North Yorkshire County Council and Selby District Council

SELBY DISTRICT TRAFFIC MODEL

Transport Forecasting Report

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FEBRUARY 2024

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North Yorkshire County Council and Selby District Council

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Transport Forecasting Report

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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. The 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.

1.1.5. This Report is presented to North Yorkshire Council and may not be used or relied on by any other person or by the client in relation to any other matters not covered specifically by the scope of this Report. Notwithstanding anything to the contrary contained in the Report, WSP Limited is obliged to exercise reasonable skill, care and diligence in the performance of the services required by 'North Yorkshire Council' and WSP Limited shall not be liable except to the extent that it has failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.

1.2 BACKGROUND

1.2.1. Selby 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 Council (SDC) covers wards including Selby East, Selby West, Tadcaster, Sherburn in Elmet and Eggborough. Selby district has a population of around 84,000 based on 2011 Census information.

1.2.2. 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.

1.2.3. 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).

1.2.4. As of 2023, a present year validation was undertaken, which considers the update of the highway assignment model element of the SDSTM, which will then be used as the started point for the forecast models.

1.2.5. This Traffic Forecasting Report is part of the deliverable agreed within the in the MSR and is based on the updated 2023 present year validation 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 – Fixed scenario assignment results,
- Chapter 8 – Variable Demand Forecasting,
- 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),
- 2019 Highway Local Model Validation Report (Highway LMVR),
- 2023 Present Year Validation Report (PYV); 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 LMVR, PYV and VDMR document the development, calibration, and validation of the 2019 base year highway assignment model, updated 2023 present year validation 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. The Do-Minimum forecasting forms a precursor to application of the model for any specific scheme, which will form the basis for the Do-Something scenario.

1.4.2. In this context, the 'Do-Minimum' scenario is based on the inclusion of development, which includes schemes/developments that are considered "more than likely" or "near certain", based on local and national scheme uncertainty. The 'Do-Something' scenario includes any other schemes/developments in local plan testing and schemes that are considered 'reasonably foreseeable' or 'hypothetical'.

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, the uncertainty assumptions will likely change as each scheme progresses.

1.4.4. 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

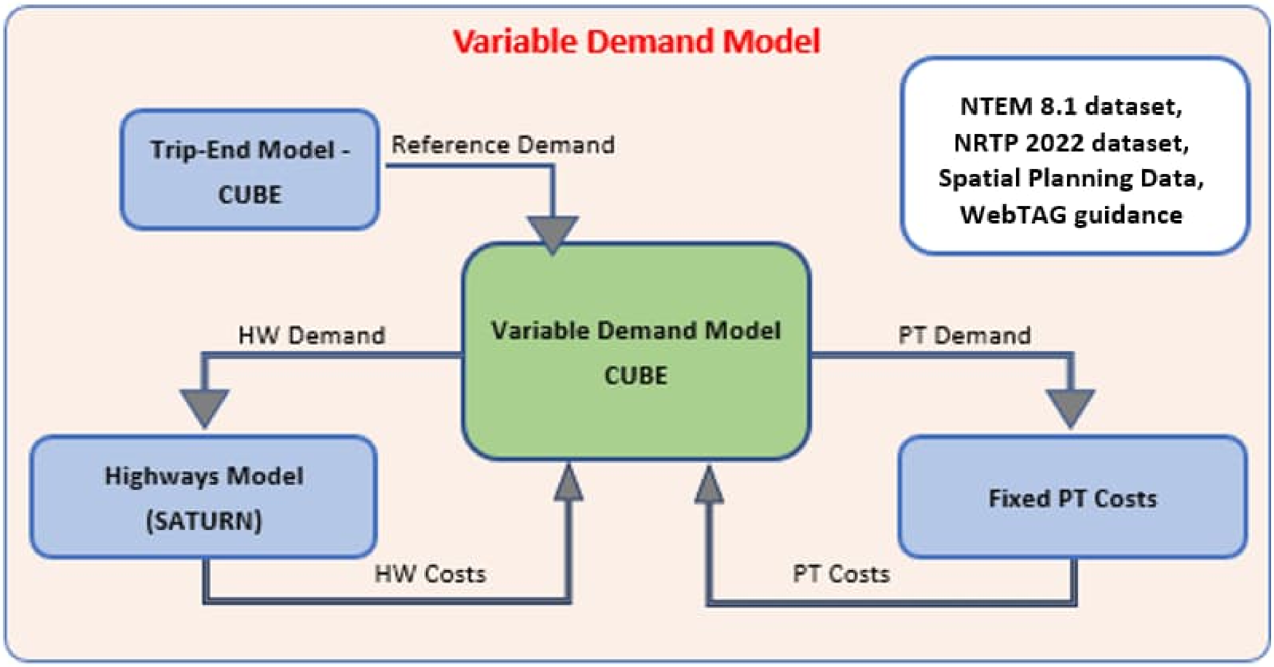
2.1.1. This section of the report provides a brief overview of the calibrated 2019 base year model and its key assumptions and principal features.

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 Do-Minimum and Do-Something forecasts, using the calibrated base year SDSM and SVDM models.

Figure 2-1 – Selby District Transport Model



2.2 SUMMARY OF MODEL AREA

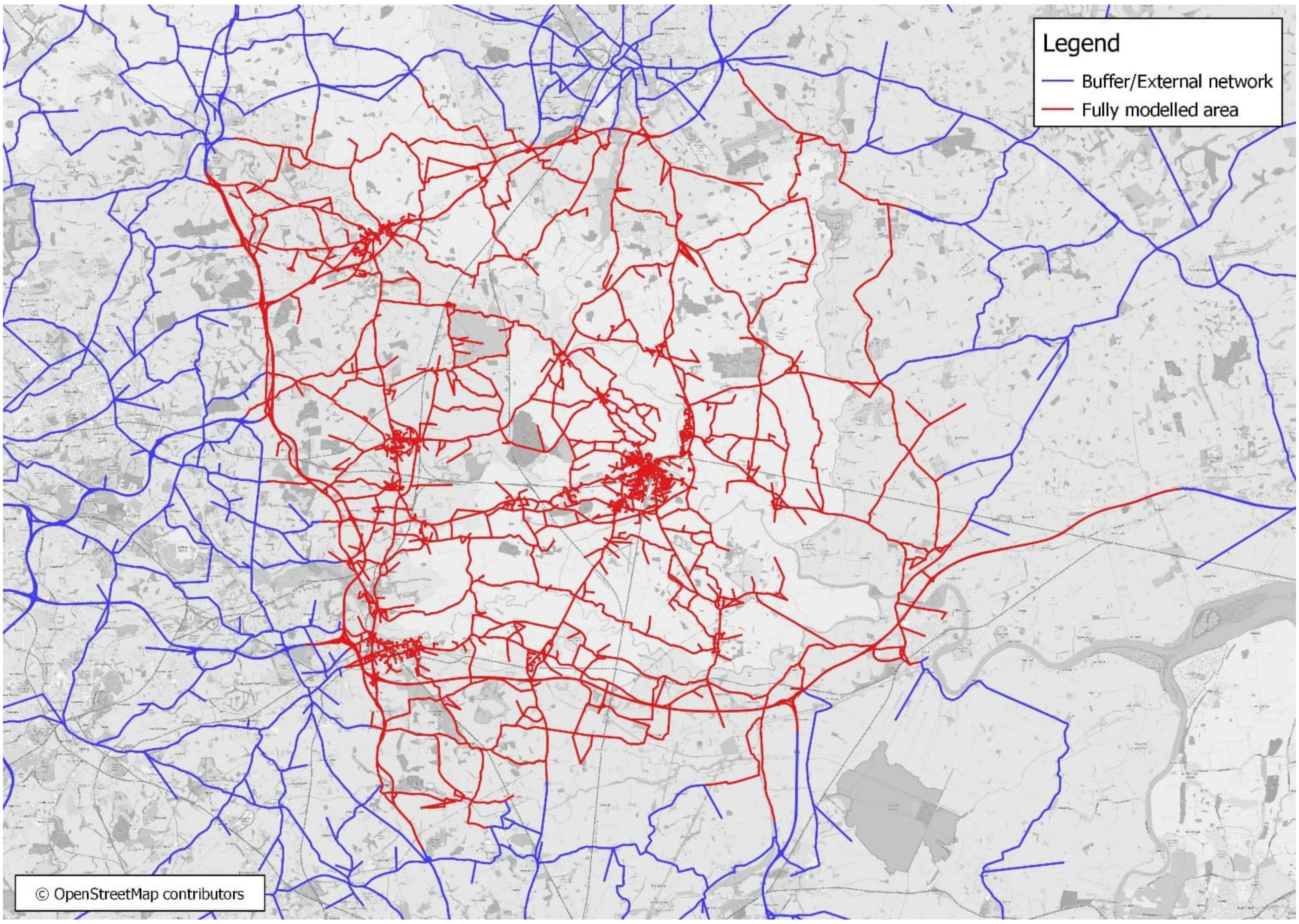
2.2.1. The SDSTM base year model coverage adopts a hierarchical approach to level of detail, in line with TAG. The network coverage and areas of detail, referring to the fully modelled area (FMA), buffer and external area definitions, have been developed as they were defined in the MSR.

- 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.

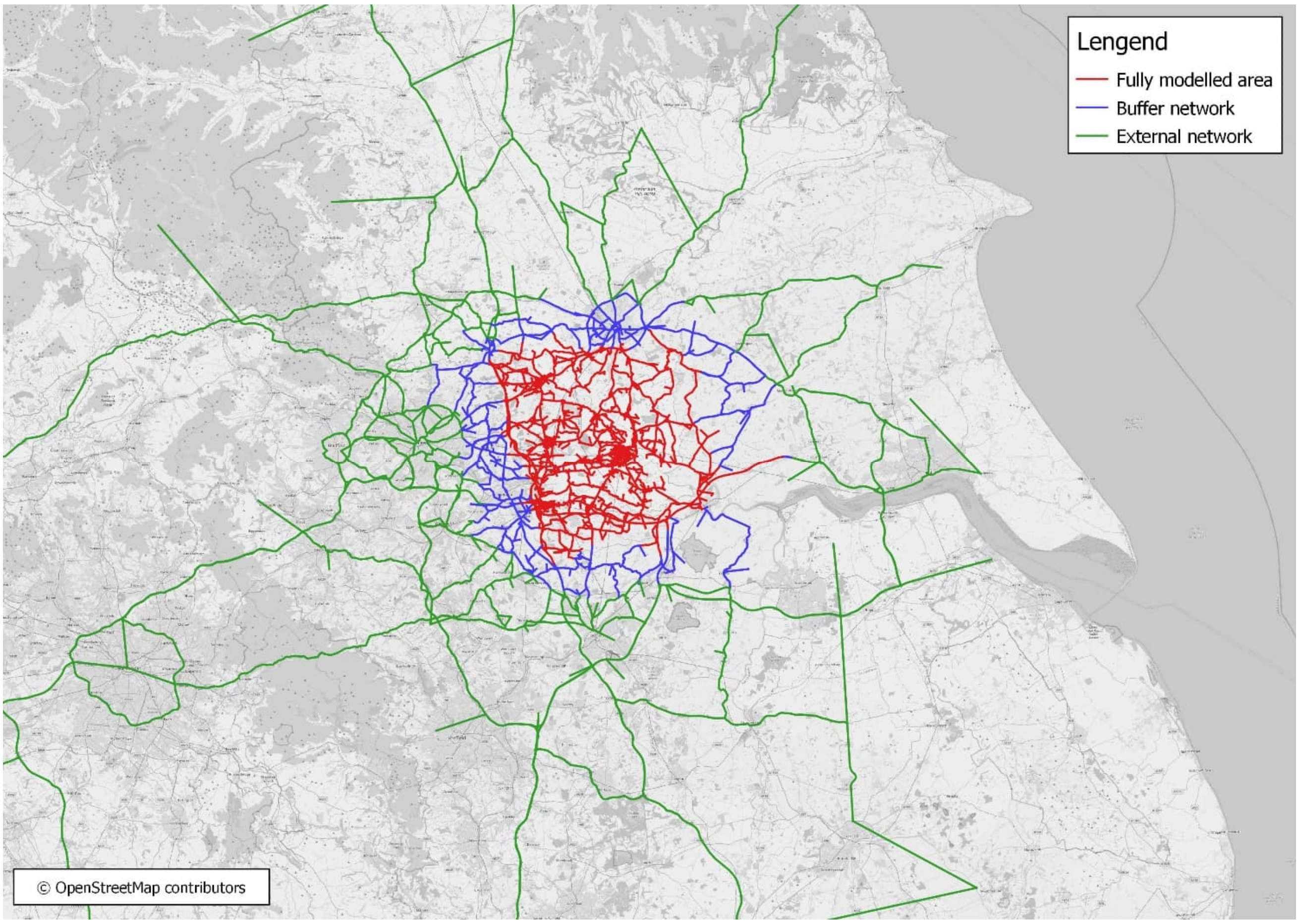
2.2.2. The extent of the FMA is illustrated in Figure 2-2 and covers the whole Selby District area and slightly beyond, including Knottingley and major routes into/across the district, such as the M62, A1(M) and A64.

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 distinct 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 be documented in the Appraisal Specification Report.

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 and Do-Something scenarios.

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.

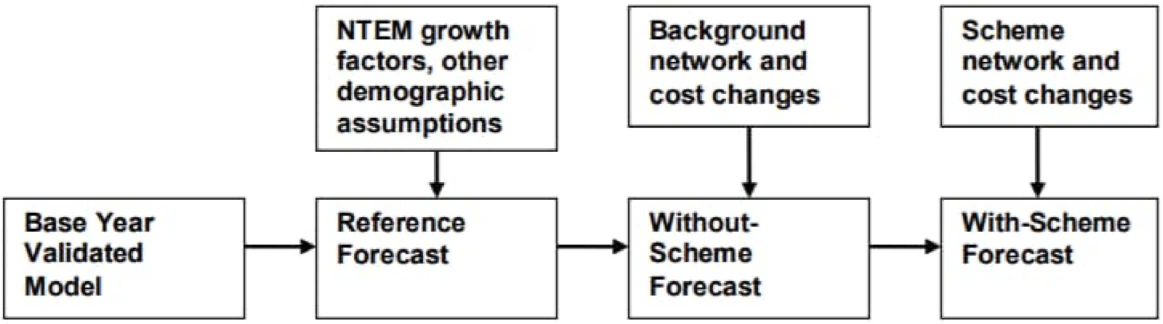
3.2.3. The Reference Case forecasts incorporate changes in travel demand incurred through demographic changes but not changes related to travel costs (including congestion and fares) or other parameters (e.g. value of time). Development of the Reference Case demand is detailed in Chapter 5.

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. The proposal set out in the MSR does not include for these 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

Fixed Scenario

4.3.1. TAG M4 describes the **Fixed 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 Fixed Scenario listed below

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

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 Fixed 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, with developments that were “Near certain” or “More than likely” considered to be explicitly modelled in the 2040 DM scenario and developments that were ‘reasonably foreseeable’ and ‘hypothetical’ modelled in the 2040 DS scenario. This is in line with production of a fixed 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 June 2023 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 4-1.

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

4.5 DEVELOPMENT SITES

4.5.1. As stated in Section 4.4, Selby developments that were "Near certain" or "More than likely" were considered to be explicitly modelled in the 2040 DM scenario and developments that were 'reasonably foreseeable' and 'hypothetical' modelled in the 2040 DS scenario.

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 model the larger more significant developments only explicitly.

4.5.3. For both residential and employment sites, the lower threshold for inclusion was at least 30 two-way trips in any time period. 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 sites taken forward to be explicitly modelled are given in Table 4-2 and Table 4-3. The total number of residential units is 5,180 and the total number of jobs is 18,033.

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

Table 4-2 – Selby District Residential Sites Modelled

Site Ref	Address	TAG Uncertainty	Total Site Capacity	Completed up to 2023	Completion by 2040
2017/0542/ OUTM	Land West of Meadow View	More Than Likely	120	0	120
2015/0452/ EIA	Phases 4A,4B,4C,4D,4E, Staynor Hall Development, Bawtry Road	More Than Likely	215	25	215
2015/0580/ EIA	Phase 3E, 3F, 3G, 3K Staynor Hall, Abbots Road	More Than Likely	212	212	212
2020/0354/ REMM	Hodgsons Lane, Sherburn in Elmet	More Than Likely	150	0	150
AERO-K	Land adjacent to Hillcrest, Colton Lane	Reasonably Foreseeable	28	0	28
AROE-N	Therncroft, Malt Kiln Lane	Reasonably Foreseeable	6	0	6
AROE-I	Land West of Northfield Avenue	Reasonably Foreseeable	36	0	36
BRAY-X	Land north of Mill Lane	Reasonably Foreseeable	188	0	188
CARL-G	Land north of Mill Lane	Reasonably Foreseeable	150	0	150
CLIF-O	Land north of Cliffe Primary School, Main Street	Reasonably Foreseeable	63	0	63
EGGB-B	Land west of White House Farm, Low Eggborough Road	Reasonably Foreseeable	114	0	114
EGGB-Y	Land West of Kellington Lane	Reasonably Foreseeable	1500	0	1085
HAMB-A	Manor Farm, Chapel Street	Reasonably Foreseeable	128	0	128
HAMB-F	Land south of Scalm Lane	Reasonably Foreseeable	103	0	103
HEMB-G	Land to the rear of Plinthstones, School Road	Reasonably Foreseeable	123	0	123
HENS-A	Land to North of Weeland Road	Reasonably Foreseeable	24	0	24
HENS-L	Land north of Wand Lane	Reasonably Foreseeable	54	0	54

Site Ref	Address	TAG Uncertainty	Total Site Capacity	Completed up to 2023	Completion by 2040
HENS-P	Land South of Station Road	Reasonably Foreseeable	22	0	22
OSGB-C	Land East of St Leonards Avenue	Reasonably Foreseeable	20	0	20
OSGB-D	Osgodby Nurseries, Hull Road	Reasonably Foreseeable	25	0	25
OSGB-G	Lake View Farm	Reasonably Foreseeable	21	0	21
OSGB-I	Land east of Sand Lane	Reasonably Foreseeable	72	0	72
SELB-BZ	Land at Cross Hills Lane	Reasonably Foreseeable	1270	0	875
SELB-B	Industrial Chemicals Ltd, Canal View, Bawtry Road	Reasonably Foreseeable	450	0	450
SELB-AG	Rigid Group Ltd, Denison Road	Reasonably Foreseeable	328	0	328
SHER-H	Land adjacent to Prospect Farm, Low Street	Reasonably Foreseeable	380	0	380
TADC-J	Land at Station Road	Reasonably Foreseeable	104	0	104
TADC-I	Land at Mill Lane	Reasonably Foreseeable	180	0	180
THRP-K	Land South of Leeds Road	Reasonably Foreseeable	127	0	127
THRP-V	Land at Swallowvale Leeds Road	Reasonably Foreseeable	14	0	14

