Norfolk County Council

LONG STRATTON TRANSPORT MODEL

Local Model Validation Report

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1 INTRODUCTION

1.1 INTRODUCTION

1.1.1. Norfolk County Council (NCC) has commissioned WSP to support the delivery of a Department for Transport (DfT) compliant Outline Business Case (OBC) for the Long Stratton Bypass (LSB) Scheme, a new road around the existing Long Stratton settlement encouraging traffic using the A140 to avoid travelling through the town.

1.1.2. This report provides a summary of the development and results of the base year Long Stratton Transport Model (LSTM). LSTM was developed to support the business case for the proposed LSB in Long Stratton, Norfolk. The transport model was developed to accurately represent existing traffic conditions so that it could be used to predict the future traffic condition with and without the LSB. The LSTM has been generated by expanding the existing Suffolk County Transport Model (SCTM). SCTM is a model developed for Suffolk County Council (SCC) for their scheme appraisal forecast modelling and it has been agreed between NCC and SCC that this was the best tool to use to assess the LSB.

1.1.3. The development of the transport model was undertaken in accordance with the DfT's guidance and the results of this exercise are discussed in the document.

1.2 PROJECT BACKGROUND

1.2.1. The SCTM has a base year of 2016 and was developed by WSP as a multi-purpose strategic modelling tool for Suffolk at the county level to enable SCC, Local Planning Authorities (LPAs) and other parties to test a variety of transport related improvements such as:

- Highway scheme appraisal;
- Major public transport business cases and funding applications;
- Inputs for transport business cases and funding applications;
- Inputs for environment appraisals;
- Local plan assessments; and
- Development impact assessment.

1.2.2. The SCTM has been developed to an extent that it is able to serve as a high-level strategic assessment tool for all such applications.

1.2.3. The model can quantify the benefits of policy change or new transport infrastructure, enabling the assessment of future transport proposals and developments (including those which are developer led) in an efficient, consistent, and evidenced based manner. This makes the model suitable for use for the appraisal of the LSB.

1.2.4. The model has been developed in accordance with the current DfT Transport Appraisal Guidance (TAG). TAG Unit M3.1 details the role of transport modelling and appraisal to assist in the provision of a consistent approach to the development of transport models such as the SCTM.

1.3 REFERENCES

1.3.1. This document refers to the following existing reports:

- Long Stratton Appraisal Specification Report (ASR);
- Long Stratton Data Collection Report.

1.4 PROPOSED USES OF THE MODEL

1.4.1. The appraisal of the proposed bypass, and the development of the LSTM base year model, will be by an extension of the SCTM.

1.4.2. The highway modelling consists of two main tasks:

- Enhancing the 2016 SCTM in the Long Stratton area and ensuring it replicates observed counts and journey times by meeting specified TAG criteria; and
- Developing two future year models based on household and job growth between 2016, 2024 and 2039, which represent both a Do Minimum and Do Something Scenario (with the inclusion of the proposed bypass).

1.4.3. The proposed bypass will open in 2024. Forecast modelling proposes to assess the opening year of the scheme and 15 years after opening and as such 2024 and 2039 will form the two forecast years.

1.4.4. The LSTM will therefore be used to inform NCC of the strategic impact of the bypass and allow for calculation of benefits using TUBA.

1.5 GUIDANCE

The model development has been guided by the following units of the DfT's TAG guidance:

- Unit M1 "Principles of Modelling and Forecasting" (January 2014)
- Unit M1.2 "Data Sources and Surveys" (January 2014)
- Unit M3.1 "Highway Assignment Modelling" (January 2014)

1.6 REPORT PURPOSE AND STRUCTURE

1.6.1. The purpose of this report is to summarise the work carried out by WSP in the development of the 2016 Base Year LSTM and to demonstrate that the model is a fair and accurate representation of existing traffic conditions in the Long Stratton area, making it suitable for the uses set out in section 1.4. This report is structured as follows:

- **Chapter 2**: Model Development Overview;
- **Chapter 3**: Data Collection;
- **Chapter 4**: Network Development;
- **Chapter 5**: Matrix Development;
- **Chapter 6**: Model Calibration and Validation;
- **Chapter 7**: Highway Assignment Model Performance; and
- **Chapter 8**: Summary and Conclusions.

2 MODEL DEVELOPMENT OVERVIEW

2.1 INTRODUCTION

2.1.1. This chapter of the report details the specifications of the LSTM, including the design of the model, geographical coverage of the model, its scope, and its intended function as a forecasting model.

