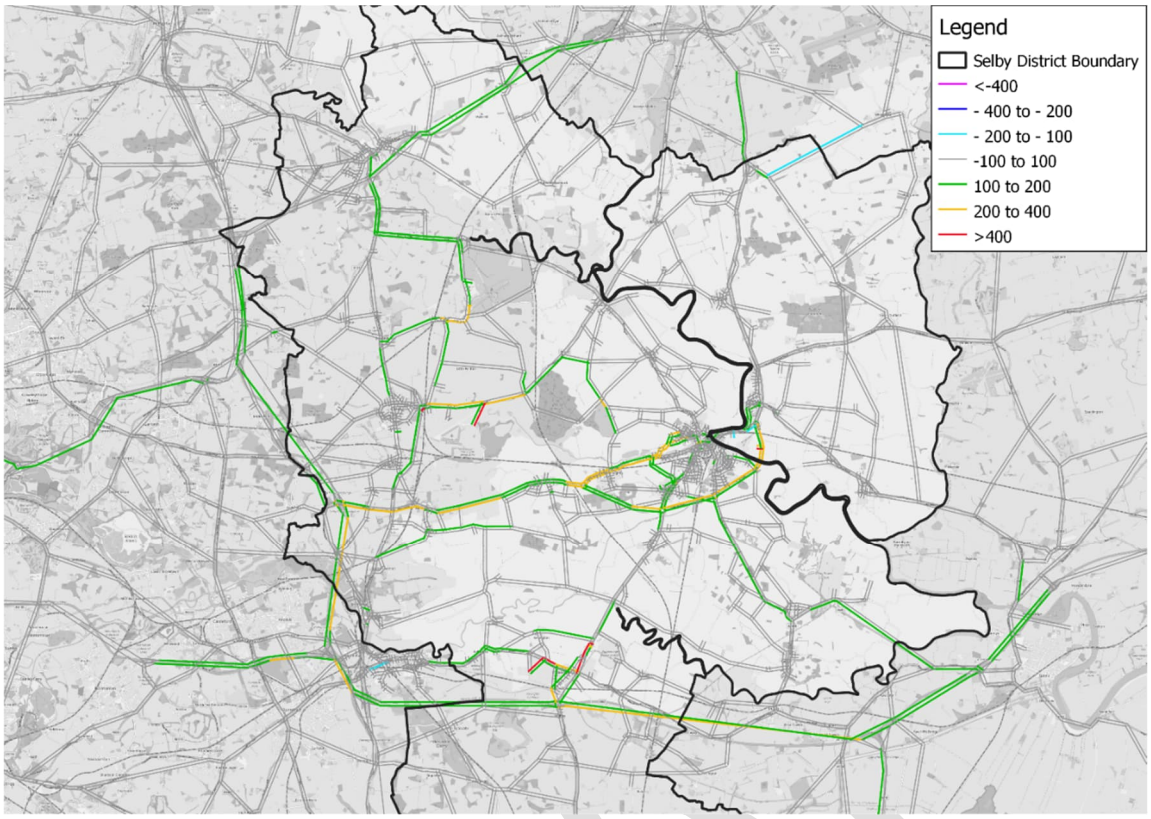


Figure 8-21 - Demand Flow Difference 2040 DS2-DM (IP)

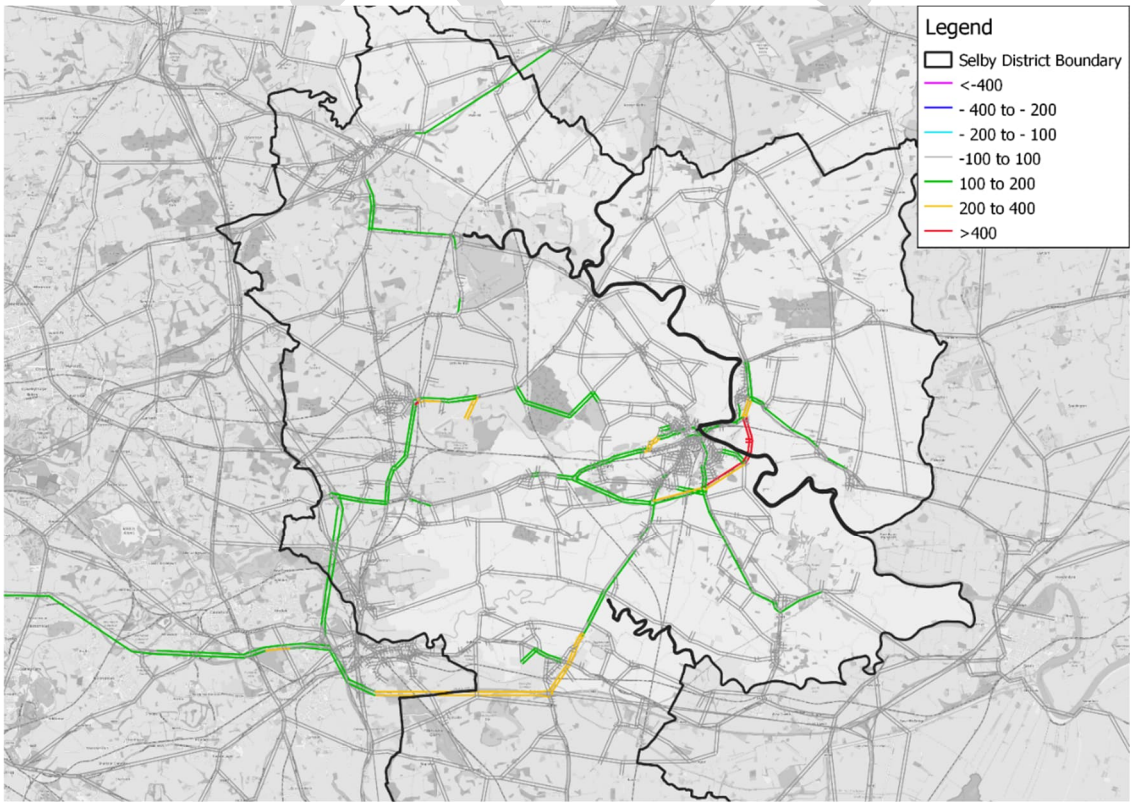
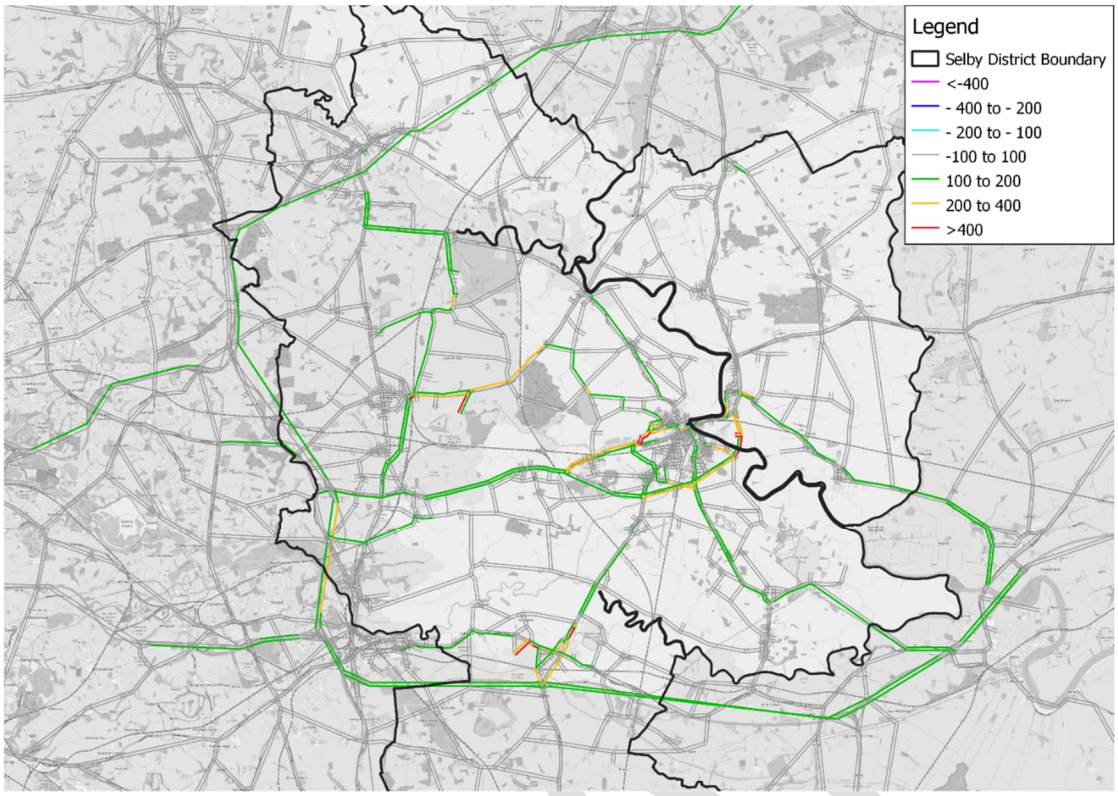


Figure 8-22 - Demand Flow Difference 2040 DS2-DM (PM)



Volume over capacity assessment - Link

8.8.5. The following figures show the link VoC plots for 2040 DS2 for the AM, IP and PM peak hours

Figure 8-23 - Link VOC 2040 DS2 (AM)

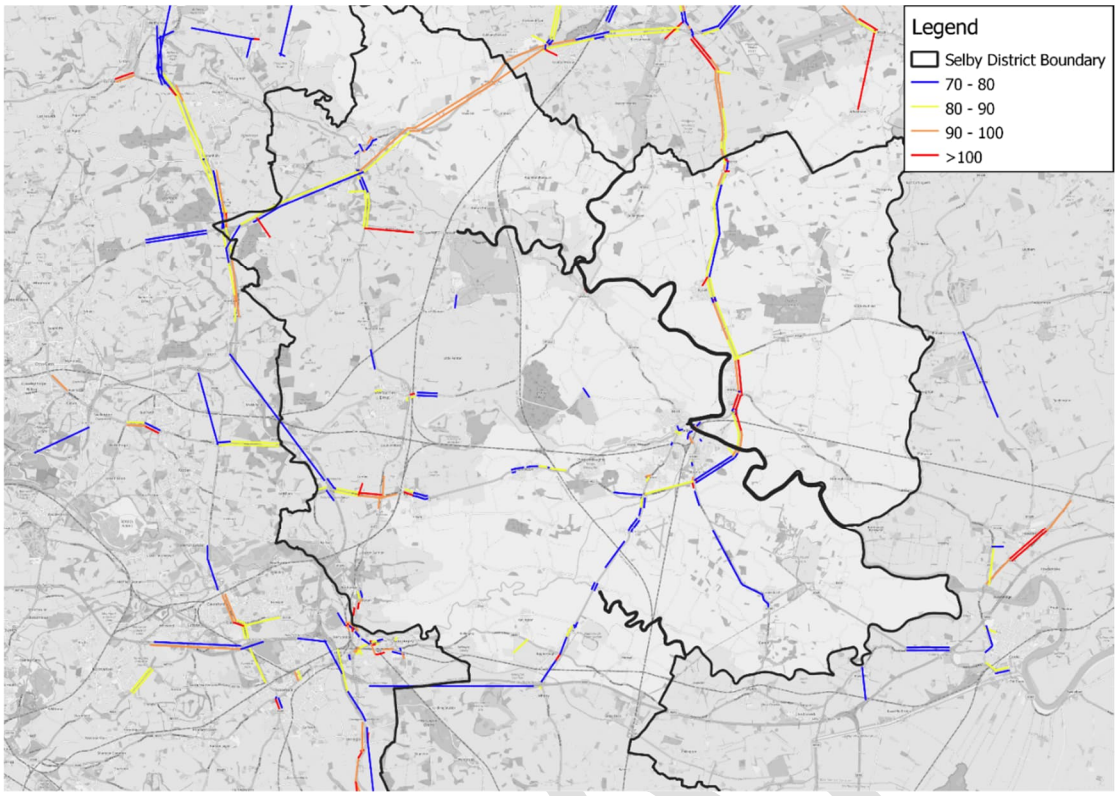


Figure 8-24 - Link VOC 2040 DS2 (IP)