Table 4-3 – Selby District Employment Sites Modelled

Site Ref	Address	TAG Uncertainty	Total Site Area (Ha)	Jobs by 2040
2018/0673/OUTM	Leeds East Airport, Busk Lane , Church Fenton, Tadcaster, North Yorkshire, LS24 9SE	Near Certain	27.61	1087
2018/1369/FULM	Sedalcol UK Ltd , Denison Road, Selby, YO8 8EF	Near Certain	15.4	10
2019/0045/EIA	Land between New Road and Wheldrake Lane, Wheldrake Lane, Escrick	More Than Likely	36.4	18
2019/0104/CPE	Land At Acaster Airfield, Back Lane, Acaster Selby, York	More Than Likely	1.8	383

Site Ref	Address	TAG Uncertainty	Total Site Area (Ha)	Jobs by 2040
2019/0244/FUL	Land South of Chapel Lane, South Duffield, Selby, North Yorkshire	More Than Likely	0.88	1
2019/0399/FULM	English Village Salads Brigg Lane	Near Certain	0.73	10
2019/0961/FULM	The Maltings, Long Trods, Selby, YO8 4BG	More Than Likely	0.3	3
2019/1340/FULM	Brocklesby, Unit 1 , Long Lane , Great Heck, Goole , East Yorkshire, DN14 0BT	Near Certain	1.73	0
2019/1343/EIA	Eggborough Power Station, Selby Road, Eggborough, Goole, Selby, East Yorkshire, DN14 0BS	Near Certain	53.5	3895
2019/1355/FULM	Sedalcol UK Ltd , Denison Road, Selby, YO8 8EF	Near Certain	15.4	31
2020/0149/FULM	Sellite Blocks Ltd, Long Lane, Great Heck, Goole, East Yorkshire, DN14 0BT	More Than Likely	2	32
2020/0256/FUL	Land Off Lincoln Way	Near Certain	0.28	0
2020/0315/FUL	Barnsdale Bar, Great North Road, Wentbridge, Pontefract, Wakefield.	More Than Likely	0.85	50
2020/0341/FUL	Former Kellingley Colliery, Turvers Lane , Kellingley, Knottingley, West Yorkshire , WF11 8DT	Near Certain	0.97	0
2020/0659/COU	A19 Caravan Storage Limited, Hazel Old Lane, Hensall, Goole, East Yorkshire, DN14 0QA	Near Certain	0.68	1
2020/0834/S73	Esterform Packaging, Moor Lane Trading Estate, Sherburn in Elmet, Leeds, North Yorkshire, LS25 6ES	Near Certain	0.6	0
2020/1042/FULM	Police Station, Portholme Road, Selby	More Than Likely	0.64	40
2020/1071/COU	Keepers Cottage, Landing Road, Gateforth, Selby, North Yorkshire, YO8 9LG	More Than Likely	1.2	19
2020/1086/FUL	Park Farm, Church Lane, Gateforth	More Than Likely	0.33	1

Site Ref	Address	TAG Uncertainty	Total Site Area (Ha)	Jobs by 2040
2020/1104/COU	Cliffe Country Lodges, Cliffe Common, Cliffe, Selby, North Yorkshire, YO8 6PA	More Than Likely	0.2	3
2020/1193/CPE	Land Off Broad Lane, Appleton Roebuck, York, North Yorkshire	More Than Likely	0.01	1
2021/0088/COU	Old Pasture Park, York Road , Stillingfleet, York	More Than Likely	7.33	5
2021/0135/CPE	Heck Hall Farm, Heck and Pollington Lane, Heck, Goole, East Yorkshire	More Than Likely	2.96	274
2021/0188/COU	Land Off Hirst Road, Carlton, Goole, East Yorkshire	More Than Likely	0.49	41
2021/0372/FULM	Sherburn Rail Freight Terminal, Lennerton Lane, Sherburn in Elmet, North Yorkshire, LS25 6LH	More Than Likely	4.45	185
2021/0400/FULM	Just Paper Tubes, Cliffe Common , Cliffe, Selby , North Yorkshire , YO8 6EF	More Than Likely	0.43	26
2021/0543/FULM	Worsley Court, Doncaster Road, Selby, North Yorkshire, YO8 9BX	More Than Likely	3.56	50
2021/0642/FUL	Gay Lane, Church Fenton, Tadcaster, North Yorkshire	More Than Likely	0.84	70
2021/0703/FUL	Gateforth Grange, West Lane, Burn, Selby, North Yorkshire, YO8 8LR	More Than Likely	0.22	3
2021/0785/FUL	Field Lane Sports Centre, Field Lane, Thorpe Willoughby, Selby, North Yorkshire	More Than Likely	4	2
2021/0927/COU	Land To Rear the Close, Towton, Tadcaster, North Yorkshire	More Than Likely	1.65	138
2021/1197/COU	Heck Hall Farm, Heck and Pollington Lane, Heck, Goole, East Yorkshire	More Than Likely	2.96	0
2021/1288/MAN2	Former Kellingley Colliery, Turvers Lane , Kellingley, Knottingley, West Yorkshire , WF11 8DT	More Than Likely	57	2787

Site Ref	Address	TAG Uncertainty	Total Site Area (Ha)	Jobs by 2040
2021/1464/FUL	St Gobain Glass UK Ltd , Glassworks, Weeland Road , Eggborough , Goole, East Yorkshire, DN14 0FD	More Than Likely	33.3	17
2022/0189/FUL	Selby Hydroponics, West Bank , Carlton , Goole, East Yorkshire , DN14 9PZ	More Than Likely	0.17	0
2022/0290/FULM	St Gobain Glass UK Ltd , Glassworks, Weeland Road , Eggborough , Goole, East Yorkshire, DN14 0FD	More Than Likely	33.3	194
2022/0358/FULM	P3P Energy Management, Brigg Lane, Camblesforth, Selby, North Yorkshire, YO8 8HD	More Than Likely	13.6	54
2022/0808/COU	Dovecote Lodge, Hull Road, Cliffe	More Than Likely	0.75	1
2022/0840/REM	Land At Former Airfield, Lennerton Lane, Sherburn in Elmet	More Than Likely	35	1823
2022/1011/FUL	Merlin House, Aviation Road, Sherburn in Elmet, North Yorkshire, LS25 6NB	More Than Likely	0.41	5
	East Common Lane HGV Park	Reasonably Foreseeable	0.53	56
SELB-CA	Olympia Park, Barlby Road	Reasonably Foreseeable	33.6	2335
SHER-AA	Gascoigne Wood Interchange (former Gascoigne Wood mine site)	Reasonably Foreseeable	57.35	4340
	Land at Cross Hill Lane	Reasonably Foreseeable		40

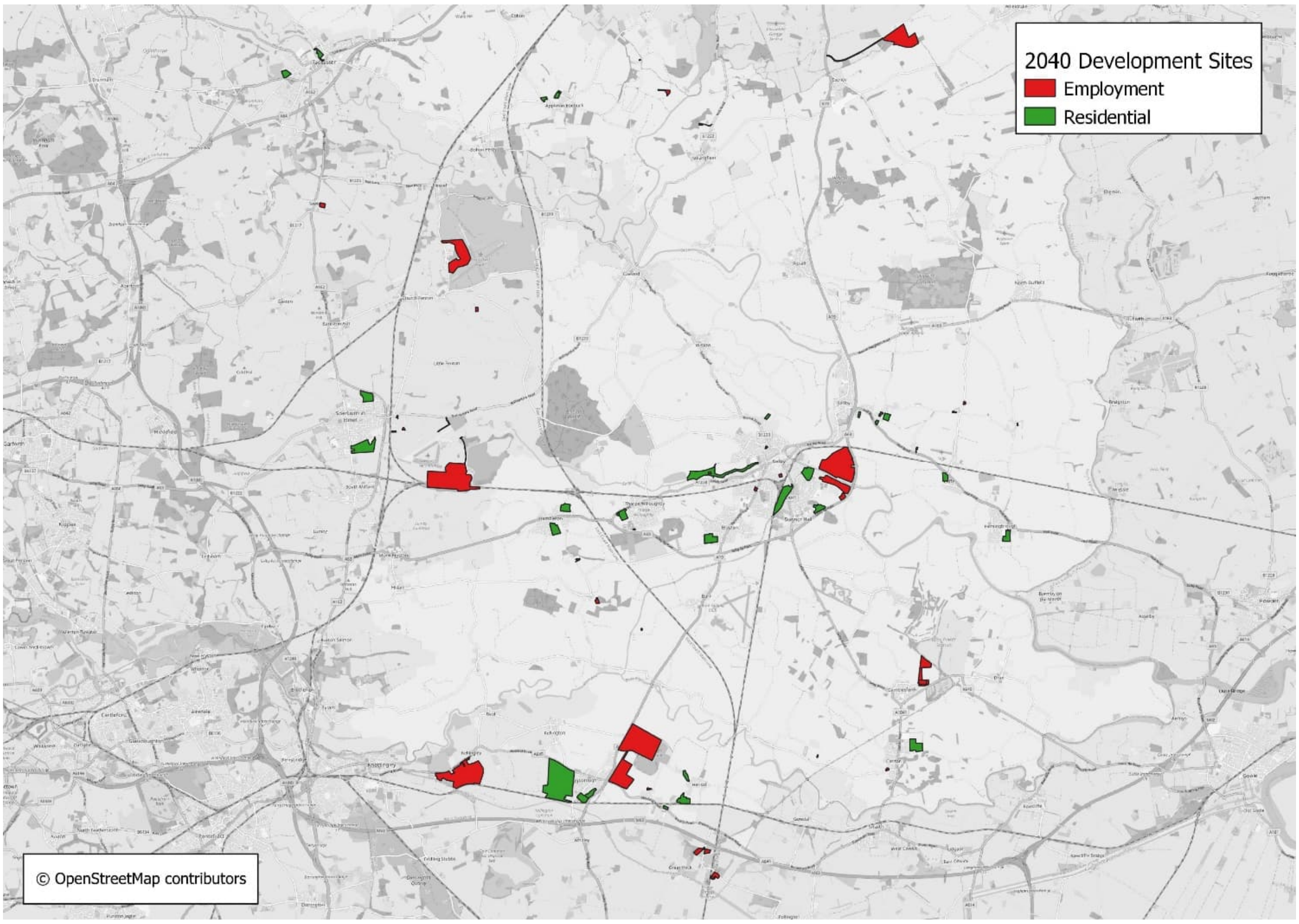
4.5.7. Where there was no access to a transport assessment, the estimated number of jobs given in Table 4-3 is calculated using data given in the Employment Densities Guide 3rd edition, 2015, which is summarised in Table 4-4.

Table 4-4 – 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	95
A1 Retail	18
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
Suis Generis	618

4.5.8. The figure below shows the location of the residential and employment developments considered in the 2040 DM and DS.

Figure 4-1 – Locations of Selby District Residential and Employment Development



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 fixed 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 the table below.

Table 4-5 – 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 place and movement within the town centre	Not committed	Excluded from 2040 DM
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	Excluded from 2040 DM
A162/B1222	Improvements to roundabout capacity		Included in base as advised by SDC
M1 J47 Upgrade	Extra lane on M1 northbound off slip at J47		Not included as specification not available at the time of forecasting
TransPennine 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:

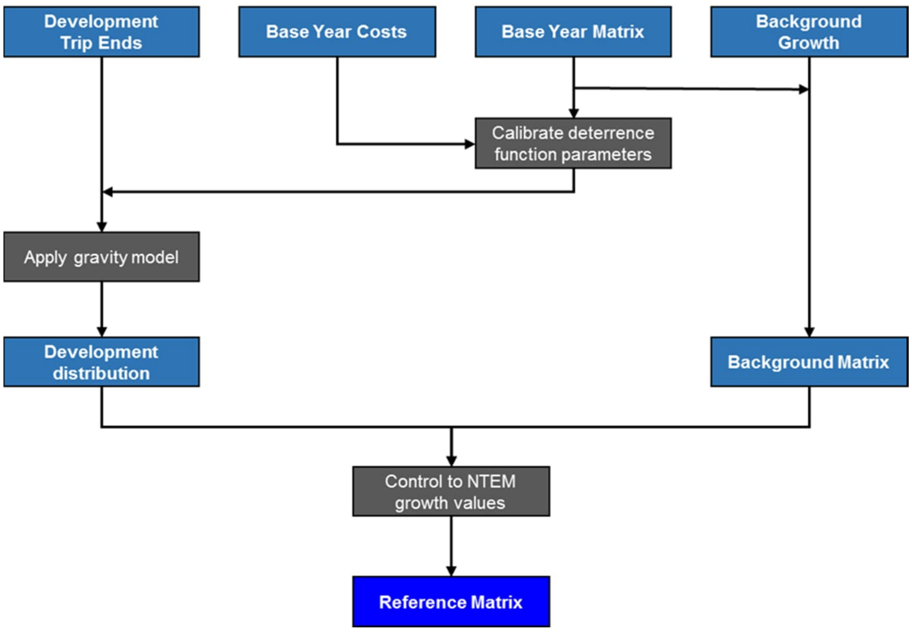
- Background growth,
- Development trip generation; and
- Development trip distribution.

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.

Figure 5-1 – Reference Demand Methodology



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 parameters required to distribute the development trips as per base year demand patterns. 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.

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 8.1 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 varies between 4-9% across time periods in 2040.
- Bus passenger demand decreases roughly 3-9% across the time periods, with it decreasing as low as 9% in the PM.
- Rail passenger demand is broadly flat across the time periods.

Table 5-1 – Summary of NTEM Growth Factors (2023-2040)

Year	Mode	AM Peak		Inter Peak		PM Peak	
		O	D	O	D	O	D
2040	Car	1.0865	1.0379	1.0670	1.0733	1.0555	1.0854
	Bus	0.9690	0.9145	0.9385	0.9506	0.9058	0.9558
	Rail	1.0338	0.9760	1.0039	1.0005	0.9815	1.0353

National Transport Model

5.2.8. Background LGV and HGV forecast growth was derived from the National Road Traffic Projections (NRTP) 2022 which are produced by the DfT from the National Transport Model (NTM).

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	1.1775	1.0803

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 Table 5-3, Table 5-4 and Table 5-5.

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
Town Centre 0-400	avg trip rate per unit	0.127	0.266	0.017	0.015	0.002	0.001
Out of Town 0-400	avg trip rate per unit	0.117	0.325	0.016	0.019	0.002	0.001
Out of Town 400-800	avg trip rate per unit	0.145	0.388	0.019	0.022	0.002	0.002
Out of Town 800+	avg trip rate per unit	0.131	0.316	0.017	0.018	0.002	0.001
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
Town Centre 0-400	avg trip rate per unit	0.104	0.120	0.014	0.017	0.001	0.002
Out of Town 0-400	avg trip rate per unit	0.138	0.135	0.019	0.019	0.001	0.002
Out of Town 400-800	avg trip rate per unit	0.134	0.129	0.018	0.018	0.001	0.002
Out of Town 800+	avg trip rate per unit	0.101	0.107	0.014	0.015	0.001	0.001
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
Town Centre 0-400	avg trip rate per unit	0.206	0.165	0.016	0.014	0.001	0.001
Out of Town 0-400	avg trip rate per unit	0.297	0.143	0.023	0.012	0.001	0.001
Out of Town 400-800	avg trip rate per unit	0.328	0.158	0.025	0.014	0.001	0.001
Out of Town 800+	avg trip rate per unit	0.293	0.137	0.023	0.012	0.001	0.001
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 residential build out profile by year was included in the data provided by SDC. Based on that information all but two explicitly modelled development is assumed to be fully built out by 2040. The employment sites are all assumed to be completed by 2040.

5.3.5. The assumed build out rate resulted in:

- 5,180 residential units and 18,033 jobs in 2040.

5.3.6. 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	57	129	8	7	1	1	65	137
Employment	2328	739	261	223	154	138	2743	1100
Total	2386	868	268	231	155	138	2809	1237

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	52	57	7	8	1	1	60	66
Employment	1368	1424	306	310	182	165	1856	1898
Total	1420	1481	313	318	183	166	1915	1964

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	106	73	8	6	0	0	114	80
Employment	1283	2454	158	215	75	76	1516	2745
Total	1389	2527	166	221	76	77	1631	2825

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

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

	AM (08:00-09:00)							
	Car		LGV		OGV		Total	
Land Use	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep
Residential	591	1448	78	83	8	6	677	1538
Employment	914	222	65	48	59	67	1037	337
Total	1505	1670	143	131	67	73	1715	1874

Table 5-10 – 2040 DS 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	539	564	73	80	6	8	618	652
Employment	521	551	75	80	56	47	652	677
Total	1060	1115	148	160	61	54	1270	1329

Table 5-11 – 2040 DS 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	1288	689	99	60	3	4	1391	752
Employment	238	910	30	41	40	31	308	982
Total	1526	1599	129	101	43	34	1699	1734

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 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.

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

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*

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 as 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.

6.2.5. There were no additional schemes in the Do Something scenario, so is the same as the Do Minimum network.

6.3 FUTURE YEAR SPEED FORECASTING

6.3.1. Outside of the highway model simulation area, the buffer area (see Figure 2-3) is coded with speed flow curves and so the speed/flow relationship, in respect to 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 2040 to be applied to all external area links using data from the Road Traffic Forecasts (2018 – Reference scenario)[2] which are produced by the DfT from the National Transport Model (NTM).

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

6.3.3. The factor was based on the average change for weekday 12-hour speeds on motorways and A roads between 2018 and the forecast year, with an outturn value of:

- 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). Although the latest TAG Databook as of writing this report was issued at the end of November 2023, it was decided to use TAG Databook Nov 2021, which is consistent with the version used for the generalised costs in the base year models. These are listed in Table 6-1.

Table 6-1 – Highway Assignment Generalised Cost Parameters (2023-2040)

Year	User Class	AM Peak		Inter Peak		PM Peak	
		PPM	PPK	PPM	PPK	PPM	PPK
2023	Car Business	31.68	12.27	32.47	12.27	32.14	12.27
	Car Commuting	21.25	5.74	21.56	5.74	21.32	5.74
	Car Other	14.66	5.74	15.62	5.74	15.35	5.74
	LGV	22.96	13.28	22.96	13.28	22.96	13.28
	HGV	52.59	43.30	52.59	43.67	52.59	45.37
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 FIXED SCENARIO ASSIGNMENT RESULTS

7.1 INTRODUCTION

7.1.1. This chapter details the outputs from the fixed forecast assignments for the 2040 model runs 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, Do Minimum and Do Something scenarios for the forecast year with respect to metrics including distance, time, and travel speed.