2.2 MODELLED AREA

2.2.1. The LSTM Fully Modelled Area, formerly referred to as study area, is shown in **Figure 2-1**. As defined in the DfT's TAG guidance, the Fully Modelled Area (FMA) is the area over which proposed interventions are likely to have influence. In the SCTM, and therefore the LSTM, the area is bounded by Norwich in the north, by the coastline in the east, by Felixstowe and Sudbury in the south and by Newmarket and Thetford in the west.

2.2.2. The FMA is chosen to build a traffic model that covers a sufficient area to accurately model the reassignment and redistribution effects that are likely to be produced by new development and infrastructure schemes in Suffolk boroughs and South Norfolk.

2.2.3. As shown in **Figure 2-1** The fully modelled area is further subdivided into:

- **Area of Detailed Modelling (ADM)**. This is the area over which significant impacts of interventions are certain. Modelling detail in this area would be characterised by representation of all trip movements, small zones very detailed networks and junction modelling;
- **Long Stratton Study Area**. This is the area in which network and zone refinements were made for the purpose of the LSTM;
- **Rest of the Fully Modelled Area (RoFMA)**. This is the area over which the impacts of interventions are considered to be quite likely but relatively weak in magnitude. This area generally contains reduced level of detail, with principle strategic routes modelled and capacity restraint through the use of speed flow curves and strategically important junctions. For the purposes of this assessment, the FMA represents the wider area previously defined for the SCTM and hasn't been considered within the re-validation; and
- The rest of the UK represents the **External Area**.

2.2.4. The ADM and RoFMA form the FMA in which all modelled links are included as part of the simulation network. The External Area comprises locations outside of SCTM FMA and contains the buffer network.