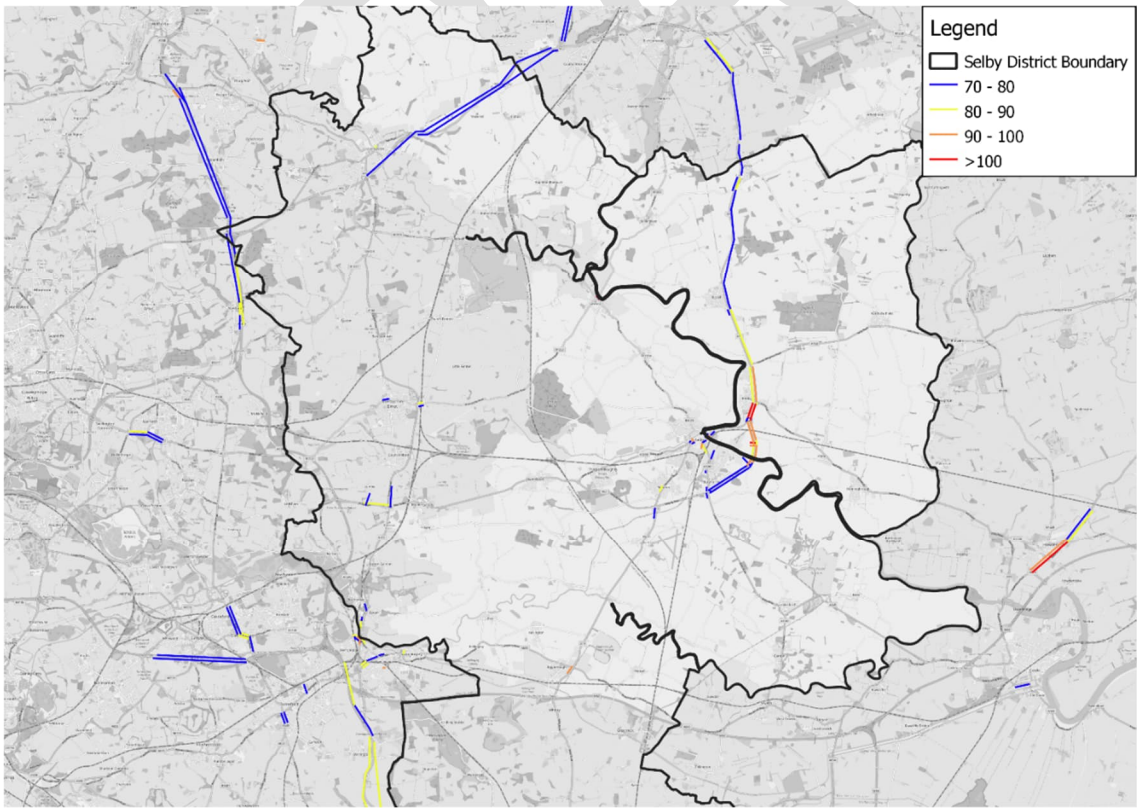
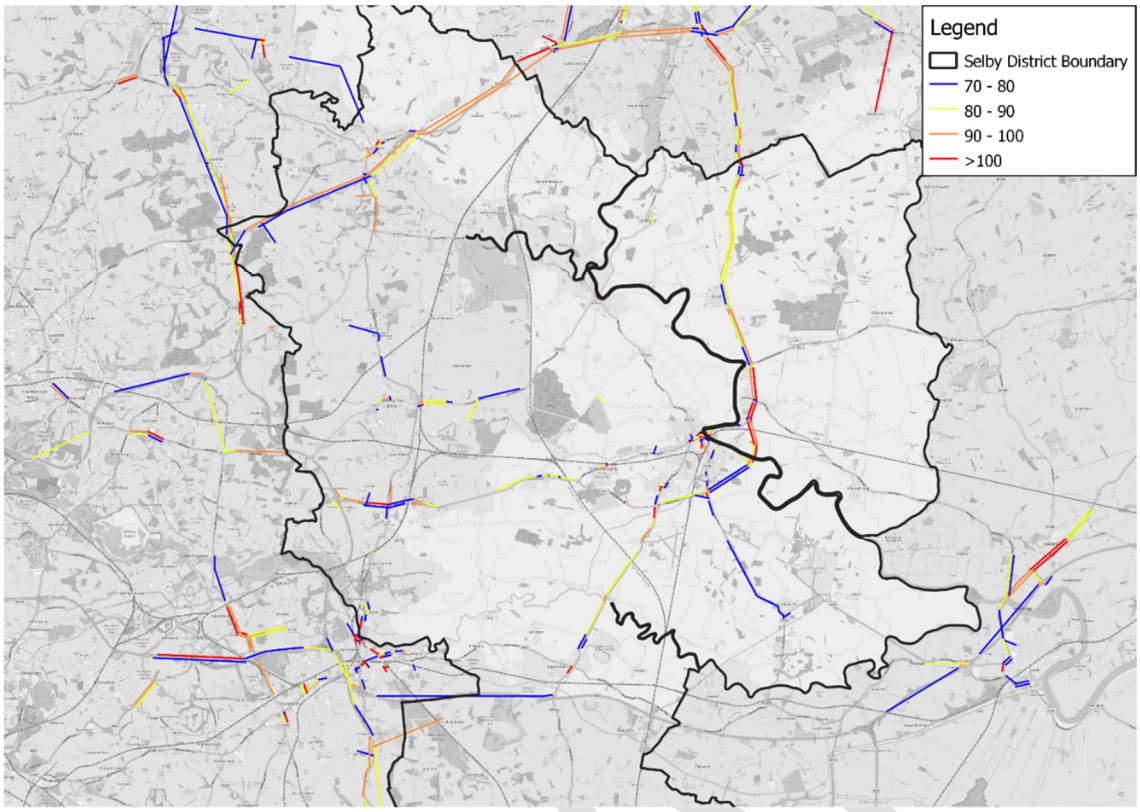


Figure 8-25 - Link VOC 2040 DS2 (PM)



Volume over capacity assessment - Junctions

8.8.6. The following figures show the junction VoC plots for 2040 DS2 for the AM, IP and PM peak hours based on the maximum VoC at any turn at the junction

Figure 8-26 - Turn VOC 2040 DS2 (AM)

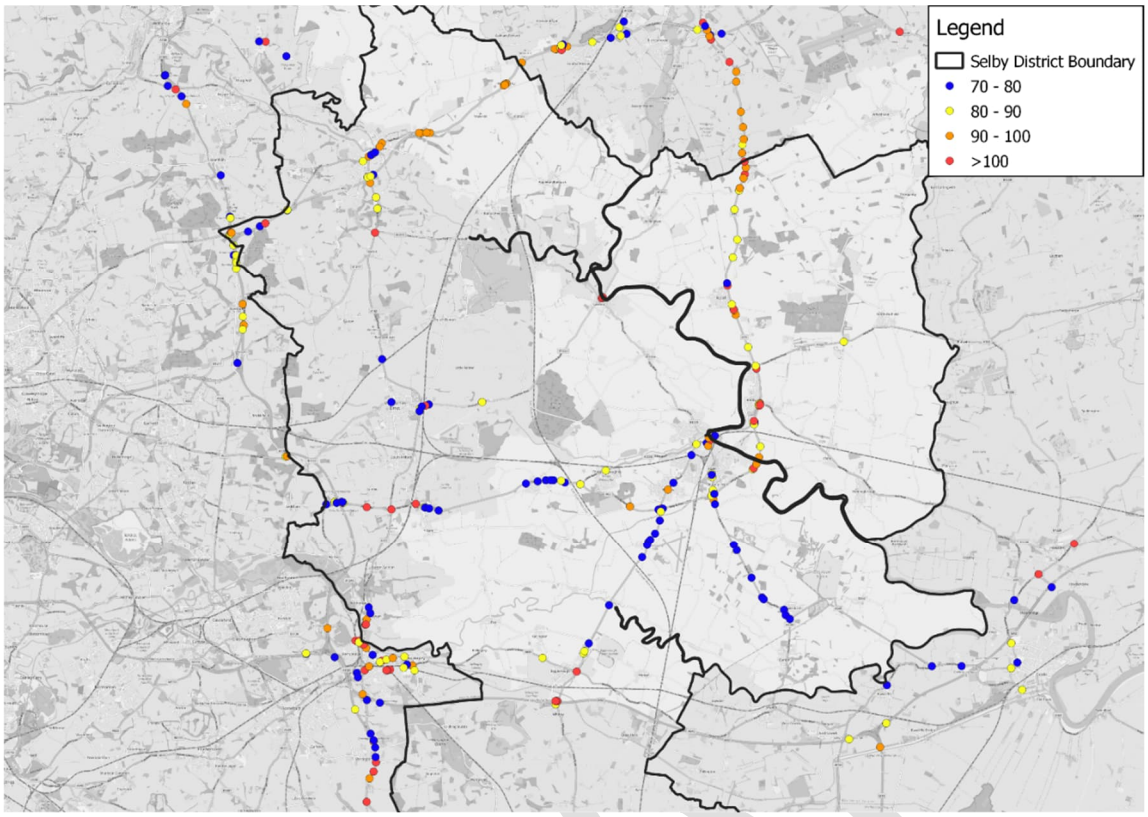


Figure 8-27 - Turn VOC 2040 DS2 (IP)

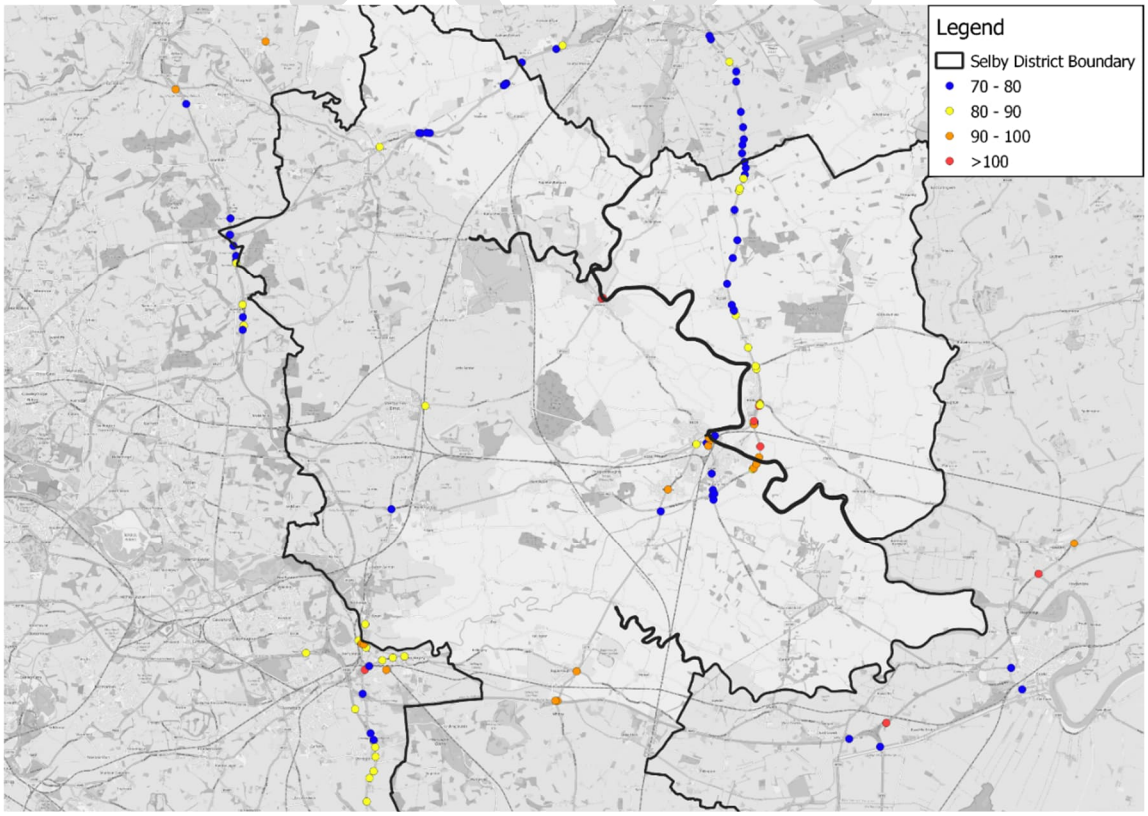
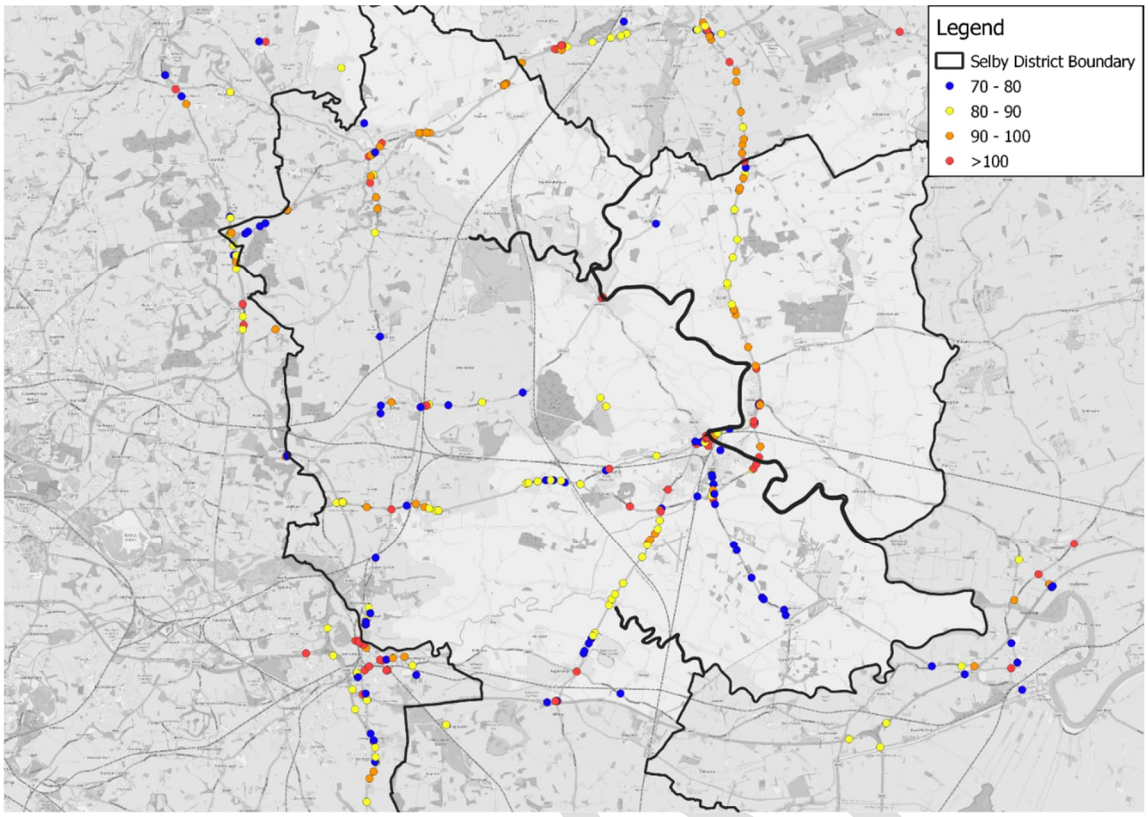


Figure 8-28 - Turn VOC 2040 DS2 (PM)



8.9 RESULTS FOR 2040 DS3

8.9.1. This section summarises the results for 2040 DS3model run for the parameter outlined in section 8.1.2

8.9.2. The convergence results are summarised in the **Error! Reference source not found.**. The core scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 8-16 – Core Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (d) / (Gap (%)	% Flow	% Delays
2040 DS3	AM	30	0.0049	99.2	99.4
		31	0.0048	99.2	99.3
		32	0.0049	99.3	99.6
		33	0.0056	99.3	99.4
	IP	15	0.00042	99.1	99.9
		16	0.00039	99.1	99.9

		17	0.00036	99.2	100
		18	0.00034	99.1	100
	PM	43	0.0048	99.2	99
		44	0.0045	99.5	99.2
		45	0.0045	99.6	99.1
		46	0.0041	99.4	99.3

Highway Network Statistics

8.9.3. A comparison of the network statistics between the 2040 DS3 and 2040 DM forecast years is provided in the tables below by time period.