7.1.2. 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.

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

- 2040 DM
- 2040 DS

7.2 DEFINITION OF VARIOUS PARAMETERS USED FOR REPORTING

7.2.1. This section summarises the definition of various parameters outlined in section 7.1.1 and 7.1.2 used for reporting in the subsequent sections of this chapter for reference.

Highway Model Assignment Convergence

7.2.2. 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.

7.2.3. 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.

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

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

Highway Network Statistics

7.2.6. 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.

7.2.7. 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.

7.3 RESULTS FOR 2040DM

7.3.1. This section summarises the results for 2040 DM model run for the parameter outlined in section 7.1.2

7.3.2. The convergence results are summarised in the Table 7-1. The fixed scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 7-1 – Fixed Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (d) / (Gap (%)	% Flow	% Delays
2040 DM	AM	16	0.0052	99.1	99.9
		17	0.0049	99.1	99.9
		18	0.0044	99.2	99.9
		19	0.0038	99.2	99.9
	IP	20	0.00011	99.8	100
		21	0.00012	99.2	100
		22	0.00025	99.3	100
		23	0.00029	99.2	100
	PM	17	0.0064	99.4	99.9
		18	0.0060	99.6	99.9
		19	0.0061	99.5	99.9

		20	0.0056	99.3	99.9

Highway Network Statistics

7.3.3. A comparison of the network statistics between the model base year and modelled forecast years is provided in Table 7-2 to Table 7-4 respectively by time period.

7.3.4. 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 7-2 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2023	2040DM	% Change 2023-40
Transient Queues (pcu-hrs)	1031.7	1491.7	44.6%
Overcapacity Queues (pcu-hrs)	13.9	132.1	853.0%
Link Cruise Time (pcu-hrs)	11382.2	14462.3	27.1%
Total Travel Time (pcu-hrs)	12427.7	16086.1	29.4%
Travel Distance (pcu-kms)	961218.0	1162271.6	20.9%
Average Journey Speed (kph)	77.3	72.3	-6.5%
Total Assigned Trips (pcus)	146205.7	182656.1	24.9%

Table 7-3 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2023	2040DM	% Change 2023-40
Transient Queues (pcu-hrs)	710.8	872.0	22.7%
Overcapacity Queues (pcu-hrs)	0.0	0.0	0.0%
Link Cruise Time (pcu-hrs)	9803.3	11275.6	15.0%
Total Travel Time (pcu-hrs)	10514.1	12147.6	15.5%
Travel Distance (pcu-kms)	864423.0	972250.8	12.5%
Average Journey Speed (kph)	82.2	80.0	-2.7%
Total Assigned Trips (pcus)	126180.6	140984.7	11.7%

Table 7-4 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2019	2040DM	% Change 2019-40
Transient Queues (pcu-hrs)	1057.2	1755.7	66.1%
Overcapacity Queues (pcu-hrs)	0.8	205.0	26971.2%

Link Cruise Time (pcu-hrs)	11195.9	14935.0	33.4%
Total Travel Time (pcu-hrs)	12253.8	16895.6	37.9%
Travel Distance (pcu-kms)	940611.0	1199966.3	27.6%
Average Journey Speed (kph)	76.8	71	-7.5%
Total Assigned Trips (pcus)	137619.7	175886.8	27.8%

7.4 RESULTS FOR 2040DS

7.4.1. This section summarises the results for 2040 DS model run for the parameter outlined in section 7.1.2

7.4.2. The convergence results are summarised in the Table 7-5. The fixed scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 7-5 – Fixed Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (d) / (Gap (%)	% Flow	% Delays
2040 DS	AM	26	0.0037	98.6	99.8
		27	0.0030	99.2	99.8
		28	0.0023	99.5	99.8
		29	0.0026	99.7	99.9
	IP	25	0.00030	99.2	100
		26	0.00012	99.8	100
		27	0.00013	99.2	100
		28	0.00014	99.6	100
	PM	35	0.0065	99.4	99.3
		36	0.0064	99.6	99.6
		37	0.0057	99.8	99.5
		38	0.0051	99.8	99.5

Highway Network Statistics

7.4.64. A comparison of the network statistics between the DM and DS scenarios is provided in Table 7-6 to Table 7-8 respectively by time period.

7.4.65. 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 7-6 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2040DM	2040DS	% Change DM-DS
Transient Queues (pcu-hrs)	1491.7	1794.0	20.3%
Overcapacity Queues (pcu-hrs)	132.1	217.9	65.0%
Link Cruise Time (pcu-hrs)	14462.3	15268.9	5.6%
Total Travel Time (pcu-hrs)	16086.1	17280.7	7.4%
Travel Distance (pcu-kms)	1162271.6	1207869.8	3.9%
Average Journey Speed (kph)	72.3	69.9	-3.3%
Total Assigned Trips (pcus)	182656.1	186470.1	2.1%

Table 7-7 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2040DM	2040DS	% Change DM-DS
Transient Queues (pcu-hrs)	872.0	998.1	14.5%
Overcapacity Queues (pcu-hrs)	0.0	8.5	
Link Cruise Time (pcu-hrs)	11275.6	11780.2	4.5%
Total Travel Time (pcu-hrs)	12147.6	12786.9	5.3%
Travel Distance (pcu-kms)	972250.8	1002718.2	3.1%
Average Journey Speed (kph)	80.0	78.4	-2.0%
Total Assigned Trips (pcus)	140984.7	143769.7	2.0%

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

Simulation Area	PM Peak		
	2040DM	2040DS	% Change DM-DS
Transient Queues (pcu-hrs)	1755.7	2057.0	17.2%
Overcapacity Queues (pcu-hrs)	205.0	629.1	206.9%
Link Cruise Time (pcu-hrs)	14935.0	15633.2	4.7%
Total Travel Time (pcu-hrs)	16895.6	18319.2	8.4%
Travel Distance (pcu-kms)	1199966.3	1239554.9	3.3%
Average Journey Speed (kph)	71.0	68	-4.6%
Total Assigned Trips (pcus)	175886.8	179444.5	2.0%

8 VARIABLE DEMAND FORECASTING

8.1 INTRODUCTION

8.1.1. 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.

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

8.2 VARIABLE DEMAND MODEL METHODOLOGY

8.2.1. 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.

8.2.2. 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:

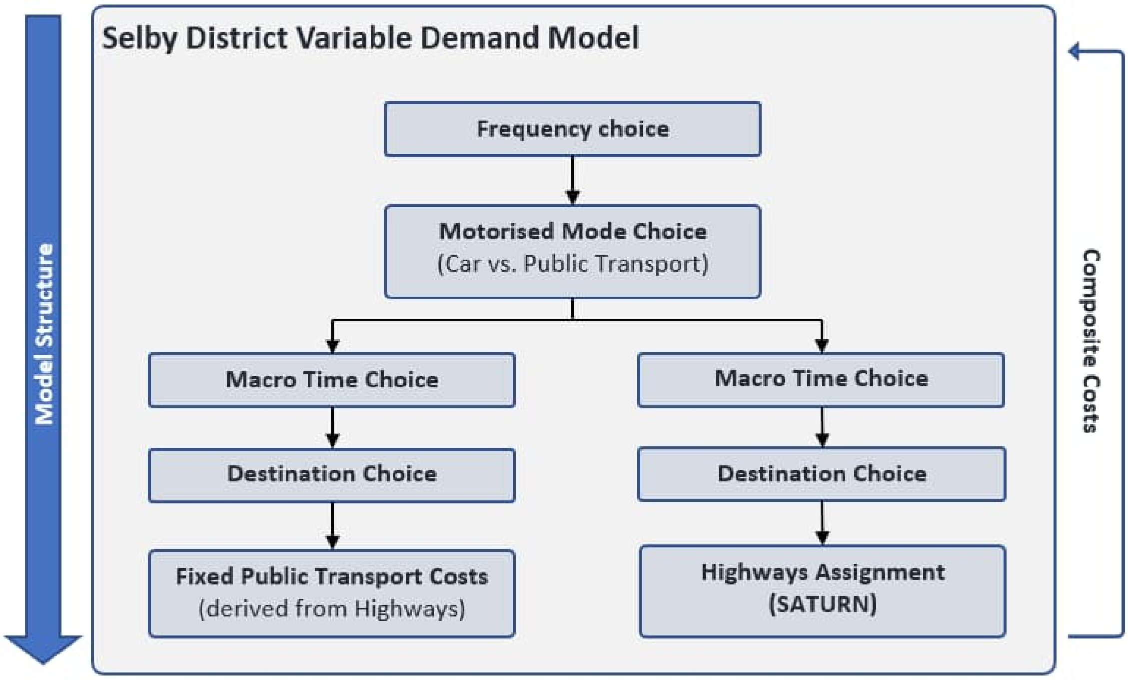
- Mode choice (between highway and public transport),
- Time of day choice (macro and/or micro time choice),
- Destination choice (a change of origin and/or destination); and
- Route choice.

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

8.2.4. The modelled choice responses and hierarchy are illustrated in Figure 8-1.

- 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.

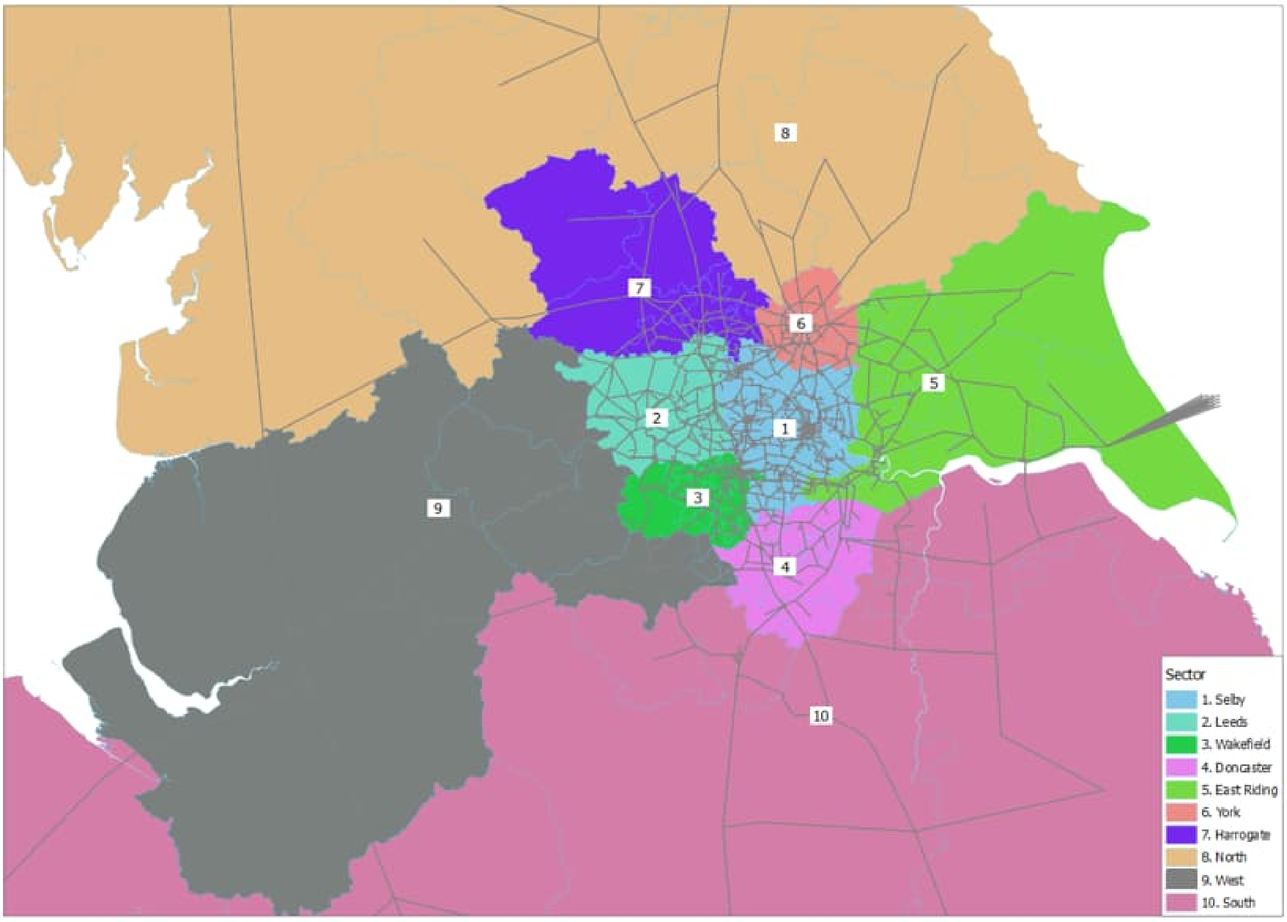
Figure 8-1 – SVDM Structure and Hierarchy



8.2.5. As mentioned in the previous chapter, the Selby District Transport Model's detailed modelling area consists all of Selby district and at least some parts of the 3 LADs: Wakefield, Leeds, East Riding and York.

8.2.6. For the purpose of the Selby District VDM, LADs 1-7 representing Selby, Leeds, Wakefield, Doncaster, East Riding, York, and Harrogate were included as 'Internal' areas and the rest of the model zone system were considered 'External' areas, as highlighted in Figure 8-2 below.

Figure 8-2 Internal / External Area for Selby District VDM



8.2.7. For the purpose of the Selby District VDM, trips that are within the Internal-Internal, Internal-External, and External-Internal movements have been included for the calculation of the choice-demand response whereas External-External demand were treated as fixed demand and not subject to the Selby District VDM.

8.2.8. 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.

8.2.9. 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.

8.2.10. 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'.

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

8.3 VARIABLE DEMAND MODEL CONVERGENCE

8.3.1. 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.

8.3.2. 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."*

8.3.3. Section 6.6 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.

8.3.4. The conference statistics are set out in Table 8-1. It can be seen that the VDM models converged quickly within 3 demand/supply loops and the convergence gap calculated from the realism tests were well within the TAG M2 recommended criterion of 0.1%.

Table 8-1 – Variable Demand Model Convergence

Year	Number of Loops	Total GAP%
2040 DM	3	0.05698
2040 DS	3	0.08615

8.4 VARIABLE DEMAND FORECAST MATRIX TOTALS

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

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

- Small increase 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.

Table 8-2 – Fixed Demand 2040 DM (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	DM Fixed	39,265	1,491	174,086	13,865	306,280	18,322	519,630	33,678	553,308
	DM VDM	39,359	1,316	173,862	12,152	307,778	15,417	520,999	28,886	549,884
IP	DM Fixed	58,754	2,098	117,967	4,910	805,230	42,509	981,950	49,517	1,031,467
	DM VDM	59,318	1,778	119,310	4,352	813,132	35,877	991,760	42,008	1,033,767
PM	DM Fixed	31,340	1,503	171,291	10,538	367,404	15,047	570,035	27,088	597,124
	DM VDM	31,109	1,326	171,919	9,403	367,875	12,639	570,903	23,369	594,272
OP	DM Fixed	33,448	1,206	141,741	7,053	354,767	19,239	529,956	27,498	557,454
	DM VDM	33,857	1,041	144,291	6,160	360,085	15,995	538,233	23,196	561,429
Total	DM Fixed	162,807	6,298	605,083	36,366	1,833,681	95,117	2,601,572	137,781	2,739,352
	DM VDM	163,643	5,462	609,382	32,067	1,848,870	79,929	2,621,894	117,458	2,739,352
Changes: VDM – Fixed										
AM	VDM - Fixed	0.2%	-11.7%	-0.1%	-12.4%	0.5%	-15.9%	0.3%	-14.2%	-0.6%
IP	VDM - Fixed	1.0%	-15.2%	1.1%	-11.4%	1.0%	-15.6%	1.0%	-15.2%	0.2%
PM	VDM - Fixed	-0.7%	-11.8%	0.4%	-10.8%	0.1%	-16.0%	0.2%	-13.7%	-0.5%
OP	VDM - Fixed	1.2%	-13.7%	1.8%	-12.7%	1.5%	-16.9%	1.6%	-15.6%	0.7%
Total	VDM - Fixed	0.5%	-13.3%	0.7%	-11.8%	0.8%	-16.0%	0.8%	-14.7%	0.0%

Table 8-3 – Reference Demand 2040 DS (Person Trips)

Time Period	Matrix	Business		Commute		Other		Total		
		Car	PT	Car	PT	Car	PT	Car	PT	Car + PT
AM	DS Fixed	39,900	1,491	177,838	13,865	314,375	18,322	532,112	33,678	565,790
	DS VDM	39,959	1,315	177,509	12,155	315,701	15,421	533,169	28,891	562,060
IP	DS Fixed	59,729	2,098	119,720	4,910	824,711	42,509	1,004,160	49,517	1,053,677
	DS VDM	60,337	1,779	121,188	4,356	833,013	35,912	1,014,538	42,047	1,056,585
PM	DS Fixed	31,908	1,503	174,284	10,538	376,642	15,047	582,835	27,088	609,923
	DS VDM	31,652	1,326	174,844	9,410	376,819	12,648	583,316	23,384	606,700
OP	DS Fixed	34,008	1,206	146,603	7,053	363,565	19,239	544,176	27,498	571,673
	DS VDM	34,434	1,041	149,186	6,161	368,889	16,006	552,509	23,208	575,718
Total	DS Fixed	165,544	6,298	618,445	36,366	1,879,293	95,117	2,663,282	137,781	2,801,063
	DS VDM	166,382	5,460	622,728	32,082	1,894,422	79,988	2,683,532	117,531	2,801,063
Changes: VDM – Fixed										
AM	VDM - Fixed	0.1%	-11.8%	-0.2%	-12.3%	0.4%	-15.8%	0.2%	-14.2%	-0.7%
IP	VDM - Fixed	1.0%	-15.2%	1.2%	-11.3%	1.0%	-15.5%	1.0%	-15.1%	0.3%
PM	VDM - Fixed	-0.8%	-11.8%	0.3%	-10.7%	0.0%	-15.9%	0.1%	-13.7%	-0.5%
OP	VDM - Fixed	1.3%	-13.7%	1.8%	-12.6%	1.5%	-16.8%	1.5%	-15.6%	0.7%
Total	VDM - Fixed	0.5%	-13.3%	0.7%	-11.8%	0.8%	-15.9%	0.8%	-14.7%	0.0%

8.5 IMPACTS OF VARIABLE DEMAND MODELLING

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

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

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

Trip Length Distribution

8.5.3. The car trip length distribution for the loop 1 (fixed demand) assignments and post-variable demand modelling assignments are compared in Table 8-4 and Table 8-5. 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 6.4,
- 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 8-4 – Impacts of VDM on Car Average Trip Length- 2040 DM

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040DM	AM	Business	47.47	50.29	5.9%
		Commute	18.56	19.12	3.0%
		Other	11.41	12.39	8.5%
	IP	Business	44.42	47.29	6.5%
		Commute	17.74	18.57	4.7%
		Other	13.76	15.11	9.8%
	PM	Business	45.13	46.98	4.1%
		Commute	21.16	21.88	3.4%
		Other	14.79	16.06	8.6%

Table 8-5 – Impacts of VDM on Car Average Trip Length- 2040 DS

Year	Time Period	User Class	Pre-VDM (km)	Post-VDM (km)	Change
2040DS	AM	Business	46.99	49.83	6.1%
		Commute	18.52	19.06	2.9%
		Other	11.30	12.25	8.4%

	IP	Business	43.85	46.69	6.5%
		Commute	17.66	18.48	4.6%
		Other	13.56	14.88	9.7%
	PM	Business	44.57	46.44	4.2%
		Commute	21.05	21.73	3.2%
		Other	14.57	15.83	8.6%

8.5.4. The changes in car sector trip ends from variable demand modelling are illustrated in tables below. The sectors are illustrated in Figure 8-2 (in section 8.2.5 of this report). The tables 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 of a reduction in demand to the central sectors in Selby and adjacent sectors and increases for external sectors. This is attributed to the level of congestion and delay around Selby District 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.