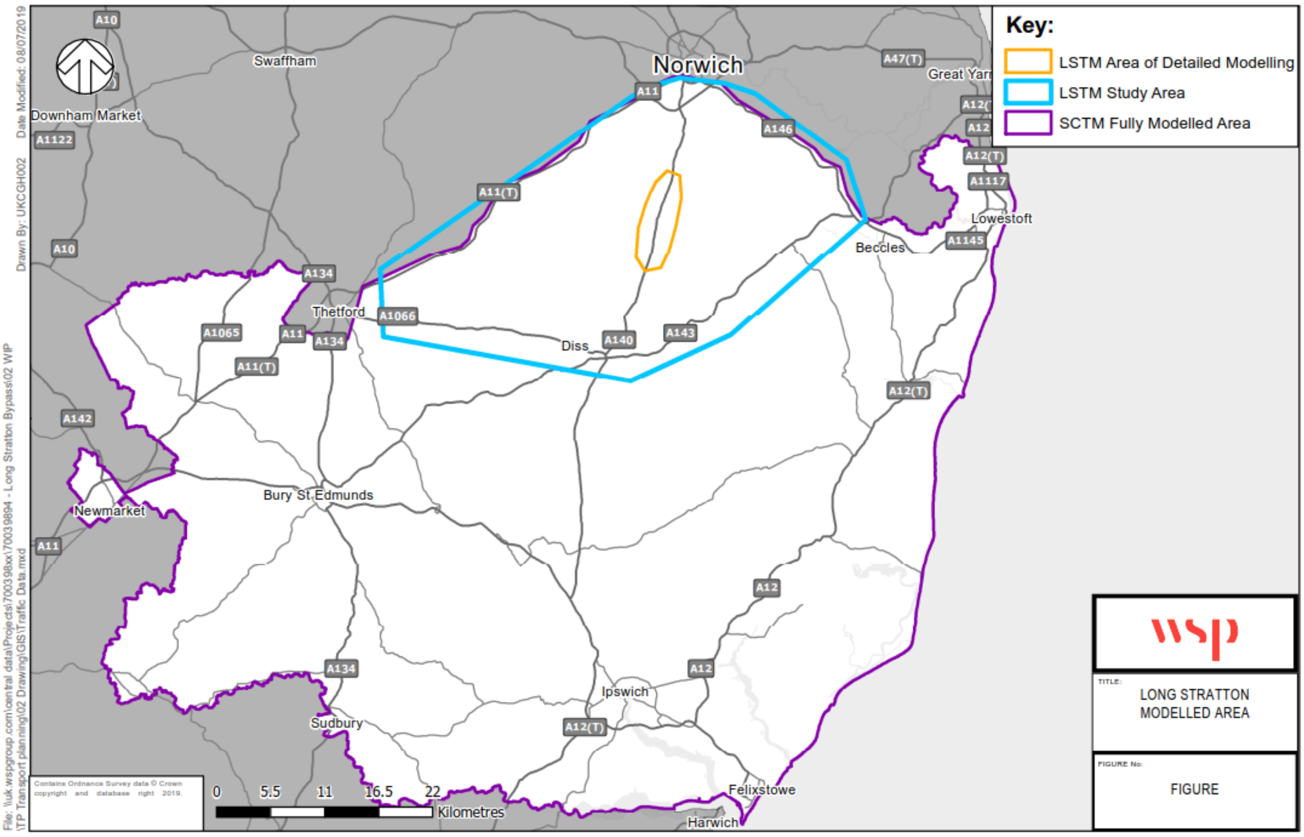

Figure 2-1: LSTM Modelled Areas

2.2.5. As shown in **Figure 2-1**, Norwich City Centre lies on the boundary of the LSTM Study Area and the city centre is within the SATURN buffer network; as such, minimal network detail has been included to model only core access and egress routes into Norwich City Centre, including A11, A47, A140 and A146. As the proposed scheme is a bypass and not expected to attract significant levels of strategic traffic from alternative adjacent or parallel routes, the impacts of traffic flows in Norwich in any forecast scenarios are expected to be minimal.

2.3 ZONE STRUCTURE

2.3.1. The LSTM zoning system was developed from the previous SCTM zoning system (within the study area), developed by WSP in the Long Stratton Study Area, with subsequent refinements. As part of the LSB analysis the zone system in the vicinity around the scheme was refined as set out in the Appraisal Specification Report.

2.3.2. The LSTM Zone boundaries are shown in **Figure 2-2** and **Figure 2-3**, before and after the refinements made for the purpose of this assessment.