8.9.4. For all time periods, all but one of the indicators is forecast to increase through the modelled year, expected given the increased travel demand (and limited supply interventions). The exception to this is average speed, which is forecast to decrease through the modelled years, attributed to increased congestion.

Table 8-17 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2040DM	2040DS3	% Change
Transient Queues (pcu-hrs)	2122	2641	24.5%
Overcapacity Queues (pcu-hrs)	544	851	56.4%
Link Cruise Time (pcu-hrs)	16489	17872	8.4%
Total Travel Time (pcu-hrs)	19156	21364	11.5%
Travel Distance (pcu-kms)	1319250	1395950	5.8%
Average Journey Speed (kph)	69	65	-5.1%
Total Assigned Trips (pcus)	145259	152142	4.7%

Table 8-18 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2040DM	2040DS3	% Change
Transient Queues (pcu-hrs)	1054	1340	27.2%
Overcapacity Queues (pcu-hrs)	18	99	452.6%
Link Cruise Time (pcu-hrs)	12467	13498	8.3%
Total Travel Time (pcu-hrs)	13538	14937	10.3%
Travel Distance (pcu-kms)	1063815	1126099	5.9%
Average Journey Speed (kph)	79	75	-4.1%
Total Assigned Trips (pcus)	113024	119056	5.3%

Table 8-19 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2040DM	2040DS3	% Change
Transient Queues (pcu-hrs)	2311	2890	25.0%
Overcapacity Queues (pcu-hrs)	641	1215	89.5%
Link Cruise Time (pcu-hrs)	16920	18235	7.8%
Total Travel Time (pcu-hrs)	19873	22340	12.4%
Travel Distance (pcu-kms)	1342632	1414933	5.4%
Average Journey Speed (kph)	68	63	-6.3%
Total Assigned Trips (pcus)	141498	148783	5.1%

8.10 HIGHWAY ASSIGNMENT IMPACTS

8.10.1. Highway assignment impacts are quantified through comparison of forecast model outputs for:

- Journey time routes;
- Traffic flow plots;
- VoC plots for each of the scenario runs .

Journey Time Routes

8.10.2. Comparisons of travel times on a subset of the local network journey time routes between 2040 DS3 and forecast 2040 DM are presented in tables below by time period.

8.10.3. There are increases in travel time between the 2040 DS3 and 2040DM forecast year. This is reflective of larger delays in the network due to increased demand and congestion and is the general trend across the network.

Table 8-20 – Journey Time Routes, 2040 DS3

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2040DM	2040DS3	% Change	2040DM	2040DS3	% Change	2040DM	2040DS3	% Change
1 EB	09:04	10:39	18%	07:56	09:18	17%	09:57	12:22	24%
1 WB	09:39	11:56	24%	07:51	09:43	24%	09:32	12:43	33%
2 NB	16:45	18:39	11%	14:47	16:53	14%	17:55	20:48	16%
2 SB	19:23	23:35	22%	15:01	17:40	18%	18:42	25:06	34%
3 ACW	05:49	06:21	9%	06:09	06:23	4%	06:38	08:02	21%
3 CW	07:18	07:49	7%	06:45	07:31	11%	07:53	09:50	25%
4 EB	14:39	16:31	13%	13:23	14:51	11%	15:49	17:42	12%
4 WB	16:35	20:02	21%	13:39	16:10	18%	16:19	20:23	25%

5 NB	11:27	14:07	23%	09:19	10:20	11%	11:39	14:22	23%
5 SB	09:01	09:30	5%	08:14	08:44	6%	09:16	09:26	2%
6 EB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
6 WB	05:29	05:49	6%	05:21	05:40	6%	05:48	06:34	13%
7 WB	05:29	05:58	9%	05:13	05:24	3%	05:32	06:08	11%
7 EB	05:48	06:45	17%	05:16	05:30	4%	05:36	05:47	3%
8 NB	09:56	10:12	3%	09:45	09:55	2%	10:06	10:15	1%
8 SB	11:16	11:51	5%	10:44	11:37	8%	11:58	13:50	16%
9 WB	08:28	08:41	3%	08:11	08:16	1%	08:26	08:29	1%
9 EB	08:03	08:06	1%	07:57	08:00	1%	08:04	08:05	0%
10 EB	06:51	06:59	2%	06:33	06:36	1%	06:33	06:38	1%
10 WB	06:30	06:40	2%	06:27	06:30	1%	06:33	08:02	23%
11 SB	04:13	04:23	4%	04:01	04:05	2%	04:05	04:09	2%
11 NB	04:43	04:39	-1%	04:02	04:05	1%	04:33	04:47	5%
12 NB	03:24	03:36	6%	03:22	03:40	9%	03:49	04:20	14%
12 SB	03:09	03:21	6%	03:10	03:18	4%	03:19	03:35	8%
13 EB	02:39	03:00	13%	02:51	03:35	25%	03:20	04:37	39%
13 WB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
14 EB	08:41	12:09	40%	07:32	07:38	1%	08:28	08:46	4%
14 WB	08:01	08:19	4%	07:34	07:45	2%	08:02	10:44	34%
15 EB	08:31	08:58	5%	07:28	07:35	2%	09:02	09:44	8%
15 WB	08:06	08:20	3%	07:18	07:22	1%	08:11	08:28	3%
16 WB	07:32	07:45	3%	06:52	06:55	1%	07:39	07:53	3%
16 EB	08:37	09:05	5%	07:15	07:23	2%	08:56	09:40	8%
17 EB	10:36	11:07	5%	09:08	09:12	1%	12:27	12:57	4%
17 WB	09:53	10:05	2%	09:06	09:10	1%	09:57	10:16	3%
18 EB	03:28	03:38	5%	03:26	03:26	0%	03:29	03:29	0%
18 WB	03:41	03:42	0%	03:27	03:27	0%	03:30	03:34	2%
19 EB	10:52	11:09	3%	10:36	10:40	1%	11:07	11:28	3%
19 WB	12:49	12:43	-1%	10:48	10:49	0%	11:16	11:22	1%

20 SB	05:55	06:03	2%	05:44	05:49	1%	06:04	06:12	2%
20 NB	06:06	06:20	4%	05:49	05:54	1%	06:04	06:11	2%
21 NB	04:11	04:57	18%	03:39	03:48	4%	03:59	04:29	13%
21 SB	04:24	05:40	29%	03:40	03:49	4%	03:50	04:03	6%
22 EB	12:30	13:17	6%	11:15	11:19	1%	14:53	14:55	0%
22 WB	18:43	18:08	-3%	11:03	11:21	3%	14:38	15:42	7%
23 EB	08:37	08:49	2%	08:23	08:28	1%	08:41	08:57	3%
23 WB	08:36	08:43	1%	08:25	08:30	1%	08:35	08:38	1%
24 NB	08:59	12:49	43%	08:05	09:28	17%	10:27	14:21	37%
24 SB	10:36	12:44	20%	07:52	09:22	19%	08:19	11:11	34%
25 NB	18:06	19:18	7%	16:00	16:23	2%	17:01	17:52	5%
25 SB	16:47	17:19	3%	15:31	15:54	3%	17:33	18:23	5%
26 NB	04:04	04:04	0%	04:01	04:02	0%	04:02	04:03	1%
26 SB	04:12	04:16	2%	04:07	04:08	0%	04:14	04:13	0%
27 NB	03:35	03:30	-3%	03:32	03:32	0%	03:34	03:35	0%
27 SB	03:30	03:34	2%	03:27	03:28	0%	03:31	03:29	-1%
28 EB	09:21	09:29	1%	09:13	09:25	2%	09:26	09:46	4%
28 WB	10:29	11:39	11%	09:34	10:03	5%	10:25	11:04	6%
29 NB	20:10	21:29	7%	13:21	14:25	8%	18:14	20:29	12%
29 SB	21:16	23:48	12%	14:49	16:23	11%	22:49	27:26	20%
30 WB	12:29	12:52	3%	09:11	09:35	4%	10:35	10:57	3%
30 EB	10:56	12:45	17%	09:25	09:58	6%	13:36	16:12	19%
31 EB	07:45	07:56	2%	07:38	07:50	3%	08:03	08:51	10%
31 WB	07:42	08:03	4%	07:24	07:32	2%	07:30	07:42	2%
32 SB	07:41	07:41	0%	07:37	07:39	0%	07:50	07:54	1%
32 NB	08:24	08:37	3%	07:44	07:46	0%	07:51	07:55	1%
33 NB	18:12	19:27	7%	13:12	13:21	1%	15:47	15:38	-1%
33 SB	17:34	17:13	-2%	14:52	15:16	3%	20:20	20:28	1%
34 EB	08:12	08:18	1%	07:53	07:55	0%	08:48	09:03	3%
34 WB	07:49	07:52	1%	07:39	07:40	0%	07:46	07:47	0%

35 EB	17:50	17:59	1%	17:39	17:44	1%	18:43	18:56	1%
35 WB	18:26	18:41	1%	17:37	17:43	1%	17:36	17:43	1%
36 NB	25:27	25:55	2%	22:25	22:31	0%	24:11	24:38	2%
36 SB	22:17	22:26	1%	22:16	22:22	0%	23:07	23:21	1%

Traffic difference plots

8.10.4. The following plots show the difference in traffic flow between the 2040 DS3 and 2040 DM for the AM, IP and PM peak hours.

Figure 8-29 - Demand Flow Difference 2040 DS3-DM (AM)

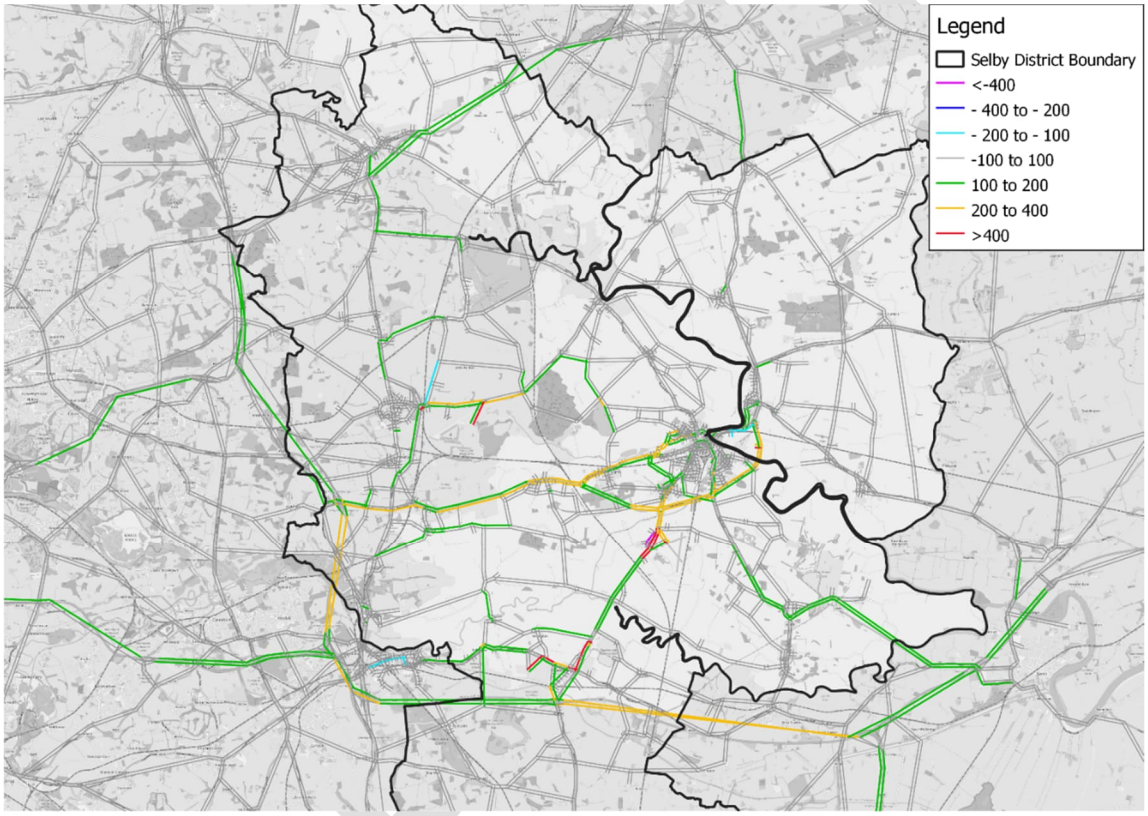


Figure 8-30 - Demand Flow Difference 2040 DS3-DM (IP)