Table 8-6 – 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	5518	5532	0.3%	29983	29760	-0.7%	49466	49473	0.0%
2	5193	5216	0.5%	25846	25984	0.5%	39681	40157	1.2%
3	4196	4192	-0.1%	23742	23664	-0.3%	36643	36754	0.3%
4	2254	2266	0.5%	11591	11635	0.4%	23375	23594	0.9%
5	4706	4709	0.1%	19540	19398	-0.7%	32081	32198	0.4%
6	3702	3723	0.6%	17718	17797	0.4%	29645	29777	0.4%
7	1937	1937	0.0%	7651	7609	-0.5%	11814	11845	0.3%
8	1792	1803	0.7%	3997	3982	-0.4%	4687	4839	3.3%
9	1600	1602	0.1%	3794	3770	-0.6%	5190	5284	1.8%
10	1705	1714	0.6%	2542	2580	1.5%	4626	4785	3.4%

Table 8-7 – 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	6184	5975	-3.4%	31734	31580	-0.5%	57684	57496	-0.3%
2	5277	5246	-0.6%	28268	28315	0.2%	40220	40537	0.8%
3	4011	3952	-1.4%	22474	22426	-0.2%	34616	34700	0.2%
4	1976	1971	-0.3%	10136	10153	0.2%	22084	22146	0.3%
5	4086	4069	-0.4%	16308	16225	-0.5%	29725	29760	0.1%
6	4130	4028	-2.5%	23339	23359	0.1%	31139	31202	0.2%
7	1916	1944	1.5%	8051	8032	-0.2%	11234	11325	0.8%
8	1808	2004	10.8%	2392	2389	-0.1%	3602	4024	11.7%
9	1456	1554	6.8%	2497	2501	0.1%	3788	4026	6.3%
10	1758	1953	11.1%	1205	1200	-0.3%	3115	3491	12.1%

Table 8-8 – 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	7549	7539	-0.1%	18601	18648	0.2%	113441	112625	-0.7%
2	7467	7560	1.3%	16749	17058	1.8%	103751	105289	1.5%
3	6218	6274	0.9%	16298	16571	1.7%	93970	94952	1.0%
4	3227	3256	0.9%	7899	8011	1.4%	59576	60154	1.0%
5	7061	7136	1.1%	12827	13034	1.6%	88854	89578	0.8%
6	6519	6607	1.3%	14654	14874	1.5%	87204	87978	0.9%
7	2661	2684	0.9%	4633	4683	1.1%	30236	30510	0.9%
8	2596	2667	2.7%	1680	1714	2.0%	15049	16429	9.2%
9	2193	2240	2.2%	2326	2373	2.0%	16927	17873	5.6%
10	2578	2670	3.6%	1503	1550	3.1%	16069	17591	9.5%

Table 8-9 – 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	10277	10155	-1.2%	24992	25191	0.8%	151165	152290	0.7%
2	6959	6915	-0.6%	14985	15241	1.7%	96724	97275	0.6%
3	5975	5951	-0.4%	15684	15931	1.6%	89599	90297	0.8%
4	3170	3150	-0.6%	7887	7998	1.4%	57123	57334	0.4%
5	6592	6596	0.1%	12257	12448	1.6%	83647	84034	0.5%
6	6166	6127	-0.6%	12471	12657	1.5%	82871	83851	1.2%
7	2466	2502	1.5%	3915	3943	0.7%	28154	28301	0.5%
8	2317	2630	13.5%	1543	1578	2.3%	11739	13261	13.0%
9	1882	2051	9.0%	2154	2198	2.0%	12574	13462	7.1%
10	2267	2556	12.8%	1282	1331	3.8%	11481	12875	12.1%

Table 8-10 – 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	3975	3884	-2.3%	24814	24742	-0.3%	53483	52130	-2.5%
2	4408	4373	-0.8%	28736	28934	0.7%	49850	50212	0.7%
3	3424	3375	-1.4%	22728	22792	0.3%	43409	43256	-0.4%
4	1733	1723	-0.6%	10268	10341	0.7%	26597	26753	0.6%
5	3346	3286	-1.8%	17274	17329	0.3%	38124	37848	-0.7%
6	3500	3448	-1.5%	23768	23902	0.6%	41011	40756	-0.6%
7	1489	1488	-0.1%	7916	7942	0.3%	13912	14024	0.8%
8	1427	1458	2.2%	3186	3221	1.1%	7522	8207	9.1%
9	1297	1298	0.0%	3851	3899	1.2%	8189	8571	4.7%
10	1678	1712	2.0%	2954	3020	2.3%	8973	9783	9.0%

Table 8-11 – 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	6105	5934	-2.8%	40869	41077	0.5%	75925	75329	-0.8%
2	3691	3656	-1.0%	21783	21952	0.8%	43329	43387	0.1%
3	3370	3324	-1.4%	22704	22779	0.3%	41641	41493	-0.4%
4	1706	1698	-0.5%	10687	10773	0.8%	25406	25484	0.3%
5	3730	3663	-1.8%	18505	18570	0.4%	38345	38253	-0.2%
6	3128	3081	-1.5%	15786	15889	0.7%	37355	37367	0.0%
7	1404	1408	0.3%	6823	6816	-0.1%	13261	13302	0.3%
8	1191	1258	5.6%	3212	3187	-0.8%	5668	6189	9.2%
9	941	964	2.5%	3167	3122	-1.4%	5503	5711	3.8%
10	1011	1062	5.0%	1959	1959	0.0%	4636	5025	8.4%

Table 8-12 – Impacts of VDM on Car Trip Ends 2040 DS AM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	5997	5992	-0.1%	33378	33092	-0.9%	56219	56093	-0.2%
2	5216	5237	0.4%	25889	26019	0.5%	39858	40326	1.2%
3	4244	4238	-0.1%	23893	23806	-0.4%	37207	37303	0.3%
4	2263	2273	0.4%	11610	11651	0.3%	23449	23665	0.9%
5	4739	4738	0.0%	19614	19456	-0.8%	32353	32463	0.3%
6	3709	3729	0.5%	17770	17846	0.4%	29717	29844	0.4%
7	1941	1941	0.0%	7654	7611	-0.6%	11836	11866	0.3%
8	1799	1811	0.6%	4001	3986	-0.4%	4725	4878	3.2%
9	1613	1613	0.0%	3800	3775	-0.7%	5255	5348	1.8%
10	1716	1724	0.5%	2549	2584	1.4%	4684	4842	3.4%

Table 8-13 – Impacts of VDM on Car Trip Ends 2040 DS AM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6665	6377	-4.3%	34585	34360	-0.7%	64577	64052	-0.8%
2	5302	5277	-0.5%	28377	28414	0.1%	40406	40760	0.9%
3	4047	3995	-1.3%	22865	22811	-0.2%	35023	35138	0.3%
4	1984	1983	-0.1%	10173	10189	0.2%	22154	22236	0.4%
5	4117	4110	-0.2%	16426	16336	-0.5%	30006	30081	0.3%
6	4146	4043	-2.5%	23430	23443	0.1%	31272	31340	0.2%
7	1921	1952	1.6%	8069	8048	-0.3%	11251	11349	0.9%
8	1814	2014	11.0%	2442	2439	-0.1%	3623	4049	11.8%
9	1465	1567	7.0%	2534	2537	0.1%	3821	4065	6.4%
10	1774	1977	11.4%	1255	1251	-0.3%	3170	3558	12.3%

Table 8-14 – Impacts of VDM on Car Trip Ends 2040 DS Inter Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	8364	8365	0.0%	20152	20252	0.5%	130333	129476	-0.7%
2	7494	7594	1.3%	16778	17099	1.9%	104160	105797	1.6%
3	6262	6322	1.0%	16356	16644	1.8%	94919	95967	1.1%
4	3234	3266	1.0%	7909	8029	1.5%	59698	60307	1.0%
5	7098	7180	1.2%	12891	13113	1.7%	89444	90253	0.9%
6	6533	6624	1.4%	14679	14910	1.6%	87426	88266	1.0%
7	2664	2689	0.9%	4635	4687	1.1%	30271	30562	1.0%
8	2604	2676	2.8%	1684	1719	2.1%	15112	16515	9.3%
9	2203	2253	2.3%	2332	2381	2.1%	17035	18008	5.7%
10	2588	2683	3.7%	1508	1558	3.3%	16158	17708	9.6%

Table 8-15 – Impacts of VDM on Car Trip Ends 2040 DS Inter Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	11086	10932	-1.4%	26462	26725	1.0%	167860	168766	0.5%
2	6987	6956	-0.4%	15011	15276	1.8%	97161	97837	0.7%
3	6021	6008	-0.2%	15798	16058	1.6%	90582	91395	0.9%
4	3176	3162	-0.4%	7899	8017	1.5%	57229	57490	0.5%
5	6628	6648	0.3%	12325	12531	1.7%	84275	84801	0.6%
6	6180	6149	-0.5%	12495	12689	1.6%	83114	84179	1.3%
7	2469	2509	1.6%	3922	3951	0.7%	28195	28363	0.6%
8	2325	2644	13.7%	1554	1590	2.3%	11814	13358	13.1%
9	1896	2071	9.2%	2163	2209	2.1%	12737	13657	7.2%
10	2277	2573	13.0%	1296	1347	3.9%	11590	13014	12.3%

Table 8-16 – Impacts of VDM on Car Trip Ends 2040 DS PM Peak - Origin

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	4407	4288	-2.7%	27386	27269	-0.4%	61149	59392	-2.9%
2	4433	4397	-0.8%	28804	28996	0.7%	50091	50466	0.7%
3	3457	3408	-1.4%	22880	22937	0.3%	43937	43779	-0.4%
4	1744	1735	-0.5%	10285	10359	0.7%	26728	26902	0.7%
5	3375	3316	-1.7%	17344	17397	0.3%	38489	38240	-0.6%
6	3513	3460	-1.5%	23829	23958	0.5%	41149	40907	-0.6%
7	1493	1492	0.0%	7924	7949	0.3%	13933	14052	0.9%
8	1432	1465	2.3%	3203	3236	1.0%	7560	8256	9.2%
9	1303	1304	0.1%	3866	3913	1.2%	8234	8623	4.7%
10	1688	1724	2.1%	2969	3035	2.2%	9037	9867	9.2%

Table 8-17 – Impacts of VDM on Car Trip Ends 2040 DS PM Peak - Destination

	Business			Commute			Other		
Sector	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff	Pre-VDM	Post-VDM	%Diff
1	6546	6332	-3.3%	43402	43549	0.3%	83581	82500	-1.3%
2	3714	3681	-0.9%	21815	21983	0.8%	43568	43669	0.2%
3	3415	3368	-1.4%	22954	23024	0.3%	42317	42186	-0.3%
4	1714	1708	-0.4%	10704	10791	0.8%	25500	25603	0.4%
5	3753	3690	-1.7%	18562	18630	0.4%	38662	38622	-0.1%
6	3135	3089	-1.5%	15818	15919	0.6%	37453	37484	0.1%
7	1406	1411	0.4%	6843	6835	-0.1%	13278	13327	0.4%
8	1194	1263	5.8%	3230	3205	-0.8%	5693	6221	9.3%
9	948	973	2.6%	3181	3134	-1.5%	5562	5777	3.9%
10	1019	1072	5.2%	1981	1979	-0.1%	4694	5095	8.5%

9 VDM SCENARIO ASSIGNMENT RESULTS

9.1 INTRODUCTION

9.1.1. This chapter details the outputs from the VDM forecast assignments for the 2040 model runs 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, Do Minimum and Do Something scenarios for the forecast year with respect to metrics including distance, time, and travel speed.

9.1.2. 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.

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

- 2040 DM
- 2040 DS

9.2 DEFINITION OF VARIOUS PARAMETERS USED FOR REPORTING

9.2.1. This section summarises the definition of various parameters outlined in section 9.1.1 and 9.1.2 used for reporting in the subsequent sections of this chapter for reference.

Highway Model Assignment Convergence

9.2.2. 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.

9.2.3. 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.

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

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

Highway Network Statistics

9.2.6. 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.

9.2.7. 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

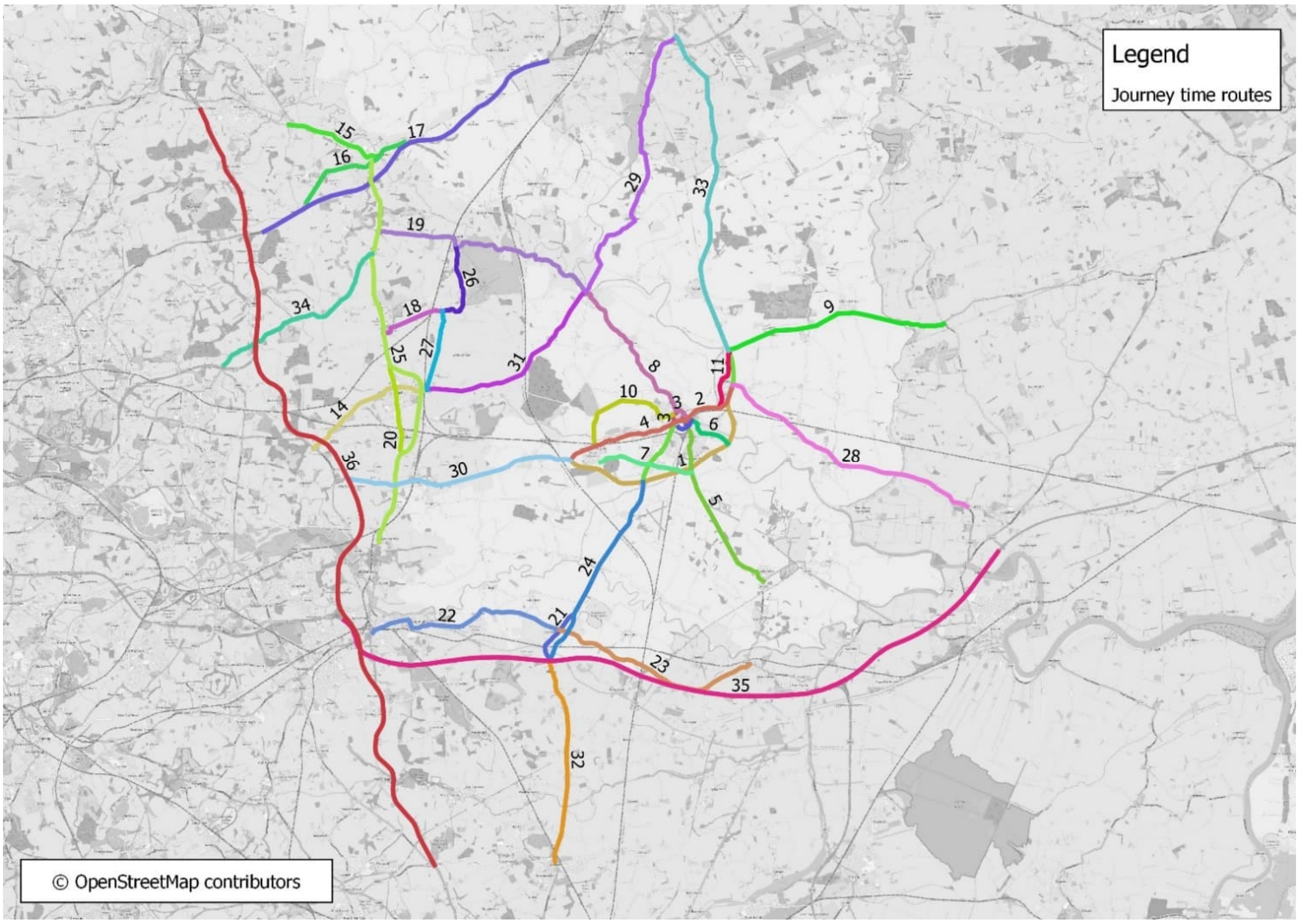
9.2.8. In addition to the above, the results also include the following

- Change in Journey time
- traffic flow difference plots comparing the traffic flow for each of the 2040 DS scenarios against the 2040 DM and 2040DM against the base, showing the change in the traffic flow. In these plots the links which are predicted to experience an increase in traffic flows are highlighted green whilst the links predicted to experience a decrease in traffic are highlighted blue.
- VoC plots for each of the scenario runs.
  These plots highlight the locations where the VoC is predicted to be over 85%

9.2.9. 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.

9.2.10. Figure 9-1 shows the various journey time routes included in the assessment.

Figure 9-1 – Journey Time Routes



9.2.11. 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.

9.2.12. 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.

9.2.13. The traffic outputs from the SATURN model will be can be used as inputs to the individual junction models. The assessment of these traffic flows from the SATURN model using the appropriate junction modelling suite will provide an operation assessment of the junction's operation indicating whether the junction has adequate capacity to accommodate the predicted demand or would require further mitigation.

9.2.14. 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.

9.2.15. 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.

9.2.16. 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.

9.2.17. 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.

9.2.18. 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.