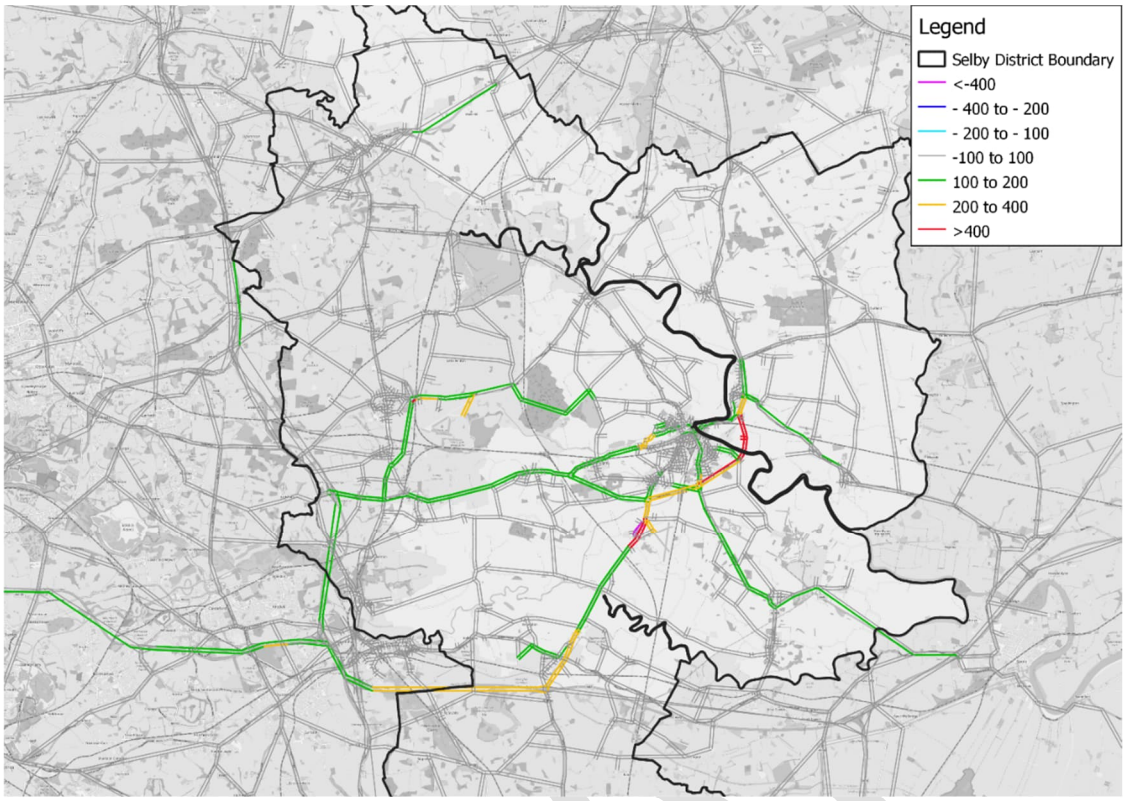
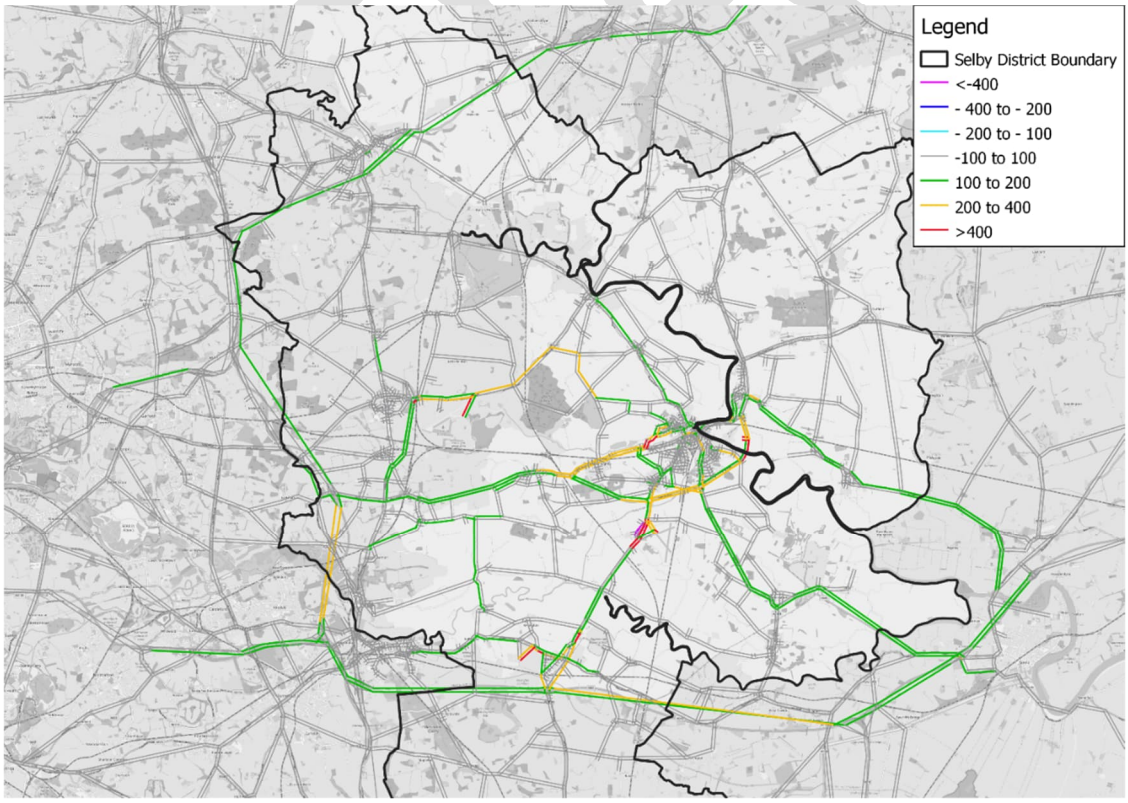


Figure 8-31 - Demand Flow Difference 2040 DS3-DM (PM)



Volume over capacity assessment - Link

8.10.5. The following figures show the link VoC plots for 2040 DS3 for the AM, IP and PM peak hours

Figure 8-32 - Link VOC 2040 DS3 (AM)

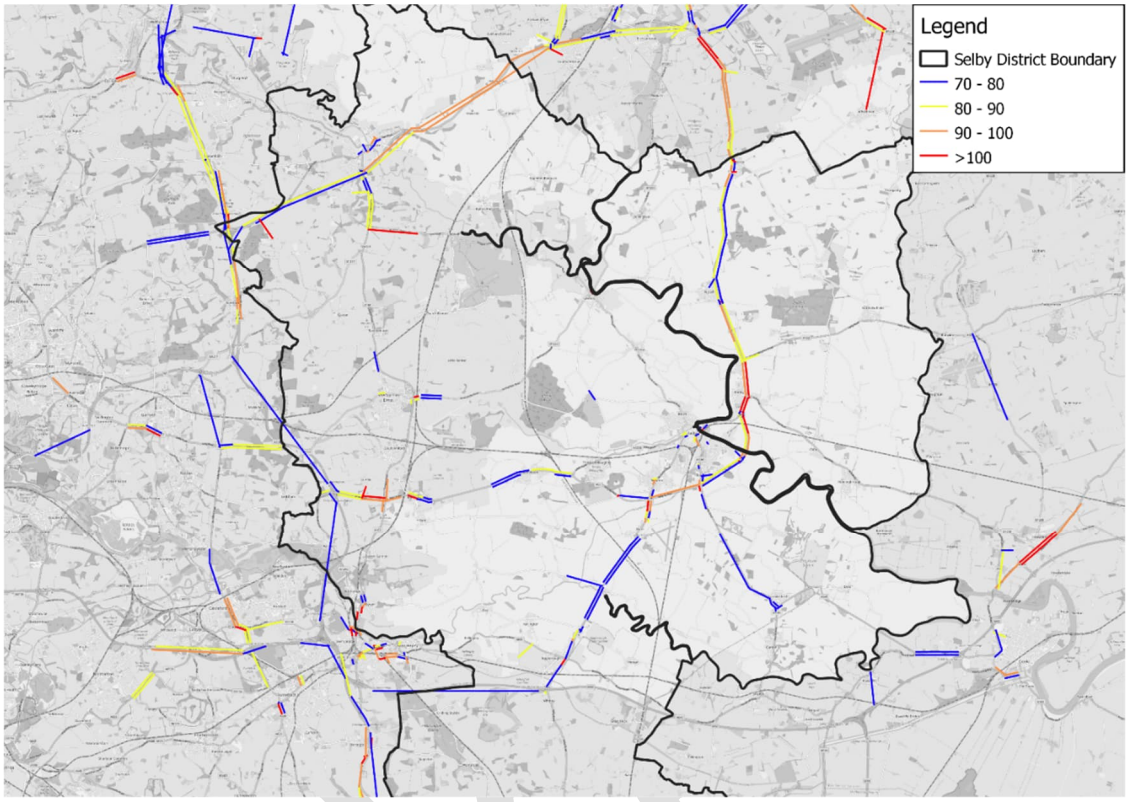


Figure 8-33 - Link VOC 2040 DS3 (IP)

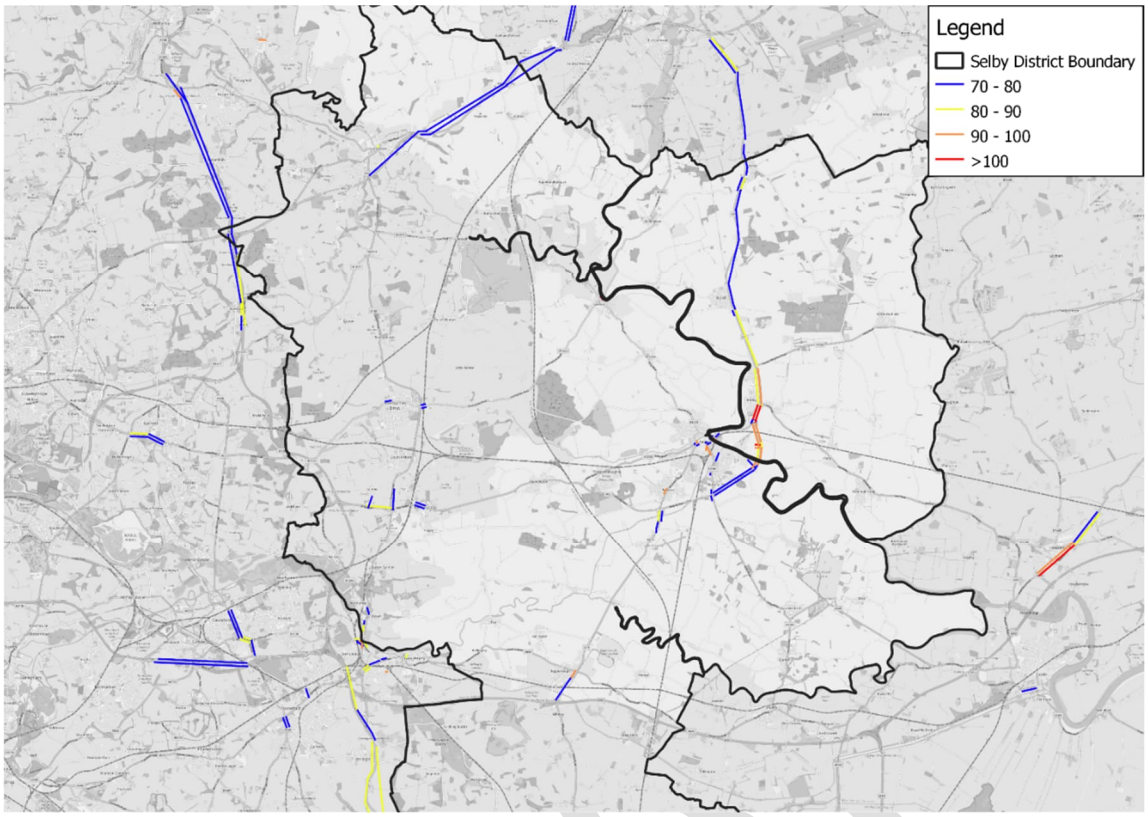
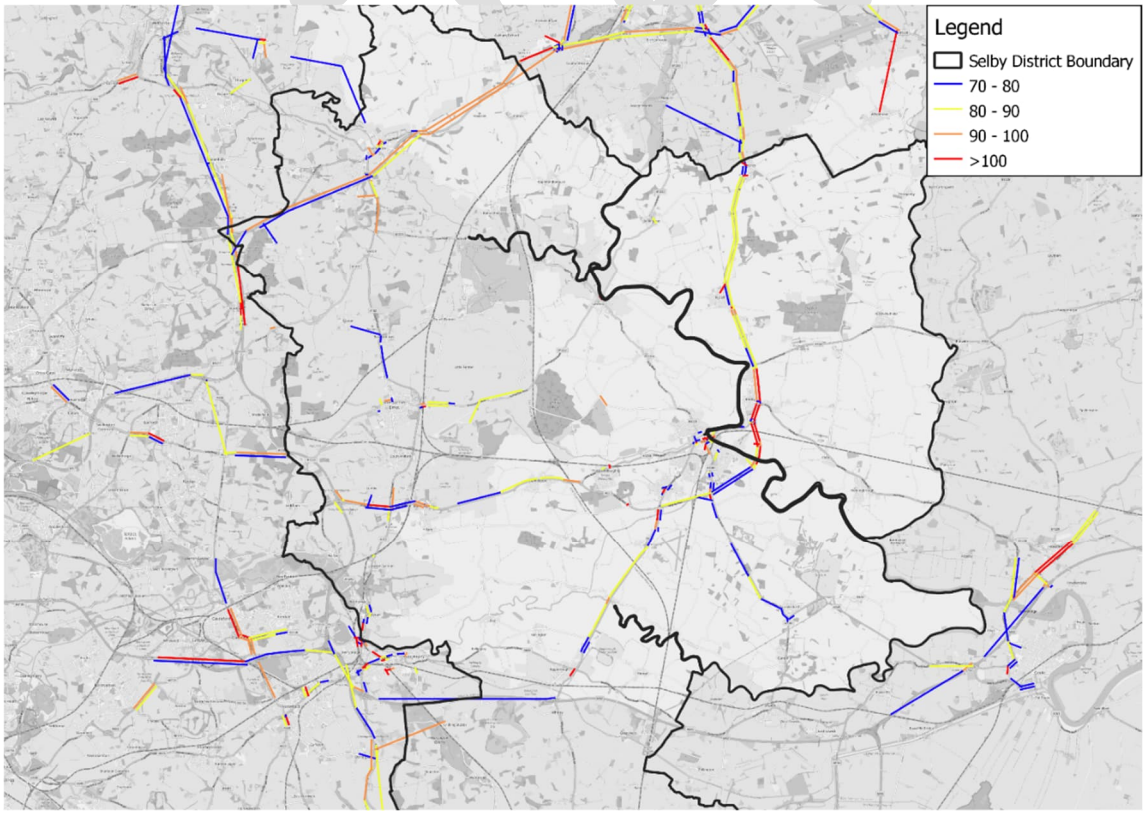