9.3 RESULTS FOR 2040DM

9.3.1. This section summarises the results for 2040 DM model run for the parameter outlined in section 9.1.2.

9.3.2. The convergence results are summarised in the Table 9-1. The VDM scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 9-1 – VDM Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator:	Stability Indicator:	Stability Indicator:
			Delta (d) / (Gap (%)	% Flow	% Delays
2040 DM	AM	11	0.0045	99.1	99.9
		12	0.0043	99.1	99.9
		13	0.0034	99.2	99.9
		14	0.0035	99.2	99.9
	IP	18	0.00041	99.1	100
		19	0.00014	99.8	100
		20	0.00019	99.3	100
		21	0.00046	99.2	100
	PM	18	0.0060	99.4	99.9
		19	0.0049	99.4	99.9
		20	0.0053	99.5	99.8
		21	0.0053	99.5	99.9

Highway Network Statistics

9.3.3. A comparison of the network statistics between the model base year and modelled forecast years is provided in Table 9-2 to Table 9-4 respectively by time period.

9.3.4. 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 9-2 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2023	2040DM	% Change 2023-40
Transient Queues (pcu-hrs)	1031.7	1548.0	50.0%
Overcapacity Queues (pcu-hrs)	13.9	136.0	
Link Cruise Time (pcu-hrs)	11382.2	14818.9	30.2%
Total Travel Time (pcu-hrs)	12427.7	16502.9	32.8%
Travel Distance (pcu-kms)	961218.0	1198000.0	24.6%
Average Journey Speed (kph)	77.3	72.6	-6.1%
Total Assigned Trips (pcus)	146205.7	182936.7	25.1%

Table 9-3 – Highway Assignment Network Statistics: Inter Peak

Simulation Area	Inter Peak		
	2023	2040DM	% Change 2023-40
Transient Queues (pcu-hrs)	710.8	917.8	29.1%
Overcapacity Queues (pcu-hrs)	0.0	0.0	
Link Cruise Time (pcu-hrs)	9803.3	11809.6	20.5%
Total Travel Time (pcu-hrs)	10514.1	12727.4	21.1%
Travel Distance (pcu-kms)	864423.0	1014596.9	17.4%
Average Journey Speed (kph)	82.2	79.7	-3.1%
Total Assigned Trips (pcus)	126180.6	141982.7	12.5%

Table 9-4 – Highway Assignment Network Statistics: PM Peak

Simulation Area	PM Peak		
	2023	2040DM	% Change 2023-40
Transient Queues (pcu-hrs)	1057.2	1860.5	76.0%
Overcapacity Queues (pcu-hrs)	0.8	194.2	
Link Cruise Time (pcu-hrs)	11195.9	15510.6	38.5%
Total Travel Time (pcu-hrs)	12253.8	17565.3	43.3%
Travel Distance (pcu-kms)	940611.0	1242337.0	32.1%
Average Journey Speed (kph)	76.8	70.7	-7.9%
Total Assigned Trips (pcus)	137619.7	176118.6	28.0%

9.4 HIGHWAY ASSIGNMENT IMPACTS

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

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

Journey Time Routes

9.4.2. Comparisons of travel times of the local network journey time routes between the base year 2023 and forecast 2040 DM are presented in Table 9-5 by time period.

9.4.3. 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. It must be noted that route 6 EB and 13 WB become one way in the forecast years.

Table 9-5 – Journey Time Routes, 2040 DM compared with 2023 Base

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2023	2040DM	% Change 2023-40	2023	2040DM	% Change 2023-40	2023	2040DM	% Change 2023-40
1 EB	480	505	5%	452	467	3%	479	514	7%
1 WB	472	521	11%	449	461	3%	474	558	18%
2 NB	876	907	4%	849	865	2%	895	960	7%
2 SB	896	990	10%	847	885	4%	878	1026	17%

3 ACW	356	352	-1%	362	372	3%	412	399	-3%
3 CW	391	433	11%	375	404	8%	428	475	11%
4 EB	802	819	2%	780	778	0%	828	838	1%
4 WB	830	908	9%	780	808	4%	809	936	16%
5 NB	616	733	19%	531	607	14%	589	794	35%
5 SB	532	542	2%	502	492	-2%	545	514	-6%
6 EB	258	0	-100%	252	0	-100%	274	0	-100%
6 WB	283	326	15%	278	318	14%	293	342	17%
7 WB	316	327	3%	309	314	1%	317	334	5%
7 EB	328	341	4%	313	316	1%	315	326	4%
8 NB	580	586	1%	578	581	1%	587	599	2%
8 SB	633	651	3%	626	643	3%	670	706	5%
9 WB	490	499	2%	485	489	1%	490	507	3%
9 EB	479	478	0%	476	474	0%	479	478	0%
10 EB	397	411	4%	388	393	1%	384	397	3%
10 WB	384	388	1%	382	385	1%	386	393	2%
11 SB	244	245	0%	241	241	0%	242	245	1%
11 NB	245	246	0%	239	238	0%	241	241	0%
12 NB	198	201	1%	199	199	0%	207	209	1%
12 SB	187	187	0%	189	187	-1%	195	194	0%
13 EB	150	157	5%	162	171	5%	178	201	13%
13 WB	162	0	-100%	161	0	-100%	164	0	-100%
14 EB	465	638	37%	442	451	2%	468	519	11%
14 WB	471	465	-1%	453	448	-1%	476	468	-2%
15 EB	441	459	4%	433	439	1%	449	476	6%
15 WB	449	455	1%	431	432	0%	447	472	5%
16 WB	425	422	-1%	405	405	0%	421	433	3%
16 EB	441	463	5%	419	424	1%	439	464	6%
17 EB	545	622	14%	519	547	5%	541	671	24%
17 WB	529	553	5%	525	535	2%	538	576	7%

18 EB	206	210	2%	205	206	1%	208	211	1%
18 WB	210	210	0%	206	206	0%	207	210	1%
19 EB	633	640	1%	633	637	1%	636	668	5%
19 WB	654	657	1%	643	644	0%	644	650	1%
20 SB	346	348	1%	341	341	0%	360	363	1%
20 NB	358	366	2%	345	347	1%	358	364	2%
21 NB	245	263	8%	215	222	3%	219	237	8%
21 SB	248	249	1%	217	220	2%	221	226	2%
22 EB	612	662	8%	607	636	5%	654	719	10%
22 WB	610	629	3%	597	607	2%	630	660	5%
23 EB	514	534	4%	501	510	2%	515	530	3%
23 WB	517	526	2%	505	509	1%	513	524	2%
24 NB	464	580	25%	438	519	19%	469	681	45%
24 SB	466	514	10%	444	464	4%	464	470	1%
25 NB	989	1044	6%	923	955	3%	928	997	7%
25 SB	901	927	3%	899	917	2%	950	1054	11%
26 NB	236	244	3%	235	240	2%	237	241	2%
26 SB	243	248	2%	242	246	2%	243	253	4%
27 NB	209	212	1%	209	212	2%	210	216	3%
27 SB	207	209	1%	204	206	1%	205	210	2%
28 EB	564	561	-1%	558	553	-1%	591	570	-4%
28 WB	584	669	14%	561	591	5%	578	686	19%
29 NB	789	800	1%	756	767	1%	767	791	3%
29 SB	781	830	6%	774	812	5%	831	1185	43%
30 WB	591	571	-3%	531	522	-2%	550	555	1%
30 EB	537	588	10%	522	569	9%	599	824	37%
31 EB	460	463	1%	454	466	3%	462	500	8%
31 WB	449	453	1%	444	445	0%	447	448	0%
32 SB	459	459	0%	458	457	0%	475	469	-1%
32 NB	475	519	9%	461	466	1%	464	475	2%

33 NB	860	872	1%	684	685	0%	709	715	1%
33 SB	720	806	12%	715	821	15%	898	1147	28%
34 EB	469	478	2%	466	473	2%	481	532	11%
34 WB	465	462	-1%	457	456	0%	459	458	0%
35 EB	1031	1058	3%	1034	1052	2%	1040	1090	5%
35 WB	1040	1082	4%	1030	1051	2%	1019	1047	3%
36 NB	1340	1561	16%	1305	1358	4%	1299	1458	12%
36 SB	1264	1313	4%	1304	1333	2%	1287	1371	7%

9.4.4. The above table shows that in the AM peak hour, the maximum increase in journey time of approximately 37% can be observed for Route 14 Eastbound; and the smallest increase of about 0.1% is observed on Route 32 Southbound. There is a reduction of 3% for Route 30 Westbound.

9.4.5. For IP peak hour the maximum increase in journey time of approximately 19% can be observed for Route 24 Northbound. There is a reduction of 3% for Route 5 Southbound and Route 30 Westbound.

9.4.6. For PM peak hour the maximum increase in journey time of approximately 45% can be observed for Route 24 Northbound. There is a reduction of 6% for Route 5 Southbound.

Traffic plots

9.4.7. Comparisons of link flows for the local network journey time routes between the base year 2023 and forecast 2040 DM are presented in Figure 9-2 to Figure 9-4 below.

9.4.8. There are increases in traffic demand between the base year and 2040 forecast. A truncation has been applied to remove flow differences below 20 PCUs for ease of viewing.

9.4.9. In addition, link and turn volume over capacity plots have been produced for the 2040 DM forecast assignments by time period. These are shown in Figure 9-5 to Figure 9-10 below. V/C is used as an indicator of congestion at a junction. Junctions which experience volumes of traffic approaching their capacity level, typically a V/C of greater than 85% will begin to experience increased delay and are likely to be affected by operational constraints.

Figure 9-2 - Demand Flow Difference DM-Base (AM)

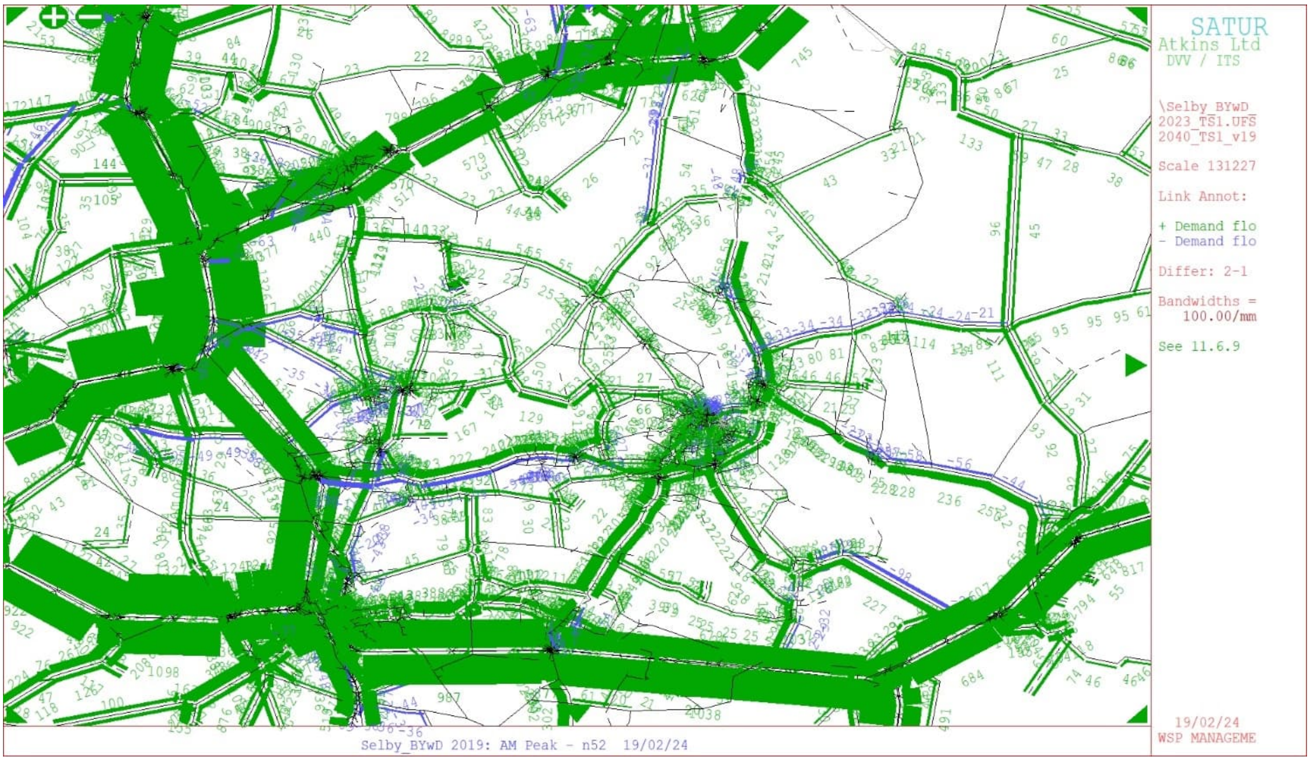


Figure 9-3 - Demand Flow Difference DM-Base (IP)

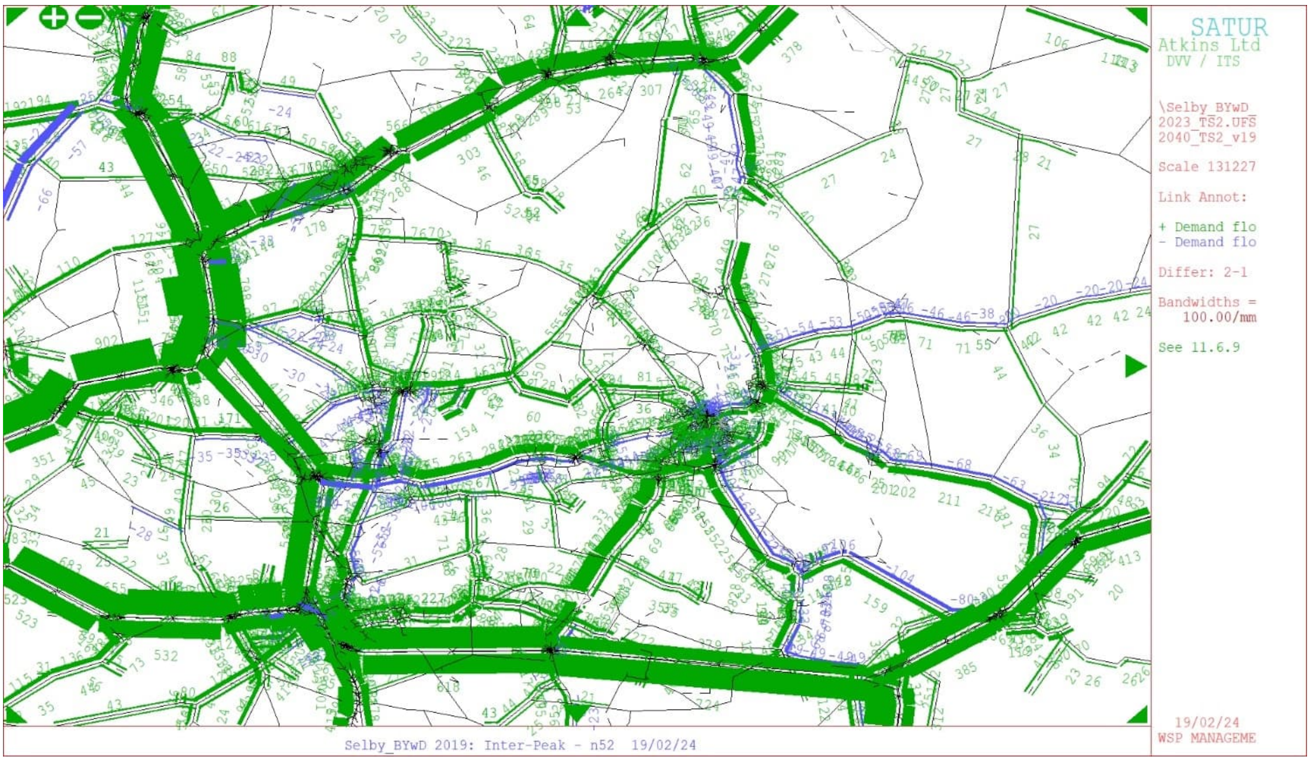
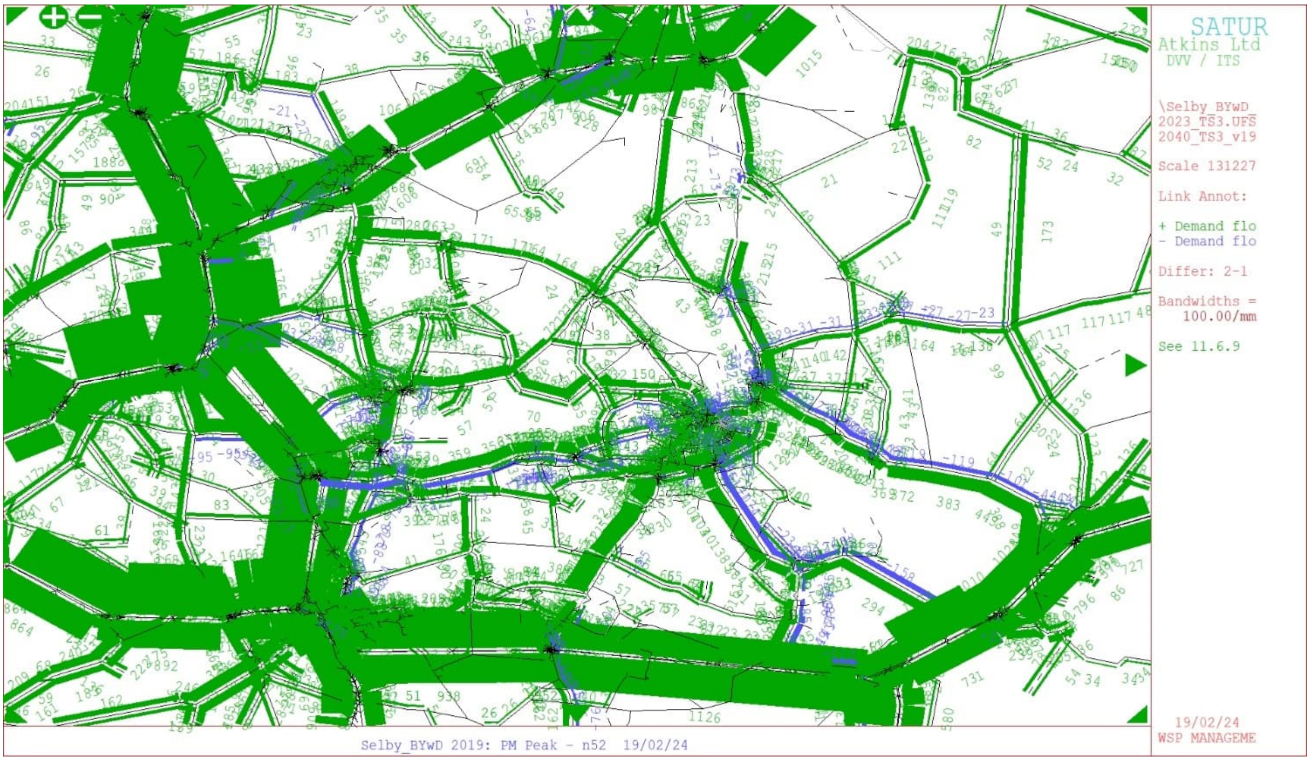


Figure 9-4 - Demand Flow Difference DM-Base (PM)



Volume over capacity assessment

Figure 9-5 - Link VOC 2040 DM (AM)

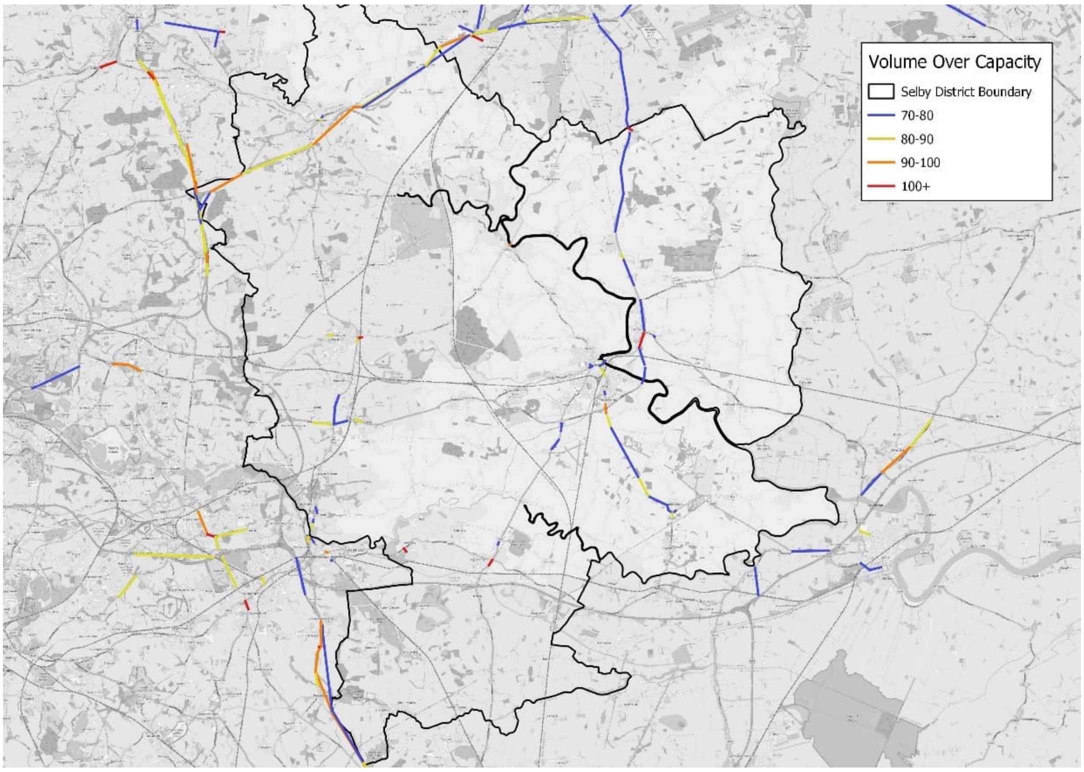


Figure 9-6 - Link VOC 2040 DM (IP)

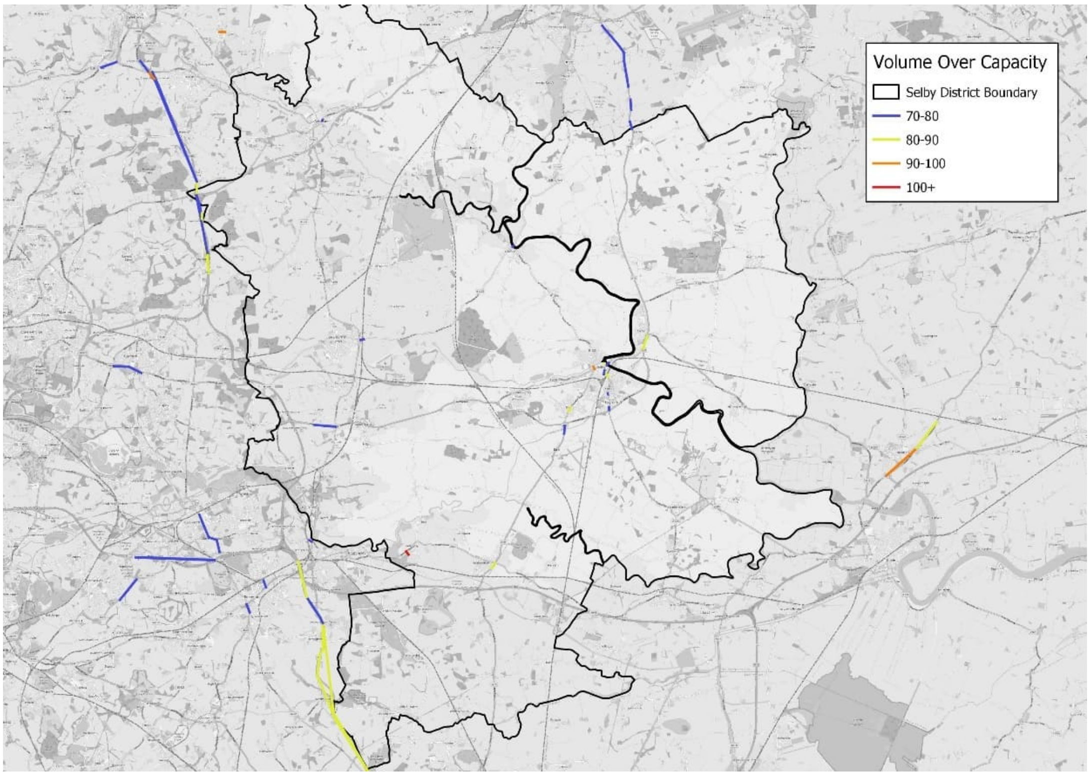


Figure 9-7 - Link VOC 2040 DM (PM)

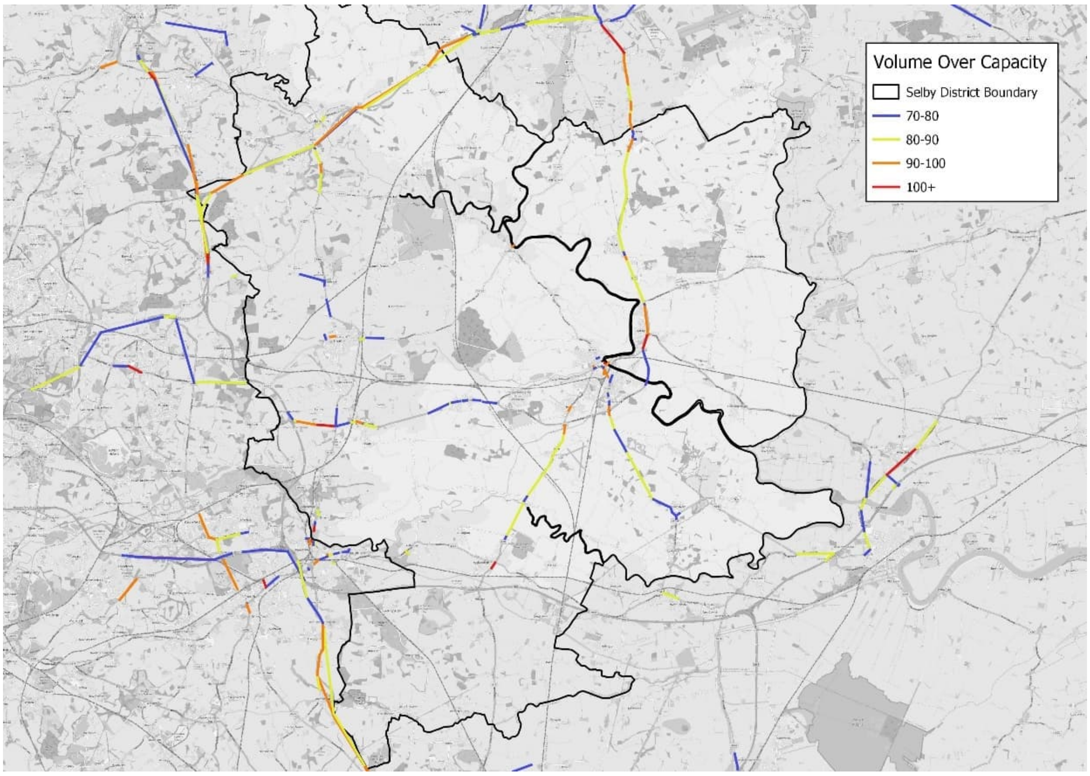


Figure 9-8 - Turn VOC 2040 DM (AM)

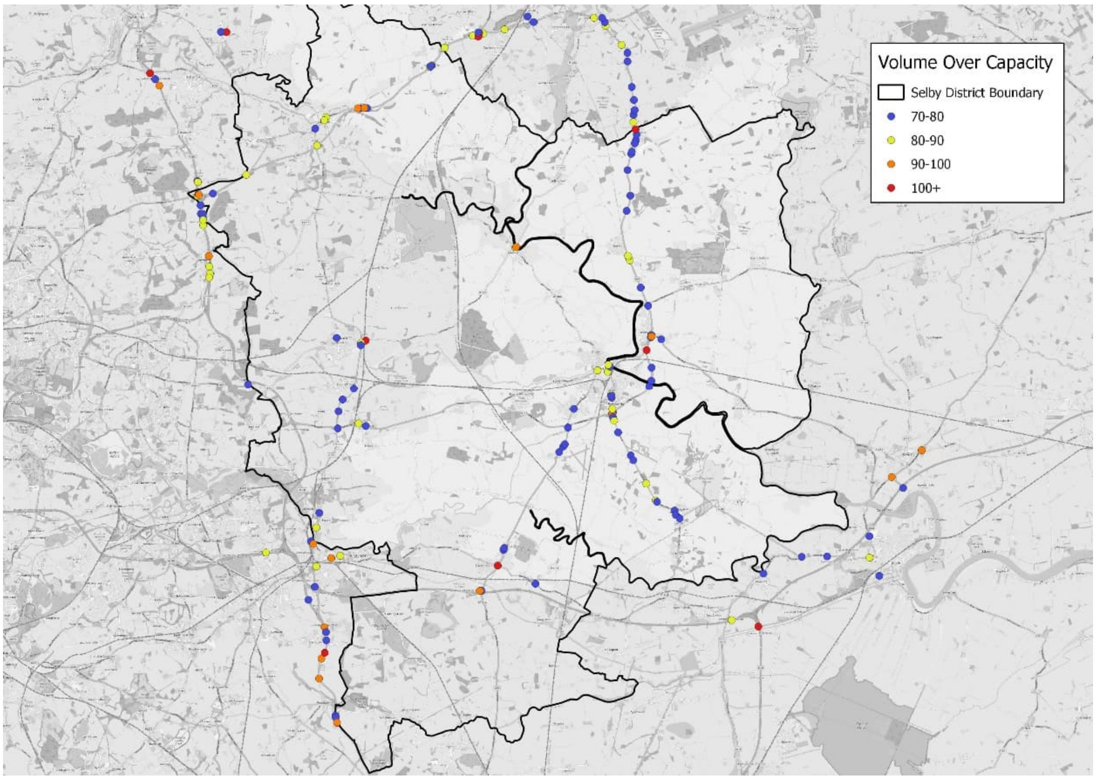


Figure 9-9 - Turn VOC 2040 DM (IP)

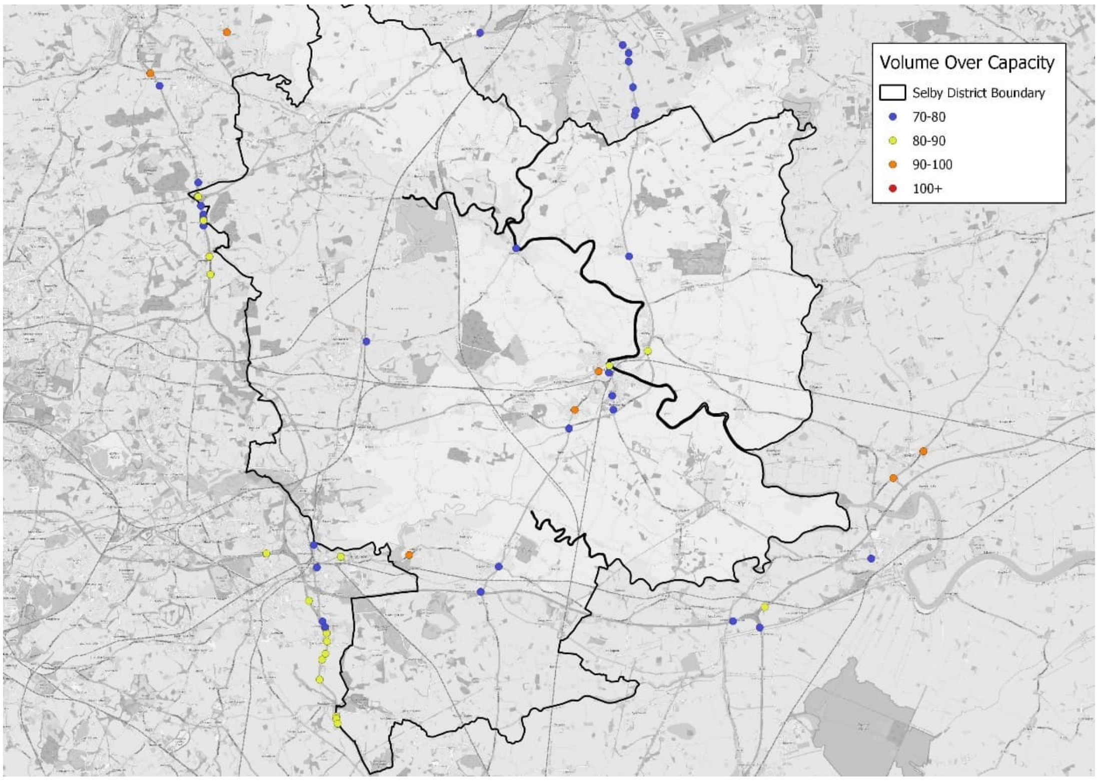
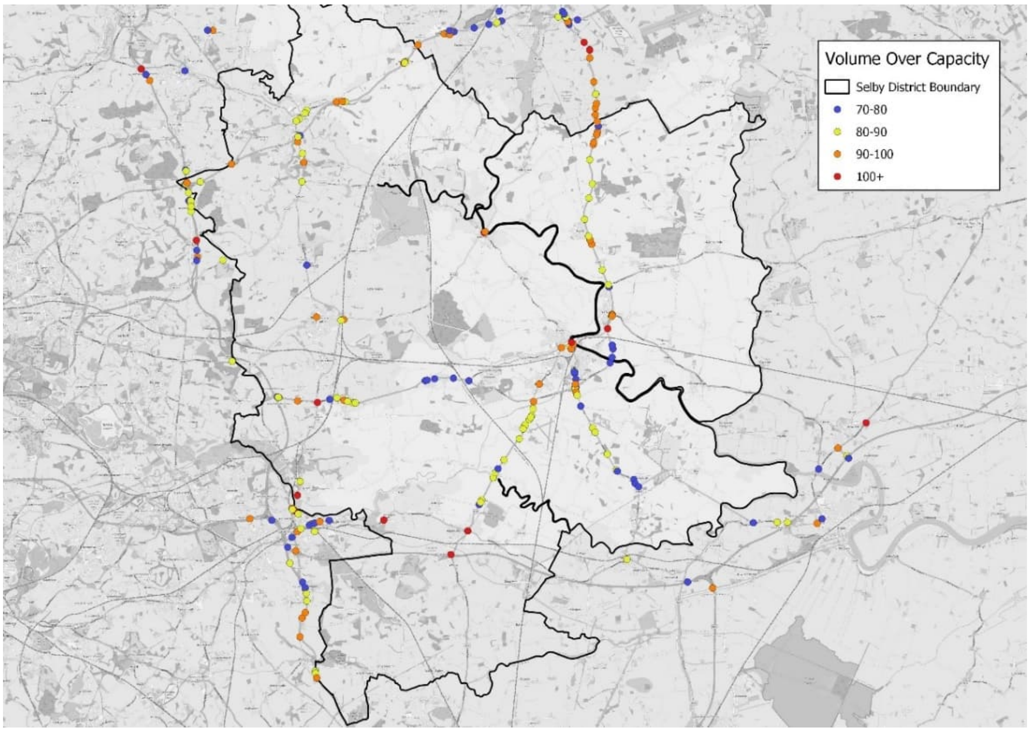


Figure 9-10 - Turn VOC 2040 DM (PM)



9.5 RESULTS FOR 2040 DS

9.5.1. This section summarises the results for 2040 DM model run for the parameter outlined in section 7.1.2.

9.5.2. The convergence results are summarised in the Table 9-6. The VDM scenario forecast year assignments are highly converged, i.e. achieving TAG criteria, in all cases.

Table 9-6 – VDM Scenario Highway Assignment Convergence Statistics

Year	Time Period	Loop	Proximity indicator: Delta (d) / (Gap (%)	Stability Indicator: % Flow	Stability Indicator: % Delays
2040 DS	AM	26	0.0054	98.4	99.7
		27	0.0030	99.0	99.7
		28	0.0021	99.7	99.9
		29	0.0026	99.2	99.8
	IP	21	0.00032	99.2	100
		23	0.00022	99.9	100
		24	0.00020	99.8	100
		25	0.00024	99.2	100
	PM	20	0.0053	99.4	99
		21	0.0056	99.4	98.8
		22	0.0055	99.4	98.9
		23	0.0043	99.6	99

Highway Network Statistics

9.5.3. A comparison of the network statistics between the model base year and modelled forecast years is provided in Table 9-7 to Table 9-9 respectively by time period.