Figure 8-34 - Link VOC 2040 DS3 (PM)



Volume over capacity assessment - Turn

8.10.6. The following figures show the turn VoC plots for 2040 DS3 for the AM, IP and PM peak hours based on the maximum VoC at any turn at the junction

Figure 8-35 - Turn VOC 2040 DS3 (AM)

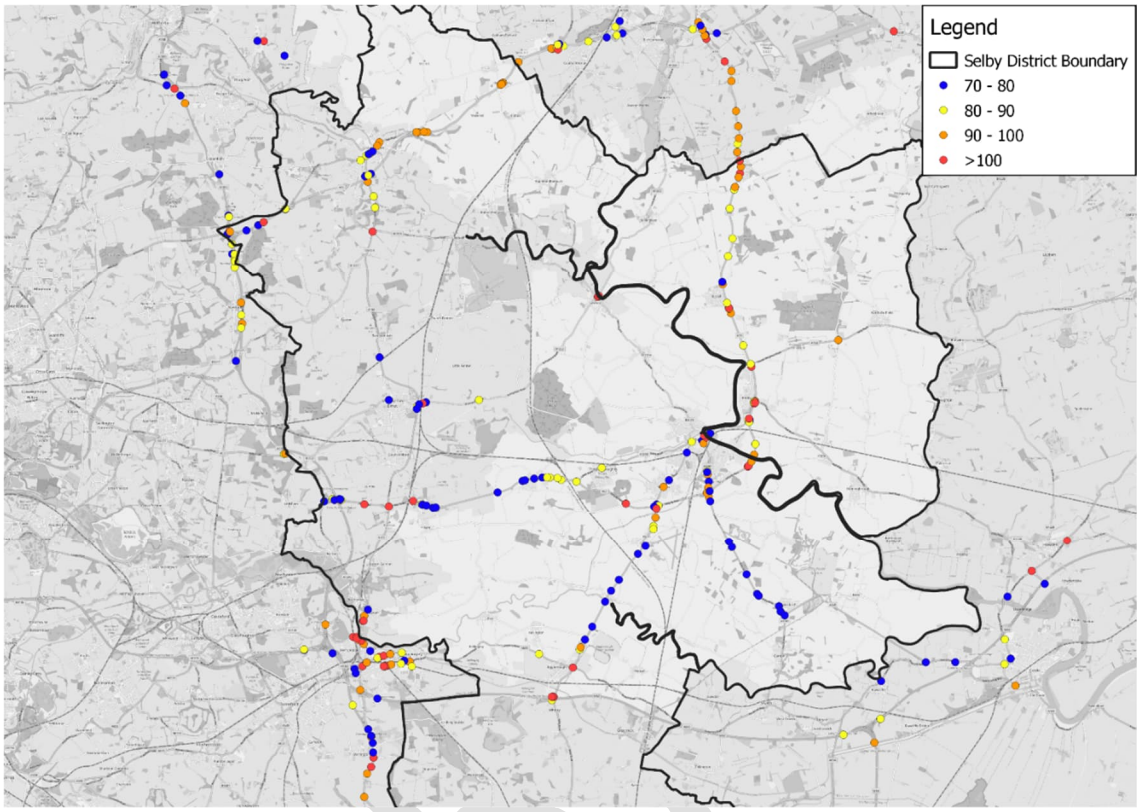


Figure 8-36 - Turn VOC 2040 DS3 (IP)

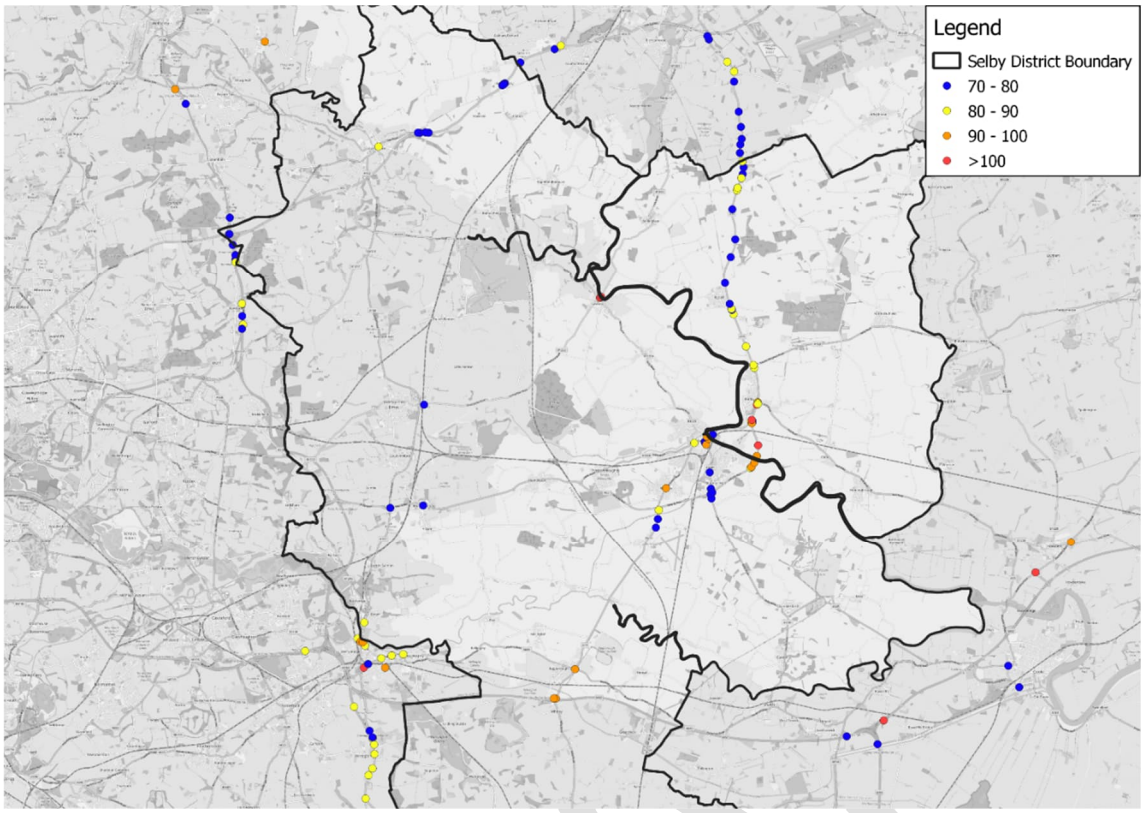
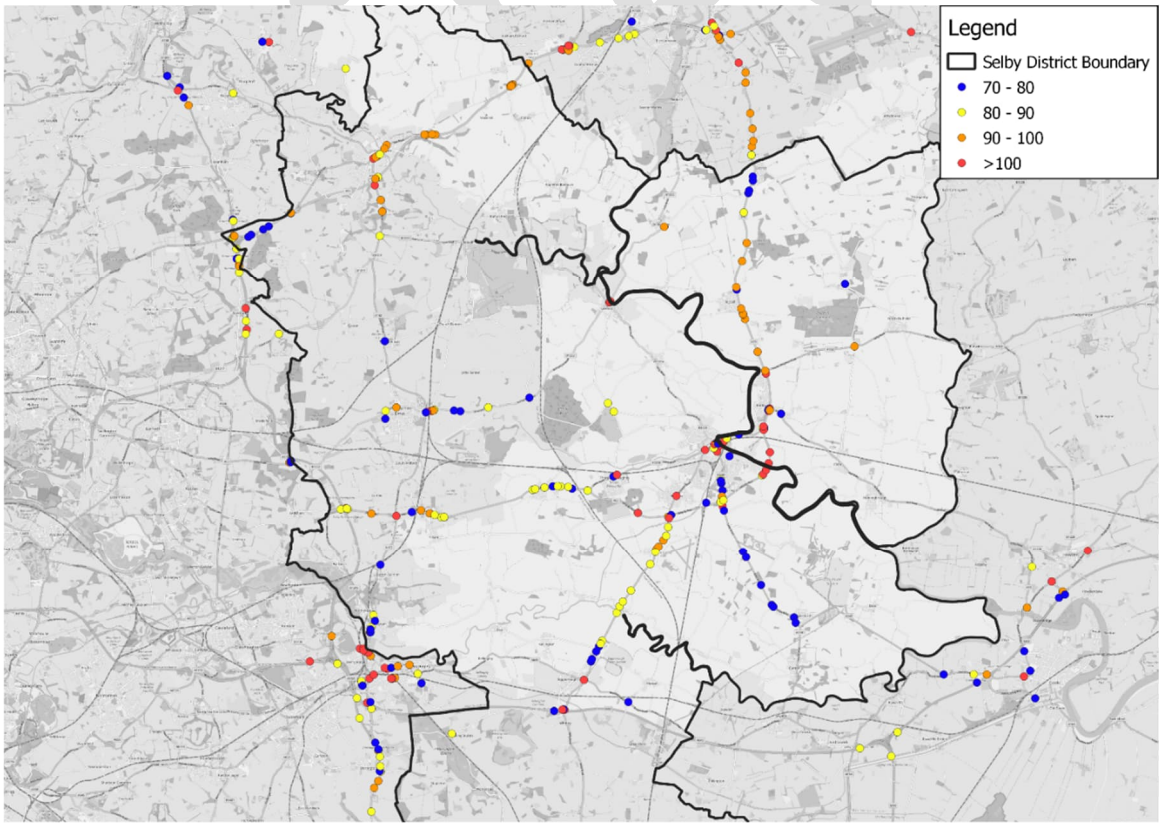


Figure 8-37 - Turn VOC 2040 DS3 (PM)



8.11 RESULTS FOR 2040 DS4

8.11.1. This section summarises the results for 2040 DS4 model run for the parameter outlined in section **Error! Reference source not found.**

8.11.2. The convergence results are summarised in the **Table 8-21Error! Reference source not found.**. The core scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 8-21 – Core Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (δ) / (Gap (%)	% Flow	% Delays
2040 DS4	AM	30	0.0045	99.2	99.5
		31	0.0039	99	99.6
		32	0.0043	99.5	99.4
		33	0.0037	99.2	99.5
	IP	23	0.00021	99.6	100
		24	0.00021	99.4	100
		25	0.0002	99.4	99.9
		26	0.00022	99.1	99.9
	PM	65	0.0063	97.7	98.8
		66	0.0043	99.4	99.2
		67	0.0049	99.7	99.3
		68	0.0075	99.1	99.1

Highway Network Statistics

8.11.3. A comparison of the network statistics between the model base year and modelled forecast years is provided in tables below respectively by time period.

8.11.4. For all time periods, all but one of the indicators is forecast to increase through the modelled year, expected given the increased travel demand (and limited supply interventions). The exception to this is average speed, which is forecast to decrease through the modelled years, attributed to increased congestion.

Table 8-22 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2040DM	2040DS4	% Change
Transient Queues (pcu-hrs)	2122	2664	25.5%
Overcapacity Queues (pcu-hrs)	544	957	76.0%
Link Cruise Time (pcu-hrs)	16489	17865	8.3%
Total Travel Time (pcu-hrs)	19156	21486	12.2%
Travel Distance (pcu-kms)	1319250	1396005	5.8%
Average Journey Speed (kph)	69	65	-5.7%
Total Assigned Trips (pcus)	145259	152194	4.8%

Table 8-23 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2040DM	2040DS4	% Change
Transient Queues (pcu-hrs)	1054	1353	28.5%
Overcapacity Queues (pcu-hrs)	18	133	638.2%
Link Cruise Time (pcu-hrs)	12467	13533	8.6%
Total Travel Time (pcu-hrs)	13538	15019	10.9%
Travel Distance (pcu-kms)	1063815	1128109	6.0%
Average Journey Speed (kph)	79	75	-4.4%
Total Assigned Trips (pcus)	113024	119109	5.4%

Table 8-24 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2040DM	2040DS4	% Change
Transient Queues (pcu-hrs)	2311	2958	28.0%
Overcapacity Queues (pcu-hrs)	641	1283	100.0%
Link Cruise Time (pcu-hrs)	16920	18304	8.2%
Total Travel Time (pcu-hrs)	19873	22545	13.4%
Travel Distance (pcu-kms)	1342632	1418182	5.6%
Average Journey Speed (kph)	68	63	-6.9%
Total Assigned Trips (pcus)	141498	148908	5.2%

8.12 HIGHWAY ASSIGNMENT IMPACTS

8.12.1. Highway assignment impacts are quantified through comparison of forecast model outputs for:

- Journey time routes;
- Traffic flow plots;
- VoC plots for each of the scenario runs .

Journey Time Routes

8.12.2. Comparisons of travel times on a subset of the local network journey time routes between the 2040 DS4 and forecast 2040 DM are presented in tables below by time period.

8.12.3. There are increases in travel time between the 2040DS4 and 2040 DM forecast. This is reflective of larger delays in the network due to increased demand and congestion and is the general trend across the network, whilst noting the checks on convergence and traffic signal timings that were referred to in Section 6.7.