9.5.4. 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 9-7 – Highway Assignment Network Statistics: AM Peak

Simulation Area	AM Peak		
	2040DM	2040DS	% Change DM-DS
Transient Queues (pcu-hrs)	1548.0	1827.8	18.1%
Overcapacity Queues (pcu-hrs)	136.0	221.6	
Link Cruise Time (pcu-hrs)	14818.9	15558.5	5.0%
Total Travel Time (pcu-hrs)	16502.9	17607.8	6.7%
Travel Distance (pcu-kms)	1198000.0	1239740.1	3.5%
Average Journey Speed (kph)	72.6	70.4	-3.0%
Total Assigned Trips (pcus)	182936.7	186668.3	2.0%

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

Simulation Area	Inter Peak		
	2040DM	2040DS	% Change DM-DS
Transient Queues (pcu-hrs)	917.8	1043.5	13.7%
Overcapacity Queues (pcu-hrs)	0.0	4.2	
Link Cruise Time (pcu-hrs)	11809.6	12312.6	4.3%
Total Travel Time (pcu-hrs)	12727.4	13360.3	5.0%
Travel Distance (pcu-kms)	1014596.9	1044871.7	3.0%
Average Journey Speed (kph)	79.7	78.2	-1.9%
Total Assigned Trips (pcus)	141982.7	144828.7	2.0%

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

Simulation Area	PM Peak		
	2040DM	2040DS	% Change DM-DS
Transient Queues (pcu-hrs)	1860.5	2134.0	14.7%
Overcapacity Queues (pcu-hrs)	194.2	381.8	
Link Cruise Time (pcu-hrs)	15510.6	16124.3	4.0%
Total Travel Time (pcu-hrs)	17565.3	18640.2	6.1%
Travel Distance (pcu-kms)	1242337.0	1276381.8	2.7%
Average Journey Speed (kph)	70.7	68.5	-3.1%
Total Assigned Trips (pcus)	176118.6	179583.6	2.0%

9.6 HIGHWAY ASSIGNMENT IMPACTS

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

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

Journey Time Routes

9.6.2. Comparisons of travel times on local network journey time routes between the DM and DS are presented in

9.6.3. Table 9-10 by time period.

9.6.4. There are increases in travel time between the DM and DS. This is reflective of larger delays in the network due to increased demand and congestion and is the general trend across the network. It must be noted that route 6 EB and 13 WB become one way in the forecast years.

Table 9-10 – Journey Time Routes, 2040 DS compared with 2040 DM

Journey Time Routes	AM Peak			Inter Peak			PM Peak		
	2040 DM	2040 DS	% Change DM-DS	2040 DM	2040 DS	% Change DM-DS	2040 DM	2040 DS	% Change DM-DS
1 EB	505	544	8%	467	491	5%	514	537	4%
1 WB	521	557	7%	461	482	5%	558	598	7%
2 NB	907	964	6%	865	904	4%	960	1015	6%

2 SB	990	1113	12%	885	932	5%	1026	1165	14%
3 ACW	352	422	20%	372	438	18%	399	511	28%
3 CW	433	501	16%	404	476	18%	475	601	27%
4 EB	819	876	7%	778	804	3%	838	887	6%
4 WB	908	993	9%	808	852	5%	936	1055	13%
5 NB	733	828	13%	607	639	5%	794	876	10%
5 SB	542	622	15%	492	506	3%	514	539	5%
6 EB	0	0	0%	0	0	0%	0	0	0%
6 WB	326	346	6%	318	328	3%	342	368	8%
7 WB	327	333	2%	314	318	1%	334	352	5%
7 EB	341	355	4%	316	319	1%	326	333	2%
8 NB	586	599	2%	581	587	1%	599	605	1%
8 SB	651	725	11%	643	701	9%	706	818	16%
9 WB	499	502	1%	489	490	0%	507	508	0%
9 EB	478	478	0%	474	475	0%	478	478	0%
10 EB	411	441	7%	393	401	2%	397	414	4%
10 WB	388	407	5%	385	396	3%	393	450	15%
11 SB	245	248	1%	241	242	0%	245	246	1%
11 NB	246	246	0%	238	239	0%	241	241	0%
12 NB	201	209	4%	199	205	3%	209	218	4%
12 SB	187	199	6%	187	191	2%	194	202	4%
13 EB	157	164	5%	171	184	8%	201	217	8%
13 WB	0	0	0%	0	0	0%	0	0	0%
14 EB	638	733	15%	451	457	1%	519	542	4%
14 WB	465	472	1%	448	451	1%	468	602	29%
15 EB	459	470	2%	439	442	1%	476	513	8%
15 WB	455	463	2%	432	433	0%	472	477	1%
16 WB	422	429	2%	405	407	0%	433	440	2%
16 EB	463	475	2%	424	428	1%	464	504	9%
17 EB	622	629	1%	547	549	0%	671	677	1%

17 WB	553	555	0%	535	536	0%	576	579	1%
18 EB	210	221	5%	206	206	0%	211	211	0%
18 WB	210	210	0%	206	206	0%	210	212	1%
19 EB	640	648	1%	637	638	0%	668	676	1%
19 WB	657	663	1%	644	645	0%	650	654	1%
20 SB	348	356	2%	341	344	1%	363	370	2%
20 NB	366	374	2%	347	349	1%	364	370	2%
21 NB	263	275	4%	222	225	1%	237	250	6%
21 SB	249	257	3%	220	223	1%	226	229	2%
22 EB	662	674	2%	636	641	1%	719	735	2%
22 WB	629	639	2%	607	611	1%	660	669	1%
23 EB	534	536	0%	510	512	0%	530	535	1%
23 WB	526	530	1%	509	511	0%	524	530	1%
24 NB	580	626	8%	519	537	3%	681	735	8%
24 SB	514	537	4%	464	473	2%	470	487	4%
25 NB	1044	1081	4%	955	971	2%	997	1014	2%
25 SB	927	955	3%	917	935	2%	1054	1099	4%
26 NB	244	244	0%	240	240	0%	241	242	0%
26 SB	248	254	2%	246	246	0%	253	253	0%
27 NB	212	208	-2%	212	212	0%	216	216	0%
27 SB	209	214	2%	206	207	0%	210	209	-1%
28 EB	561	568	1%	553	557	1%	570	575	1%
28 WB	669	711	6%	591	599	1%	686	707	3%
29 NB	800	840	5%	767	771	1%	791	816	3%
29 SB	830	903	9%	812	837	3%	1185	1272	7%
30 WB	571	610	7%	522	531	2%	555	582	5%
30 EB	588	630	7%	569	585	3%	824	885	7%
31 EB	463	488	5%	466	484	4%	500	533	7%
31 WB	453	477	5%	445	455	2%	448	462	3%
32 SB	459	460	0%	457	457	0%	469	470	0%

32 NB	519	524	1%	466	467	0%	475	477	0%
33 NB	872	865	-1%	685	691	1%	715	712	0%
33 SB	806	812	1%	821	828	1%	1147	1164	1%
34 EB	478	482	1%	473	475	0%	532	536	1%
34 WB	462	463	0%	456	456	0%	458	459	0%
35 EB	1058	1061	0%	1052	1053	0%	1090	1094	0%
35 WB	1082	1086	0%	1051	1052	0%	1047	1049	0%
36 NB	1561	1577	1%	1358	1362	0%	1458	1476	1%
36 SB	1313	1317	0%	1333	1336	0%	1371	1374	0%

9.6.5. The above table shows that in the AM peak hour, the maximum increase in journey time of approximately 20% can be observed for Route 3 Anti Clockwise; and the smallest increase of about 0.1%. Also, in the AM peak a journey time reduction is observed in Route 27 Northbound.

9.6.6. For IP peak hour the maximum increase in journey time of approximately 18% can be observed for Route 3 Clockwise; for Routes 34 Westbound, 32 Southbound, Route 26 (both directions), Route 18 (both directions) and 27 Northbound it has been observed that there is no change in journey time.

9.6.7. For PM peak hour the maximum increase in journey time of approximately 29% can be observed for Route 14 Westbound. For the PM peak, journey times have reduced in routes 27 Southbound and Route 33 Northbound.

Traffic plots

9.6.8. Comparisons of link flows for the local network journey time routes between the 2040 DM and 2040 DS forecast scenarios are presented in Figure 9-11 to Figure 9-13 below. There are increases in traffic demand between the DM and DS scenarios. A truncation has been applied to remove flow differences below 20 PCUs for ease of viewing.

9.6.9. In addition, link and turn volume over capacity plots have been produced for the 2040 DS forecast assignments by time period. These are shown in Figure 9-14 to Figure 9-19 below. V/C is used as an indicator of congestion at a junction. Junctions which experience volumes of traffic approaching their capacity level, typically a V/C of greater than 85% will begin to experience increased delay and are likely to be affected by operational constraints.

Figure 9-11 - Demand Flow Difference DS-DM (AM)

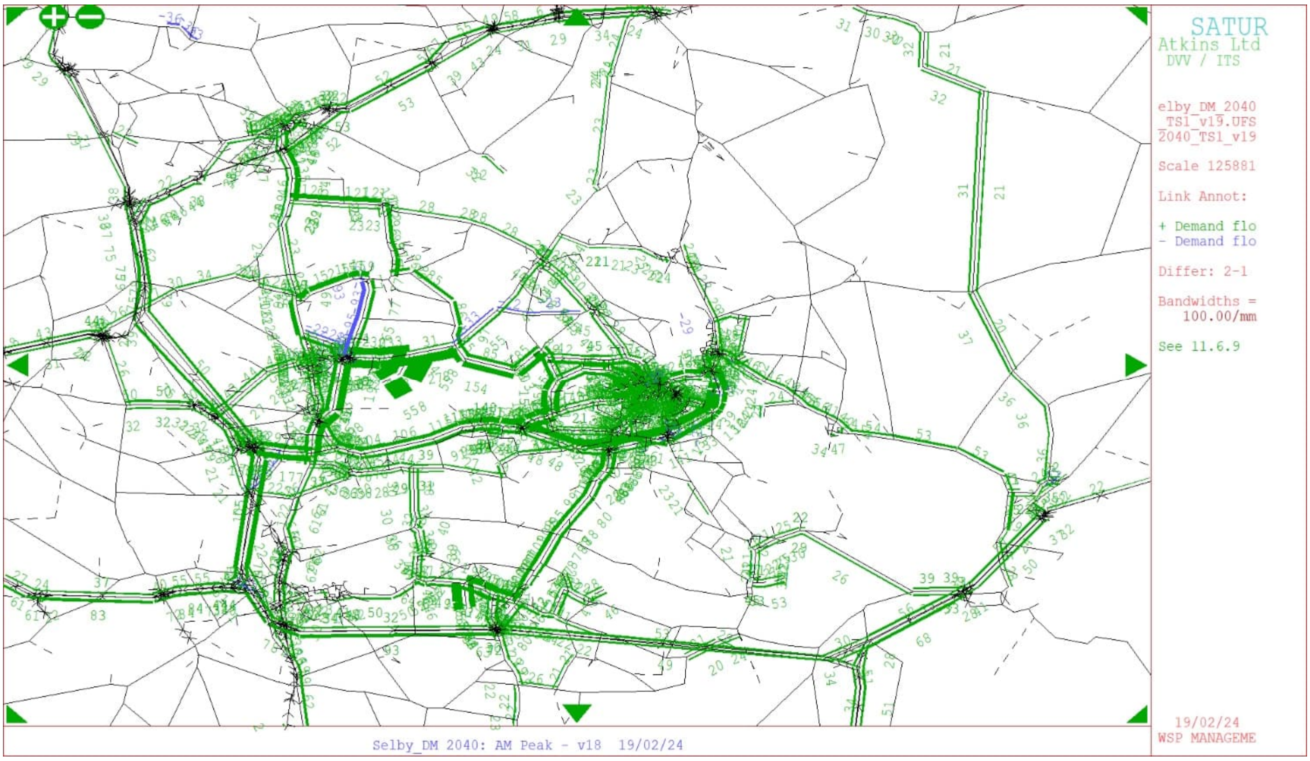


Figure 9-12 - Demand Flow Difference DS-DM (IP)

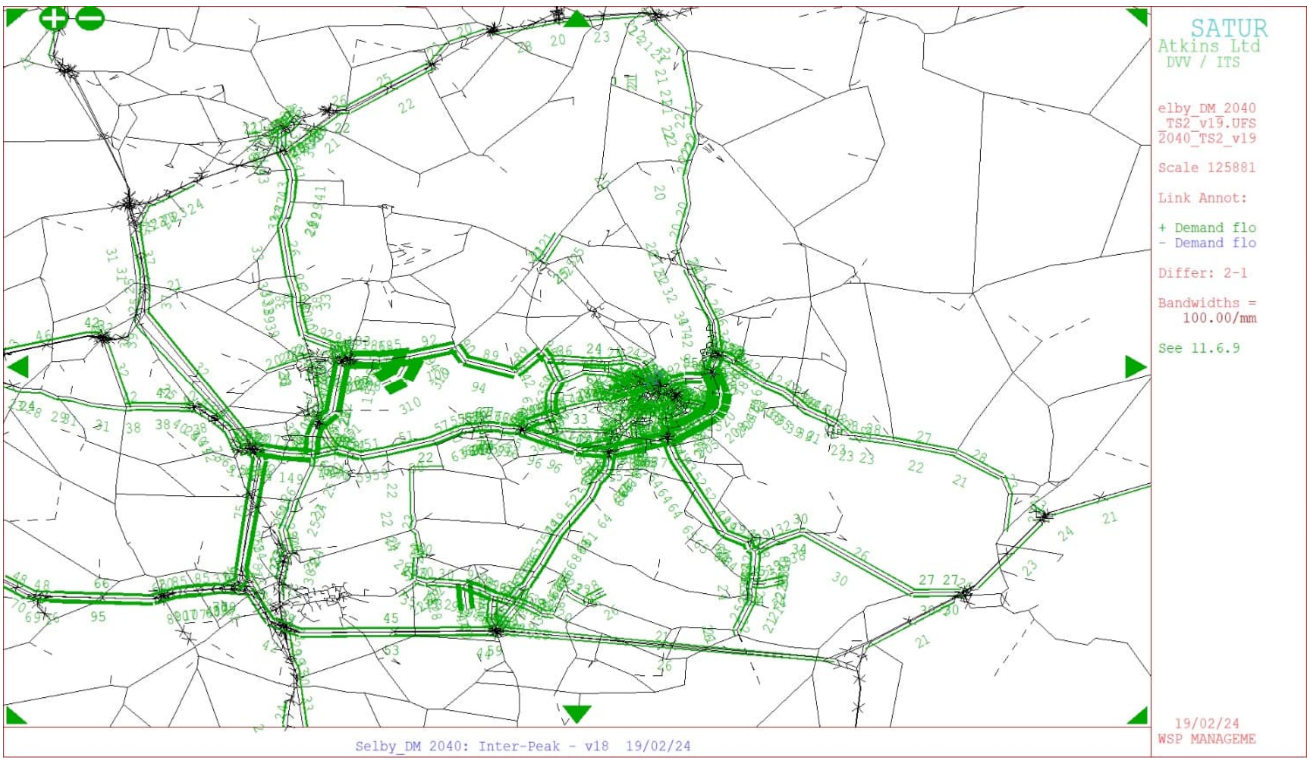
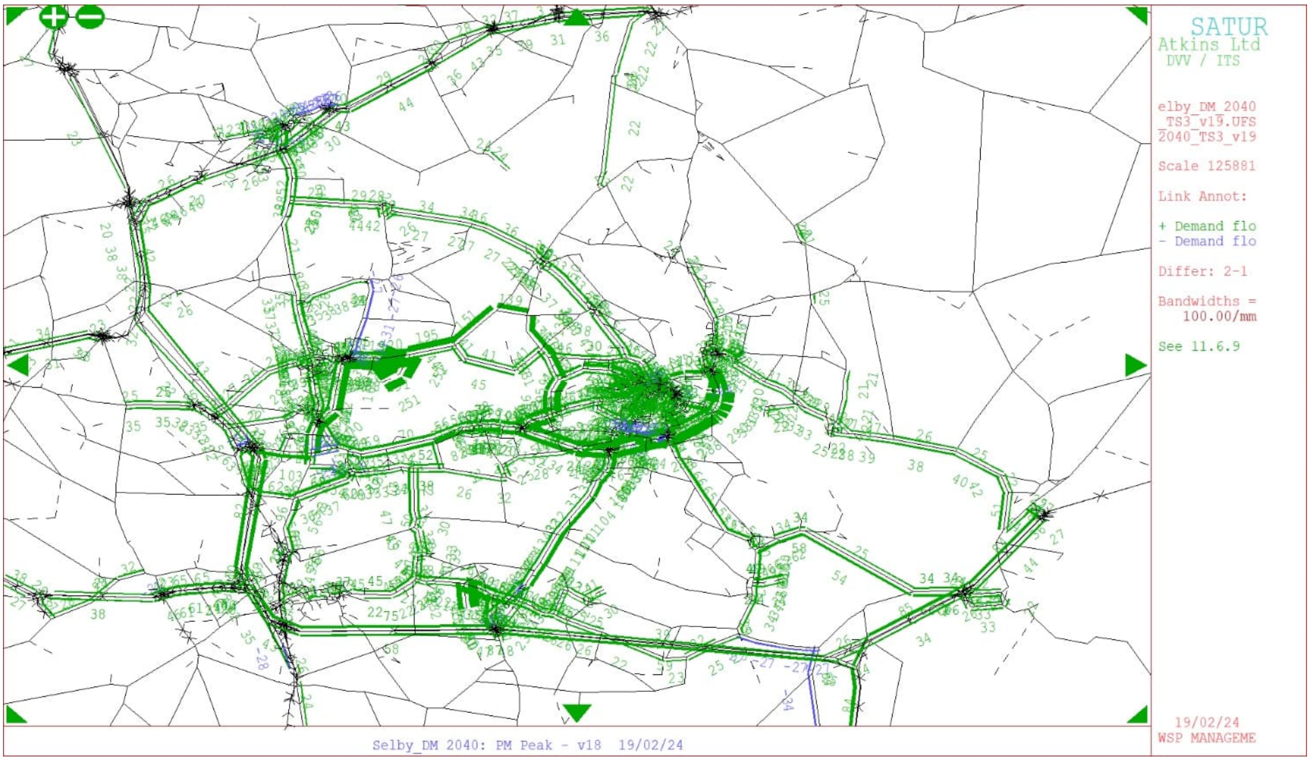


Figure 9-13 - Demand Flow Difference DS-DM (PM)



Volume over capacity assessment

Figure 9-14 - Link VOC 2040 DS (AM)