Table 8-25 – Journey Time Routes, 2040 DS4

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2040DM	2040DS4	% Change	2040DM	2040DS4	% Change	2040DM	2040DS4	% Change
1 EB	09:04	11:00	21%	07:56	09:40	22%	09:57	12:51	29%
1 WB	09:39	12:05	25%	07:51	09:51	26%	09:32	13:45	44%
2 NB	16:45	19:07	14%	14:47	17:04	16%	17:55	21:29	20%
2 SB	19:23	24:07	24%	15:01	18:00	20%	18:42	26:59	44%
3 ACW	05:49	06:28	11%	06:09	06:21	3%	06:38	08:04	22%
3 CW	07:18	07:54	8%	06:45	07:27	11%	07:53	10:16	30%
4 EB	14:39	16:55	15%	13:23	15:19	14%	15:49	18:26	16%
4 WB	16:35	20:44	25%	13:39	16:32	21%	16:19	22:03	35%
5 NB	11:27	13:43	20%	09:19	10:16	10%	11:39	14:07	21%
5 SB	09:01	09:23	4%	08:14	08:42	6%	09:16	09:16	0%
6 EB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
6 WB	05:29	05:49	6%	05:21	05:42	6%	05:48	06:33	13%
7 WB	05:29	05:51	7%	05:13	05:22	3%	05:32	06:00	9%
7 EB	05:48	06:29	12%	05:16	05:29	4%	05:36	05:52	5%
8 NB	09:56	10:09	2%	09:45	09:56	2%	10:06	10:12	1%
8 SB	11:16	11:59	6%	10:44	11:36	8%	11:58	14:09	18%
9 WB	08:28	08:31	1%	08:11	08:18	1%	08:26	08:29	1%

9 EB	08:03	08:07	1%	07:57	08:00	1%	08:04	08:07	1%
10 EB	06:51	06:59	2%	06:33	06:36	1%	06:33	06:37	1%
10 WB	06:30	06:38	2%	06:27	06:30	1%	06:33	07:56	21%
11 SB	04:13	04:24	4%	04:01	04:06	2%	04:05	04:11	2%
11 NB	04:43	05:11	10%	04:02	04:06	2%	04:33	04:53	7%
12 NB	03:24	03:35	5%	03:22	03:40	9%	03:49	04:21	14%
12 SB	03:09	03:21	6%	03:10	03:17	4%	03:19	03:31	7%
13 EB	02:39	02:57	11%	02:51	03:33	24%	03:20	04:40	40%
13 WB	00:00	00:00	0%	00:00	00:00	0%	00:00	00:00	0%
14 EB	08:41	12:14	41%	07:32	07:38	1%	08:28	08:44	3%
14 WB	08:01	08:22	4%	07:34	07:45	3%	08:02	10:42	33%
15 EB	08:31	09:00	6%	07:28	07:36	2%	09:02	08:31	-6%
15 WB	08:06	08:21	3%	07:18	07:22	1%	08:11	08:38	6%
16 WB	07:32	07:46	3%	06:52	06:55	1%	07:39	08:06	6%
16 EB	08:37	09:08	6%	07:15	07:23	2%	08:56	08:29	-5%
17 EB	10:36	11:33	9%	09:08	09:14	1%	12:27	13:06	5%
17 WB	09:53	10:08	3%	09:06	09:13	1%	09:57	10:39	7%
18 EB	03:28	03:39	5%	03:26	03:26	0%	03:29	03:30	0%
18 WB	03:41	03:42	0%	03:27	03:27	0%	03:30	03:35	2%
19 EB	10:52	11:10	3%	10:36	10:41	1%	11:07	11:35	4%
19 WB	12:49	13:46	7%	10:48	10:51	0%	11:16	11:25	1%
20 SB	05:55	06:03	2%	05:44	05:48	1%	06:04	06:12	2%
20 NB	06:06	06:20	4%	05:49	05:54	1%	06:04	06:11	2%
21 NB	04:11	04:52	16%	03:39	03:48	4%	03:59	04:30	13%
21 SB	04:24	05:47	31%	03:40	03:48	4%	03:50	04:02	5%
22 EB	12:30	13:12	6%	11:15	11:19	1%	14:53	15:15	3%
22 WB	18:43	18:00	-4%	11:03	11:20	3%	14:38	15:07	3%
23 EB	08:37	08:47	2%	08:23	08:28	1%	08:41	08:57	3%
23 WB	08:36	08:42	1%	08:25	08:30	1%	08:35	08:38	1%
24 NB	08:59	11:04	23%	08:05	08:53	10%	10:27	12:19	18%

24 SB	10:36	12:02	13%	07:52	08:31	8%	08:19	10:12	23%
25 NB	18:06	19:28	8%	16:00	16:25	3%	17:01	17:56	5%
25 SB	16:47	17:17	3%	15:31	15:56	3%	17:33	18:18	4%
26 NB	04:04	04:04	0%	04:01	04:02	0%	04:02	04:04	1%
26 SB	04:12	04:16	2%	04:07	04:08	0%	04:14	04:14	0%
27 NB	03:35	03:30	-3%	03:32	03:32	0%	03:34	03:35	0%
27 SB	03:30	03:35	2%	03:27	03:28	0%	03:31	03:28	-1%
28 EB	09:21	09:29	1%	09:13	09:22	2%	09:26	09:43	3%
28 WB	10:29	10:41	2%	09:34	10:01	5%	10:25	10:56	5%
29 NB	20:10	26:38	32%	13:21	15:54	19%	18:14	22:23	23%
29 SB	21:16	25:25	20%	14:49	17:41	19%	22:49	29:39	30%
30 WB	12:29	12:50	3%	09:11	09:29	3%	10:35	10:50	2%
30 EB	10:56	12:20	13%	09:25	09:52	5%	13:36	15:40	15%
31 EB	07:45	07:58	3%	07:38	07:51	3%	08:03	08:50	10%
31 WB	07:42	08:10	6%	07:24	07:33	2%	07:30	07:50	4%
32 SB	07:41	07:41	0%	07:37	07:39	0%	07:50	07:54	1%
32 NB	08:24	08:36	2%	07:44	07:46	0%	07:51	07:54	1%
33 NB	18:12	23:03	27%	13:12	15:01	14%	15:47	17:09	9%
33 SB	17:34	19:13	9%	14:52	16:53	14%	20:20	22:44	12%
34 EB	08:12	08:17	1%	07:53	07:55	0%	08:48	09:02	3%
34 WB	07:49	07:52	1%	07:39	07:39	0%	07:46	07:46	0%
35 EB	17:50	17:58	1%	17:39	17:44	1%	18:43	18:56	1%
35 WB	18:26	18:40	1%	17:37	17:42	0%	17:36	17:43	1%
36 NB	25:27	26:01	2%	22:25	22:31	0%	24:11	24:43	2%
36 SB	22:17	22:27	1%	22:16	22:23	1%	23:07	23:35	2%

Traffic difference plots

8.12.4. The following plots show the difference in traffic flow between 2040 DS4 and 2040 DM for the AM, IP and PM peak hours.

Figure 8-38 - Demand Flow Difference 2040 DS4-DM (AM)

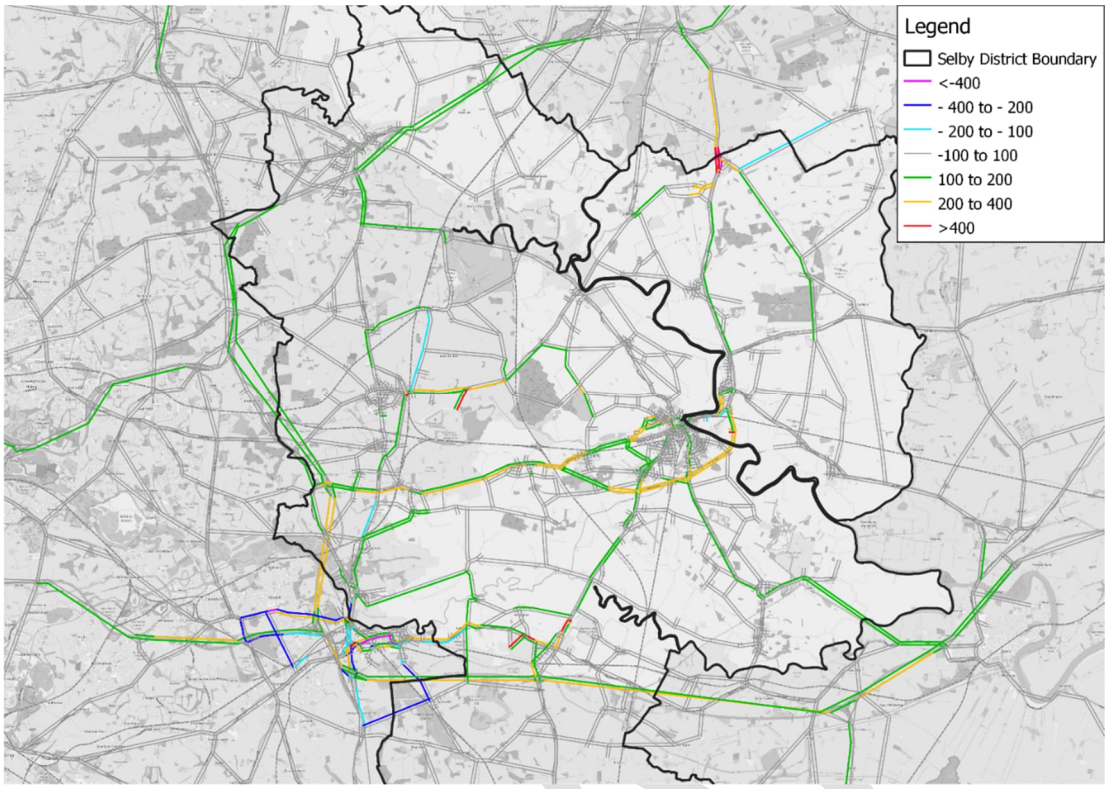


Figure 8-39 - Demand Flow Difference 2040 DS4-DM (IP)

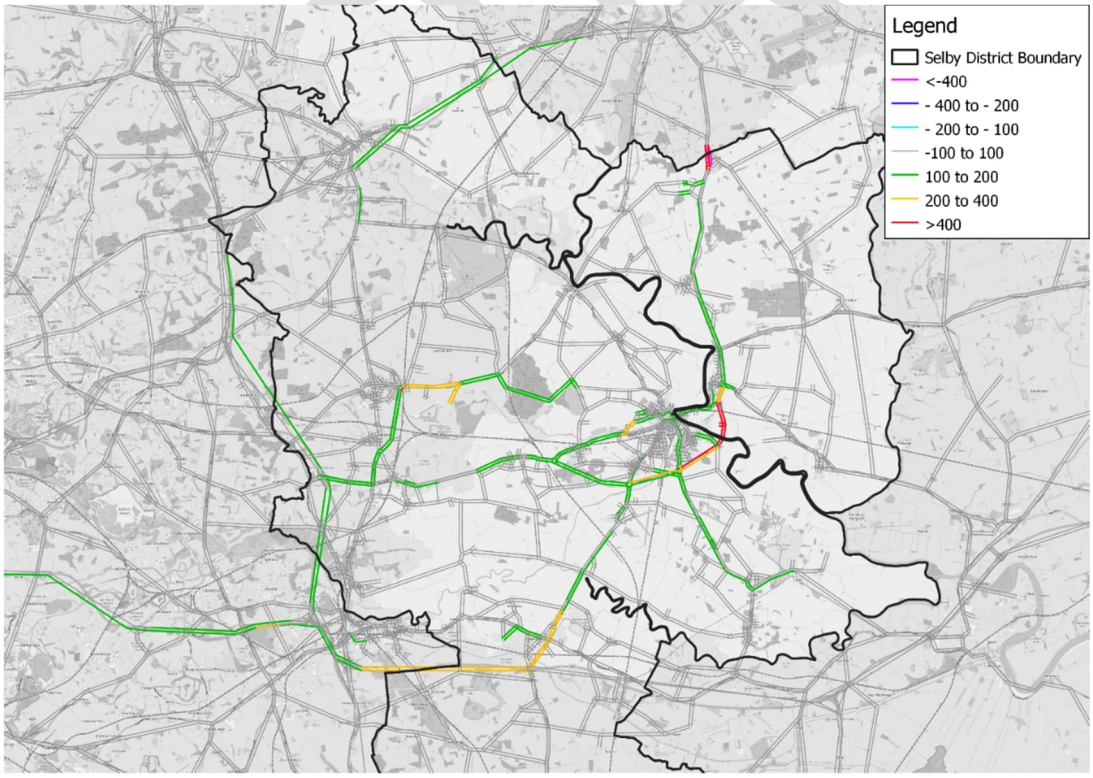
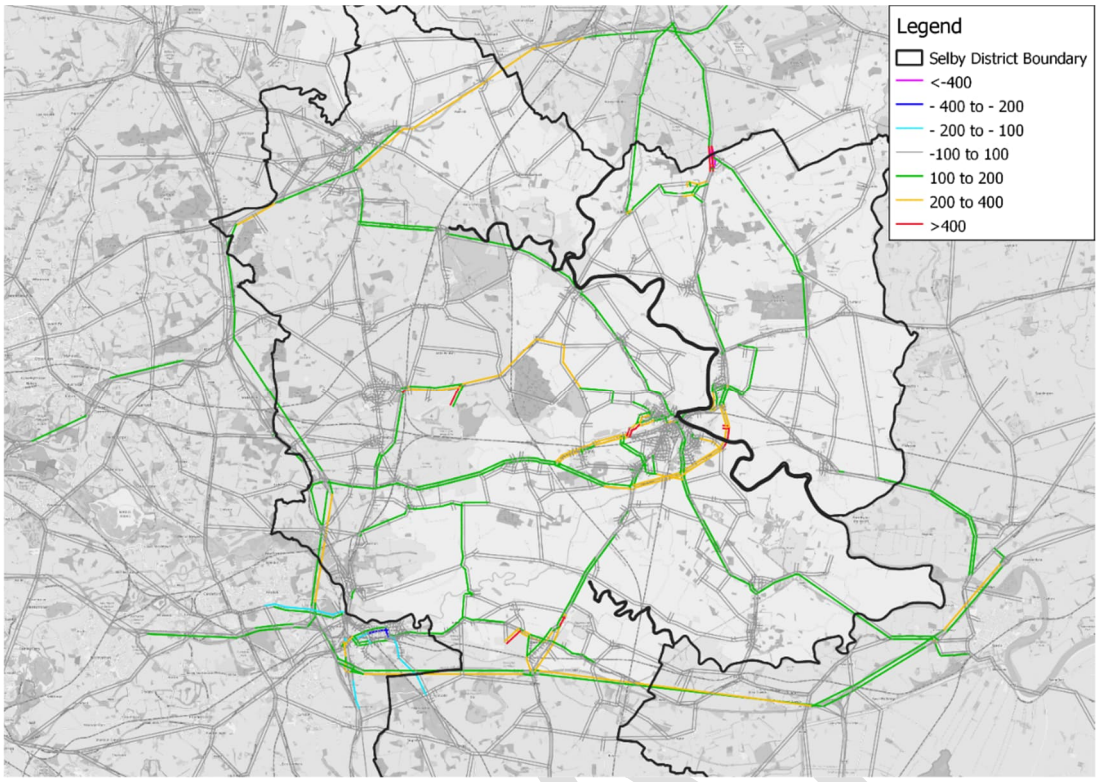


Figure 8-40 - Demand Flow Difference 2040 DS4-DM (PM)



Volume over capacity assessment - Link

8.12.5. The following figures show the link VoC plots for 2040 DS4 for the AM, IP and PM peak hours

Figure 8-41 - Link VOC 2040 DS4 (AM)

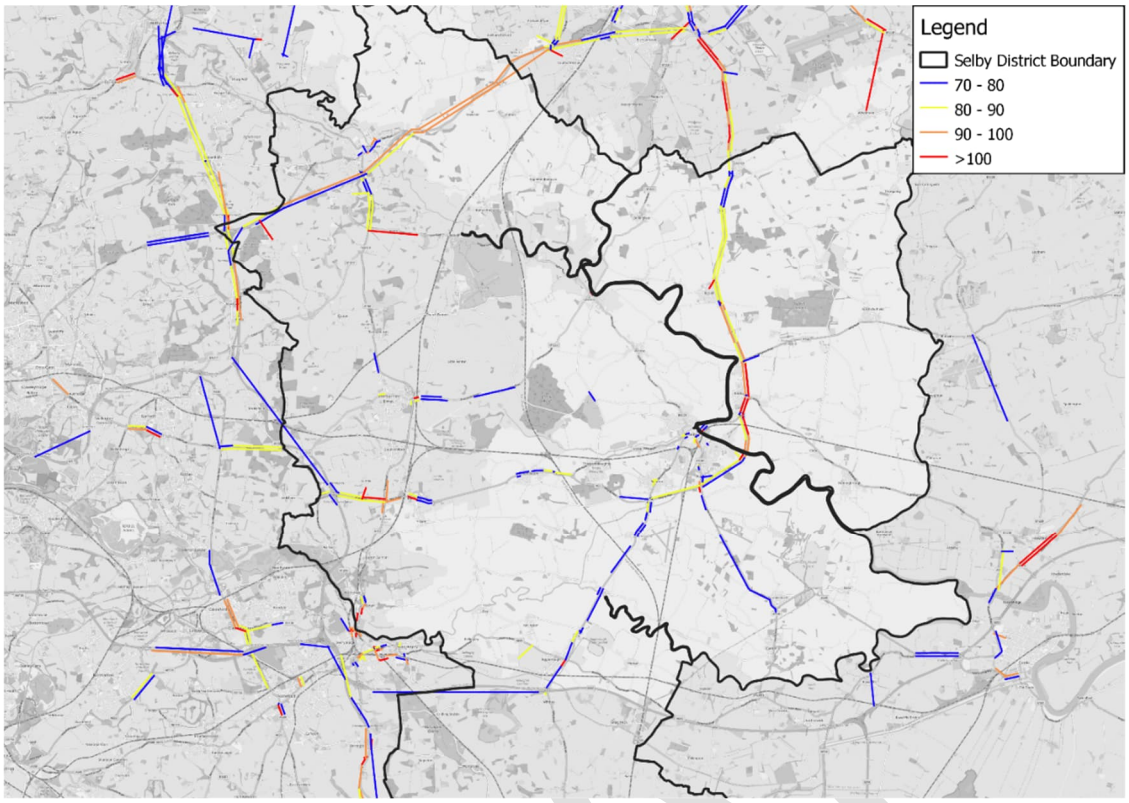


Figure 8-42 - Link VOC 2040 DS4 (IP)

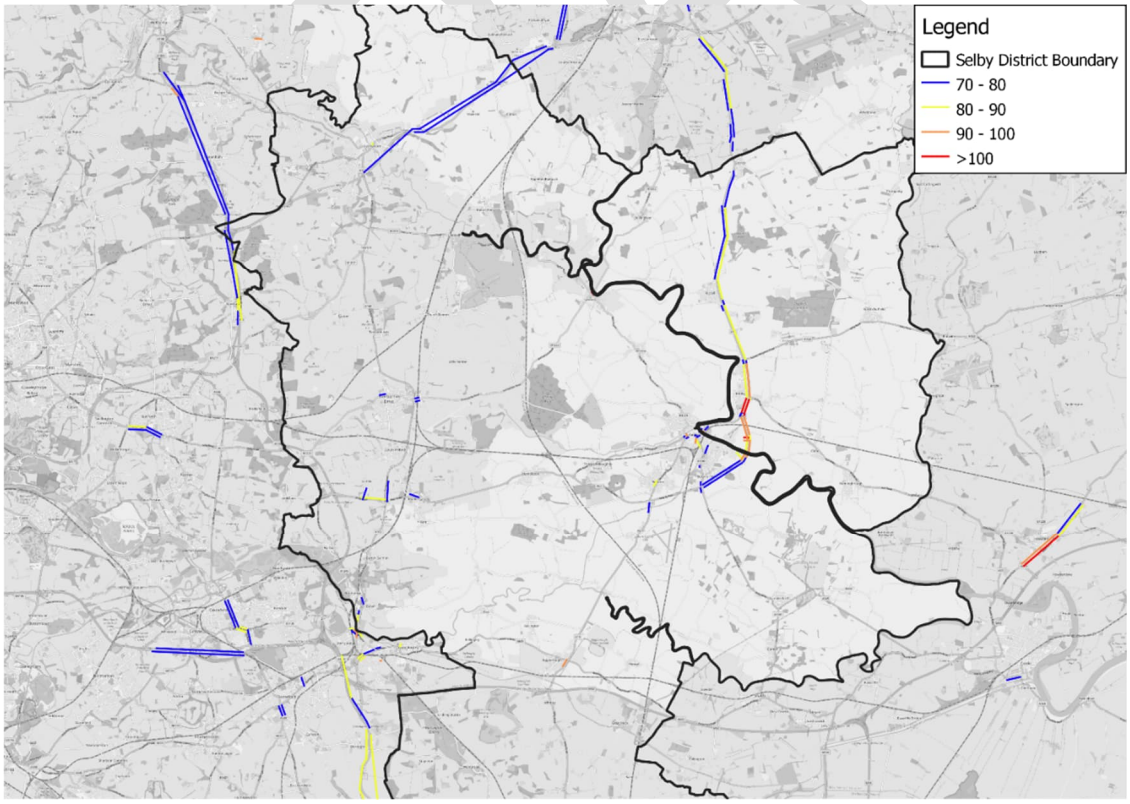
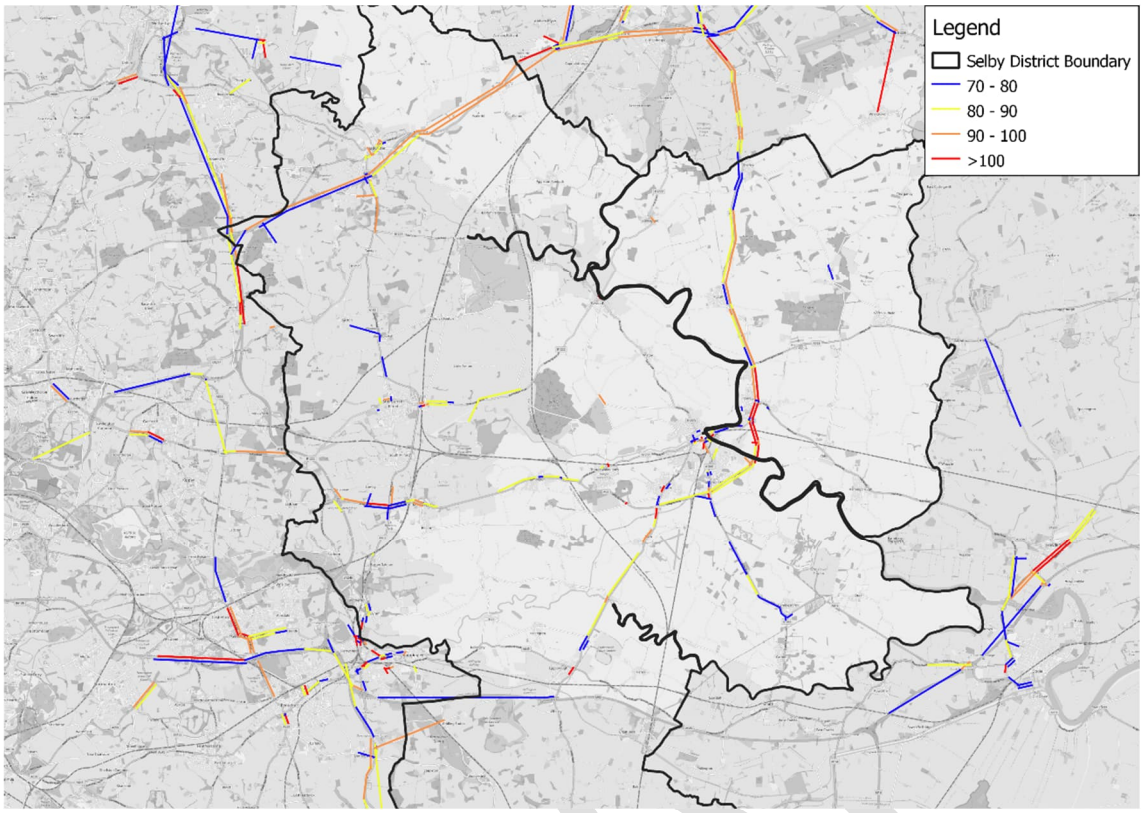


Figure 8-43 - Link VOC 2040 DS4 (PM)



Volume over capacity assessment

8.12.6. The following figures show the junction VoC plots for 2040 DS4 for the AM, IP and PM peak hours based on the maximum VoC at any turn at the junction

Figure 8-44 - Turn VOC 2040 DS4 (AM)

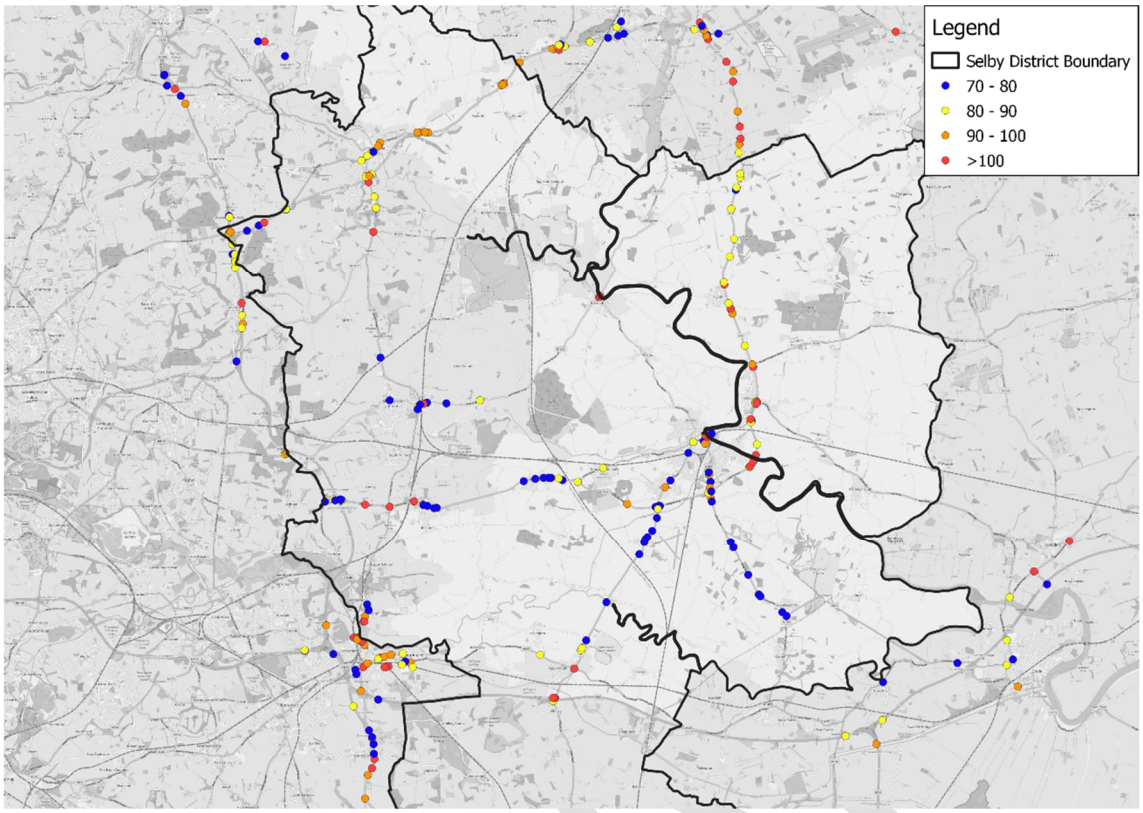


Figure 8-45 - Turn VOC 2040 DS4 (IP)