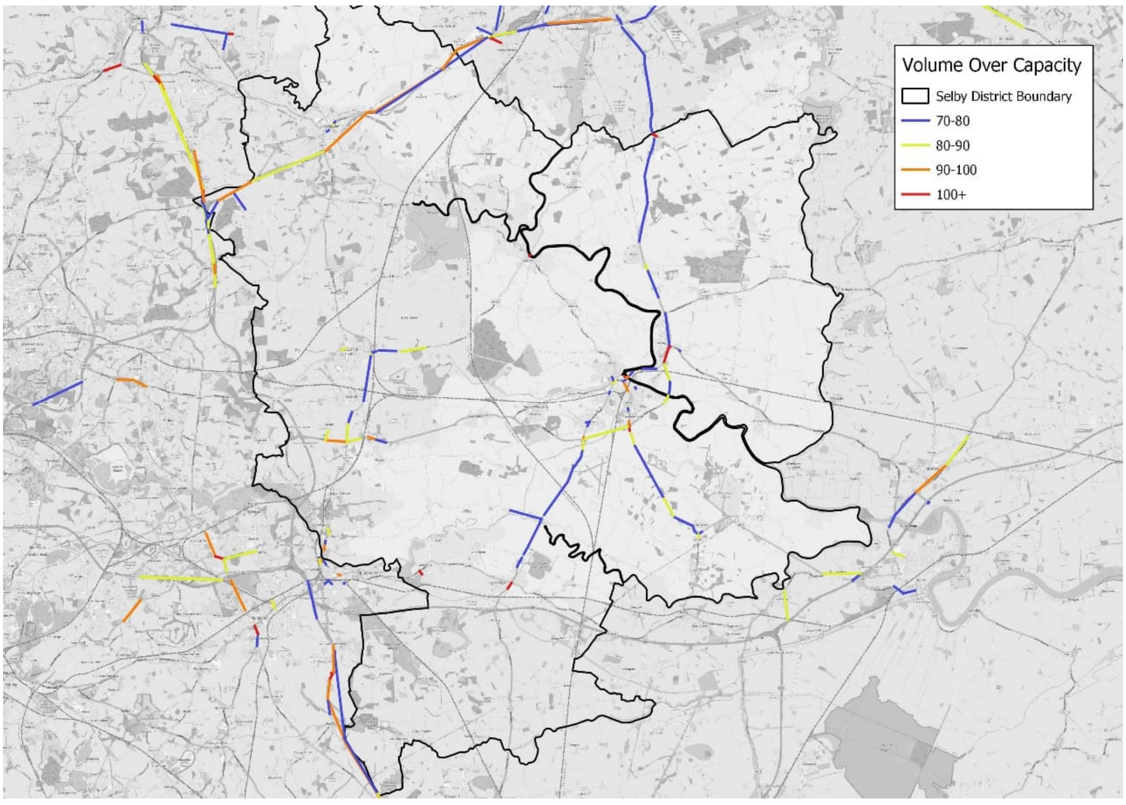


Figure 9-15 - Link VOC 2040 DS (IP)

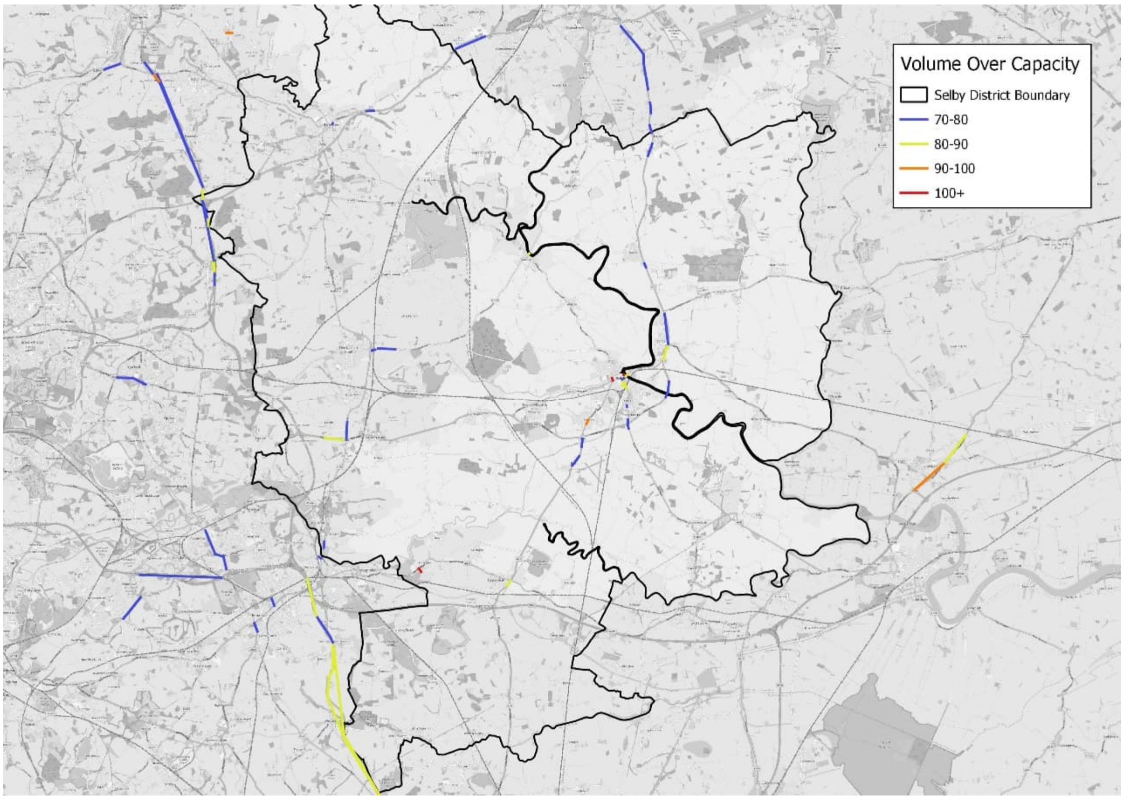


Figure 9-16 - Link VOC 2040 DS (PM)

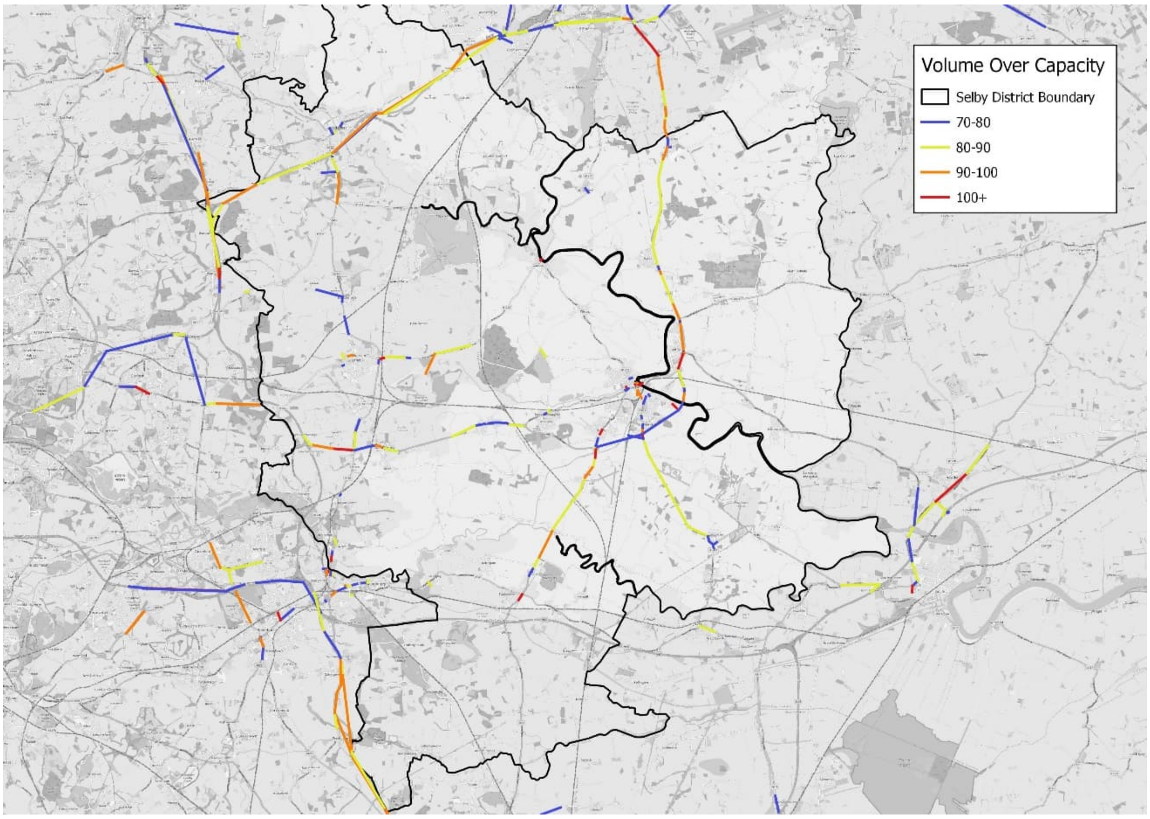


Figure 9-17 - Turn VOC 2040 DS (AM)

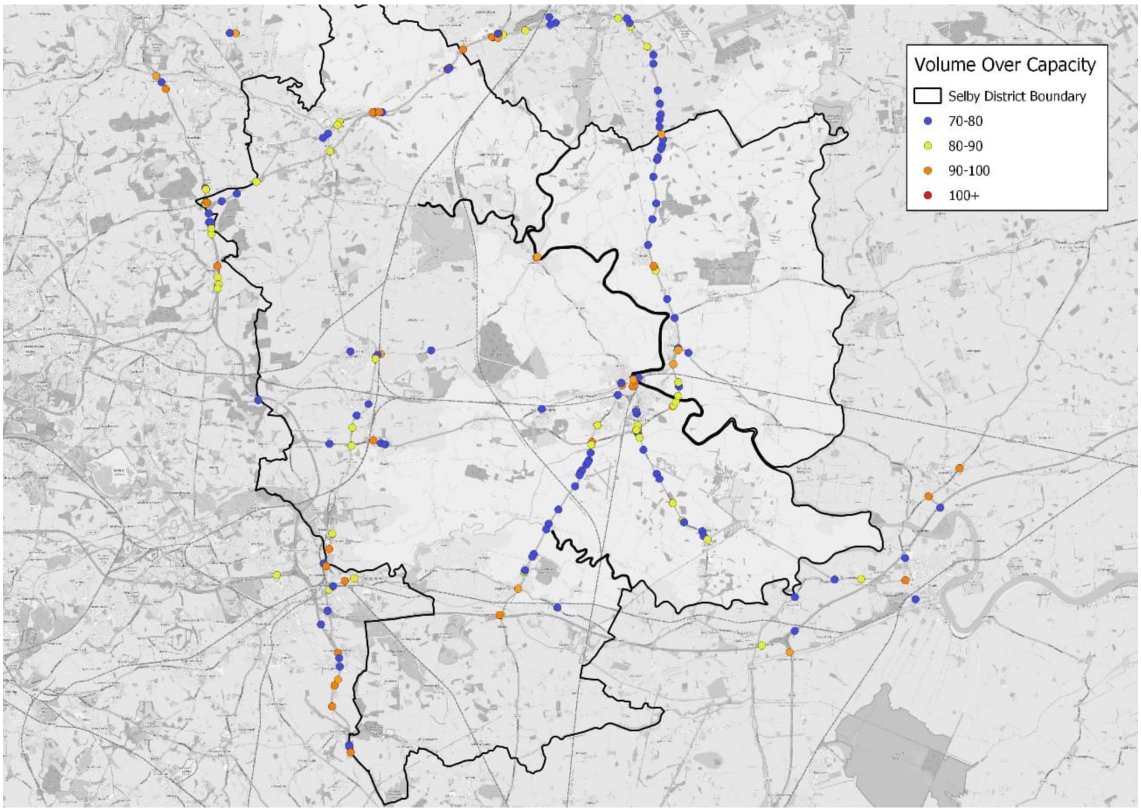


Figure 9-18 - Turn VOC 2040 DS (IP)

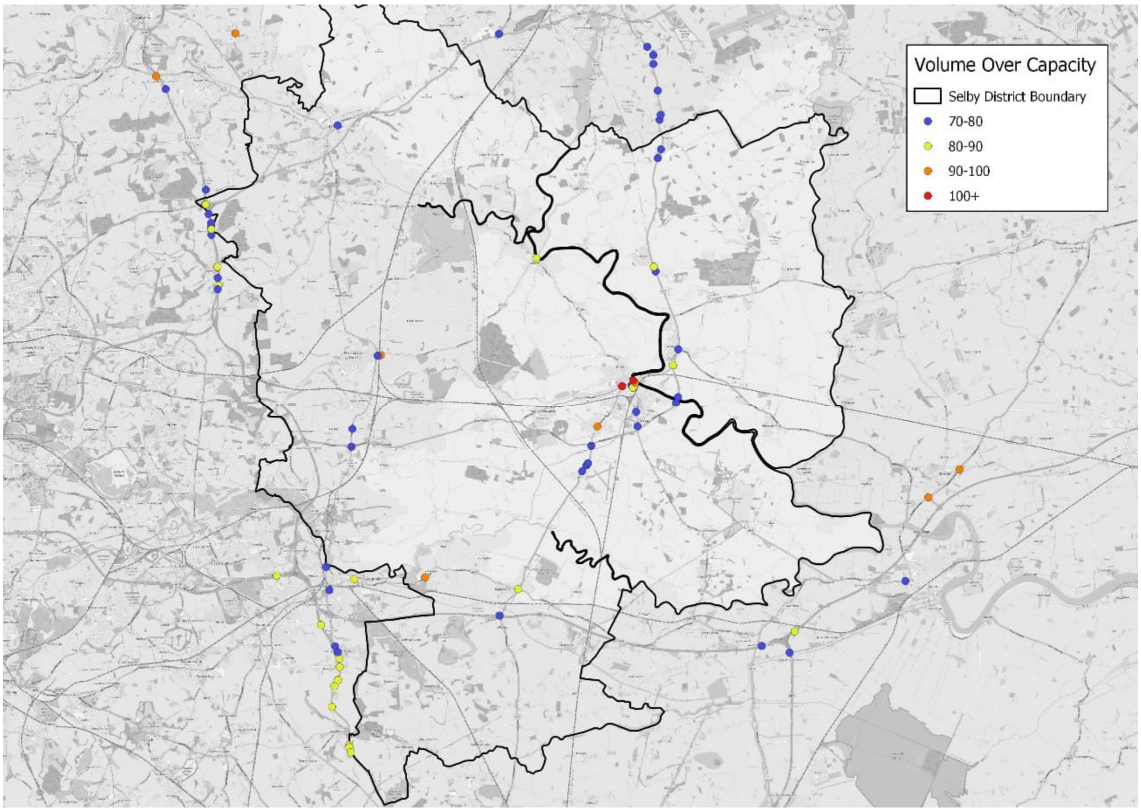
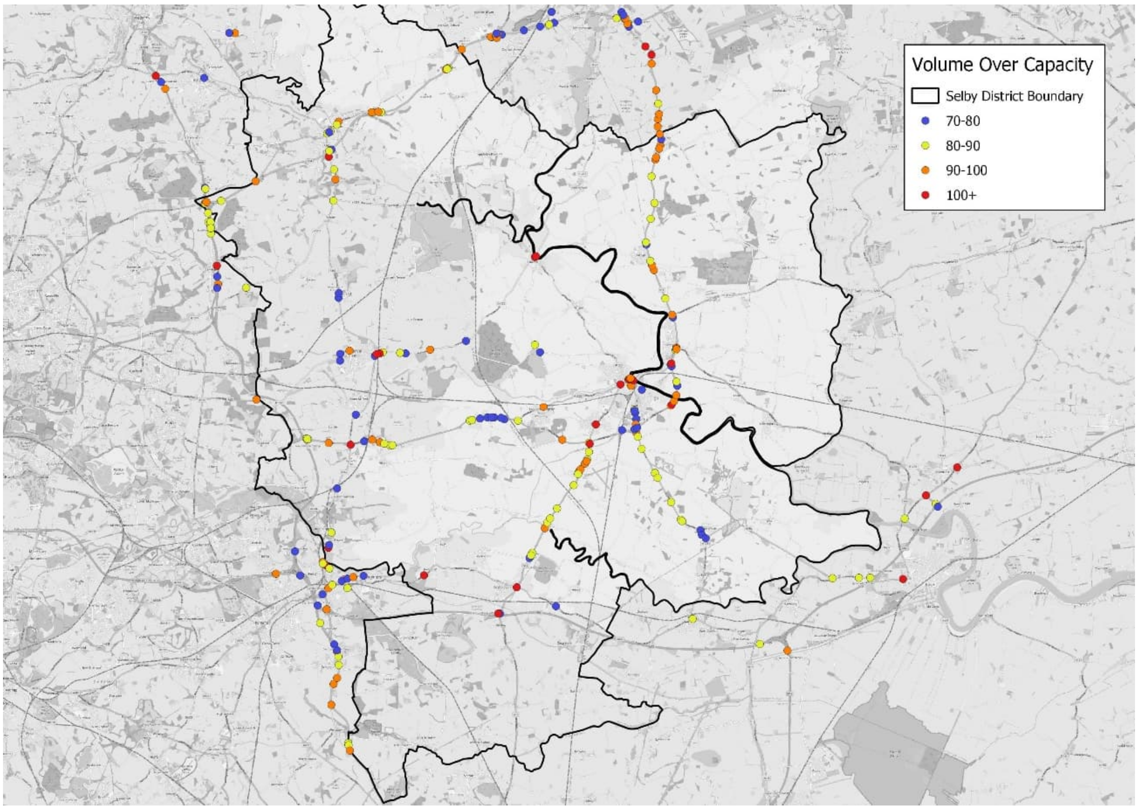


Figure 9-19 - Turn VOC 2040 DS (PM)



9.7 VOLUMES OVER CAPACITY (V/C)

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

9.7.2. V/C percentages for junctions in FMA for various scenarios are presented in sections above. Within SATURN, a V/C ratio is calculated for each permitted turn at a junction. The highest V/C 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.

9.7.3. Table 9-11 below contain details of V/C for the forecast years 2040 DM and 2040 DS

Table 9-11 – Junction Turn V/C Summary

Volume over Capacity	DM 2040			DS 2040		
	AM	IP	PM	AM	IP	PM
Number of junctions with turn V/C 80% to 90%	42	19	79	45	22	84
Number of junctions with turn V/C 80% to 90%	17	7	58	28	8	68
Number of junctions with turn V/C 100%+	11	0	14	16	2	28

9.7.4. The results are summarised as follows:

- The number of junctions over 80% and 100% V/C increases between DM and DS. This is expected given the forecast increase in traffic.
- In the AM and PM peaks the number of junctions over 100% V/C 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.

10 SUMMARY AND CONCLUSIONS

10.1 SUMMARY

10.1.1. This report concentrates on the development and results of the Do Minimum and Do Something forecast models for the Selby District Strategic Transport Model suite as specified in the project scope.

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

10.1.3. 'Do Minimum' forecast models have been developed for the fixed scenario consisting of 'Near Certain' and 'More than Likely' development and supply assumptions in line with TAG M2 guidance.

10.1.4. 'Do Something' forecast models have been developed for the fixed scenario consisting of 'Reasonably Foreseeable' and 'Hypothetical' development and supply assumptions in line with TAG M2 guidance.

10.1.5. 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.

10.2 CONCLUSIONS

10.2.1. Model runs have been reviewed and analysed in Chapters 7, 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.

10.2.2. 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.

10.3 NEXT STAGES

10.3.1. 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.

10.3.2. The demonstration forecasts described within this report reflect the content of the uncertainty log agreed during June 2023. 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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