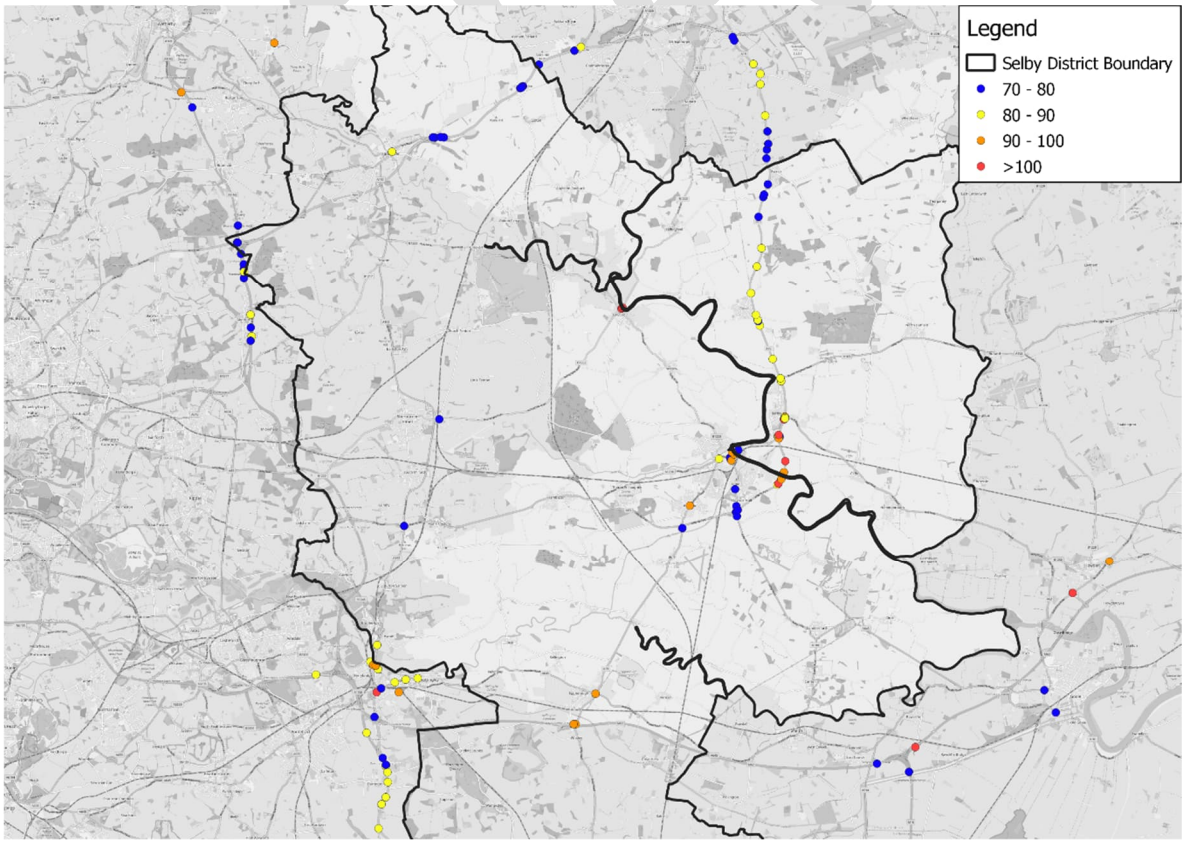
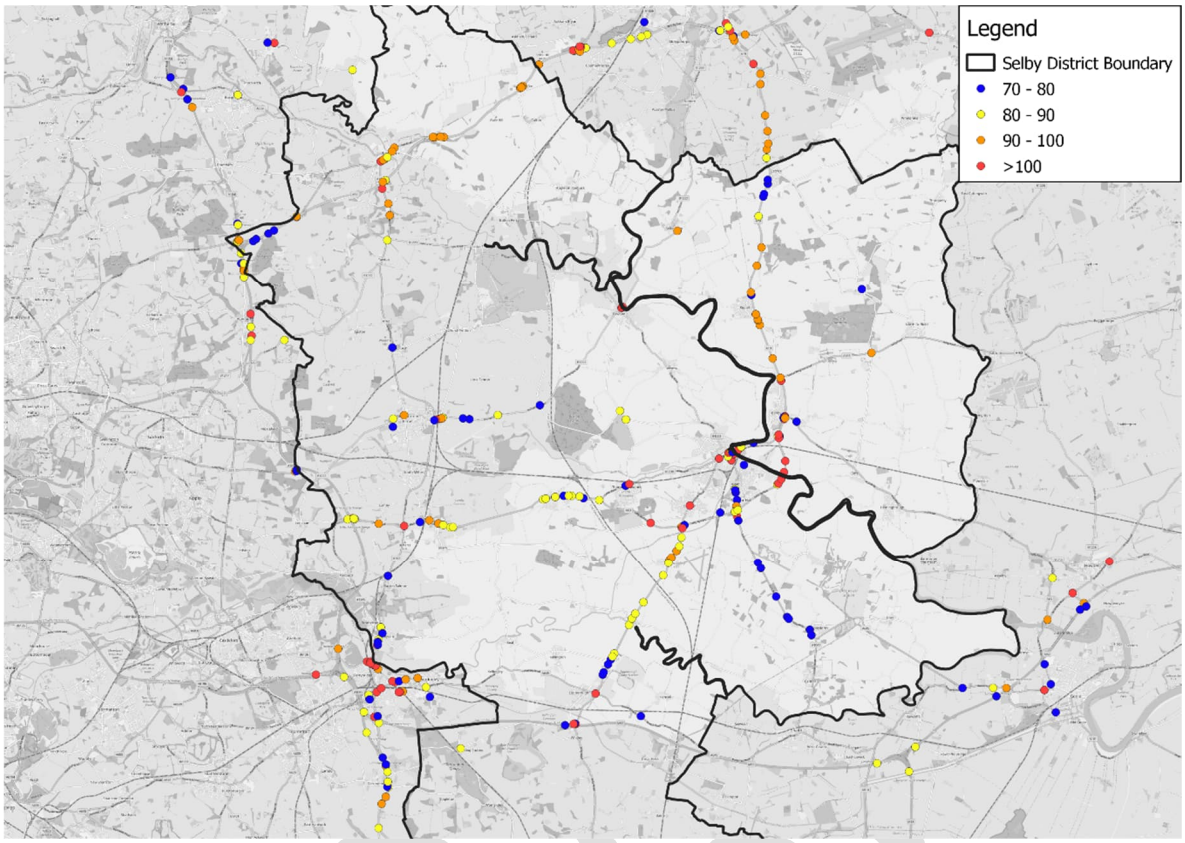


Figure 8-46 - Turn VOC 2040 DS4 (PM)



8.13 SUMMARY (BEING PREPARED)

8.13.1. This section summarises the key outcome of the analysis undertaken in this section for the forecast year model runs.

Highway Network Statistics

8.13.2. The tables below summarise the change in highway assignment network statistics for all forecast model runs by time period

Table 8-26 – Highway assignment network statistics summary, AM peak hour

Simulation Area	Base 2019	2040DM	2040DS1	2040DS2	2040DS3	2040DS4
Transient Queues (pcu-hrs)	1,140	2,122	2,803	2,621	2,641	2,664
Overcapacity Queues (pcu-hrs)	53	544	1,019	818	851	957
Link Cruise Time (pcu-hrs)	12,326	16,489	18,133	17,771	17,872	17,865

Total Travel Time (pcu-hrs)	13,518	19,156	21,955	21,209	21,364	21,486
Travel Distance (pcu-kms)	1,032,129	1,319,250	1,409,791	1,390,267	1,395,950	1,396,005
Average Journey Speed (kph)	76	69	64	66	65	65
Total Assigned Trips (pcus)	125,441	145,259	153,632	151,858	152,142	152,194

Table 8-27 – Highway assignment network statistics summary, IP hour

Simulation Area	2019	2040DM	2040DS1	2040DS2	2040DS3	2040DS4
Transient Queues (pcu-hrs)	699	1,054	1,415	1,305	1,340	1,353
Overcapacity Queues (pcu-hrs)	-	18	142	90	99	133
Link Cruise Time (pcu-hrs)	9,732	12,467	13,696	13,456	13,498	13,533
Total Travel Time (pcu-hrs)	10,431	13,538	15,253	14,852	14,937	15,019
Travel Distance (pcu-kms)	857,791	1,063,815	1,137,852	1,123,675	1,126,099	1,128,109
Average Journey Speed (kph)	82	79	75	76	75	75
Total Assigned Trips (pcus)	97,540	113,024	119,961	118,839	119,056	119,109

Table 8-28 – Highway assignment network statistics summary, PM peak hour

Simulation Area	2019	2040DM	2040DS1	2040DS2	2040DS3	2040DS4
Transient Queues (pcu-hrs)	1,207	2,311	3,124	2,875	2,890	2,958
Overcapacity Queues (pcu-hrs)	5	641	1,467	1,172	1,215	1,283
Link Cruise Time (pcu-hrs)	12,610	16,920	18,551	18,191	18,235	18,304
Total Travel Time (pcu-hrs)	13,822	19,873	23,143	22,238	22,340	22,545
Travel Distance (pcu-kms)	1,048,040	1,342,632	1,431,946	1,412,142	1,414,933	1,418,182
Average Journey Speed (kph)	76	68	62	64	63	63

Total Assigned Trips (pcus)	122,216	141,498	150,317	148,526	148,783	148,908

8.13.3. The above tables show that for all time periods and for the 20199 base, 2040 DM and 2040 DS1 all but one of the indicators are forecast to increase through the modelled year, expected given the increased travel demand (and limited supply interventions).

8.13.4. The exception to this is average speed, which is forecast to decrease through the modelled years, attributed to increased congestion.

8.13.5. The results for 2040 DS2, 2040 DS3 and 2040 DS4 are between the 2040 DM and 2040 DS1 as each of these model runs represents a slight reduction in demand due to associated development assumption changes.

Journey Time Impact

8.13.6. The analysis for journey time impact presented in this section (above) show that for all time periods and for the 2019 base, 2040 DM and 2040 DS1 journey time is predicted to increase through the network indicating higher levels of traffic and associated congestion.

8.13.7. The results for 2040 DS2, 2040 DS3 and 2040 DS4 are between the 2040 DM and 2040 DS1 as each of these model runs represents a slight reduction in demand due to associated development assumption changes.

Volume over capacity - Link

8.13.8. The analysis for link VoC impact presented in this section (above) show that for all time periods and for the 2019 base, 2040 DM and 2040 DS1 journey time is predicted to increase through the network indicating higher levels of traffic and associated congestion.

8.13.9. The results for 2040 DS2, 2040 DS3 and 2040 DS4 are between the 2040 DM and 2040 DS1 as each of these model runs represents a slight reduction in demand due to associated development assumption changes.

Volume over capacity - Junction

8.13.10. VoC is used as an indicator of congestion at a junction. Junctions which experience volumes of traffic approaching their capacity level, typically a VoC of greater than 85% will begin to experience increased delay and are likely to be affected by operational constraints.

8.13.11. Within SATURN, a VoC ratio is calculated for each permitted turn at a junction. The highest VoC value at each junction is used in this analysis. In operational terms, if any movement at a junction is approaching capacity, queues and delays are likely to form.

Table 8-29 – Junction Volume over Capacity summary

	DM 2040			DS1 2040			DS2 2040			DS3 2040			DS4 2040		
	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Number of junctions with VoC 80% to 90%	62	31	86	67	45	85	71	37	85	70	40	94	68	41	84
Number of junctions with VoC 90 to 100%	40	10	52	64	19	72	58	19	69	65	19	62	53	18	74
Number of junctions with VoC > 100%	42	1	38	56	11	66	50	8	62	53	8	63	55	9	60

8.13.12. Table above summarise the change in VoC for the forecast scenarios for all time periods. The results are summarised as follows:

- the number of junctions increases through the forecast years for each category. This is expected given the forecast increase in traffic.
- In the AM and PM peaks the number of junctions over VoC 100% increases when comparing the Do Something with the Do Minimum. This is indicative of increased congestion due to the reduction in highway capacity and route choice.

8.13.13. Similar to the other parameters, the results for 2040 DS2, 2040 DS3 and 2040 DS4 are between the 2040 DM and 2040 DS1 as each of these model runs represents a slight reduction in demand due to associated development assumption changes.

9 SUMMARY AND CONCLUSIONS

9.1 SUMMARY

9.1.1. This report concentrates on the development and results of the 2040 forecast year scenarios for the Selby District Strategic Transport Model suite as specified in the project scope.

9.1.2. The forecast models have been developed in line with TAG guidance and present the core scenario as a basis for analysing the forecast network conditions within Selby District, based on the uncertainty assumptions described in the report.

9.1.3. The forecast models have been developed for the core scenario using the development and supply assumptions in line with TAG M2 guidance.

9.1.4. Forecasts were tested using variable demand modelling to reflect a balancing of supply and demand. These forecasts were developed for 2040 and were agreed with Selby District Council.

9.2 CONCLUSIONS

9.2.1. Model runs have been reviewed and analysed in Chapters 8 and 9 of this report. Examination against key indicators show that the travel patterns and trends in the model outputs are in line with expectations, including:

- In all of the modelled time periods highway travel distance, travel time and queues are forecast to increase through the modelled years as would be expected given the increased travel demand (and limited supply interventions).
- Due to the increased demand and increased congestion average speed is forecast to decrease through the modelled years.
- The number of junctions and links over capacity is forecast to increase when comparing the Do Something with the Do Minimum. This is further indicative of increased congestion due to the reduction in highway capacity and route choice.

9.2.2. The SDSTM suite of models, including highway, demand models as well as the current reported forecast routines have been demonstrated as suitable for the purposes of Strategic Transport Model forecasting within the district.

9.3 NEXT STAGES

9.3.1. This report demonstrates the application of the SDSTM in forecasting mode and can be used to inform other local studies which may be brought forward by Selby District Council or other stakeholders. Similar forecast models can also be developed with different parameters (including forecast years and uncertainty assumptions) utilising the functionality developed within the SDSTM model suite.

9.3.2. The demonstration forecasts described within this report reflect the content of the uncertainty log agreed during January 2022. It is expected that, over time, these assumptions for subsequent applications of the SDSTM will be reviewed, and where necessary updated.

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