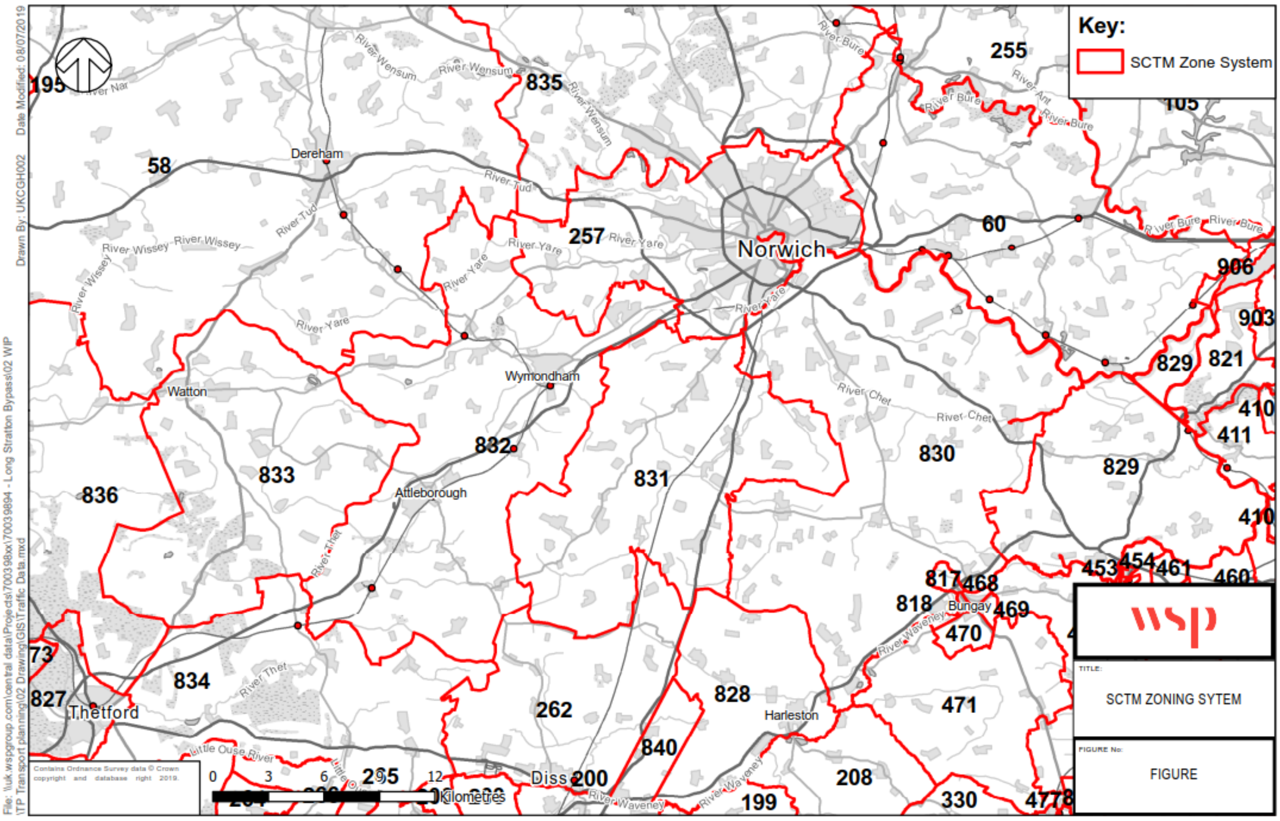

Figure 2-2: SCTM Zoning System

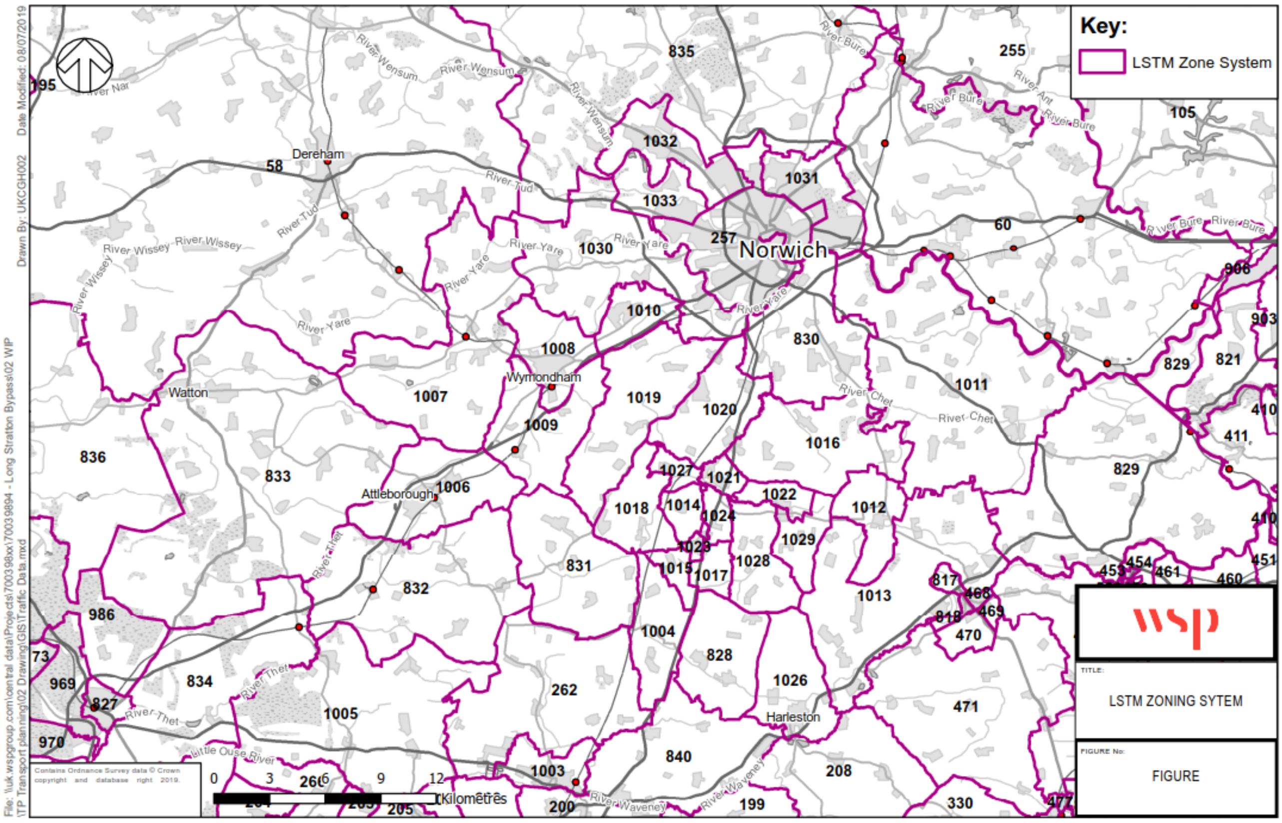

Figure 2-3: LSTM Zoning System

2.4 HIGHWAY NETWORK IMPROVEMENTS

2.4.1. The LSTM network was based on the SCTM network, with refinements incorporated within the LSTM study area. Whilst the SCTM included the A140 between Diss and Norwich, there were limited junctions and/or intersections with local road networks where vehicles could access or egress the A140. It was considered appropriate to add additional road network detail within South Norfolk in order to calibrate and validate link counts, screenlines and journey times and to ensure vehicle volumes, travel times and speeds within the model were reflective of the observed conditions.

2.4.2. Highway network detail was added to reflect the key routes between local towns and villages and in order to model zone refinements that mirrored the location of observed demand. Critically, additional network detail, a thorough review of coding and modelling of specific junctions was updated within Long Stratton itself in order to accurately reflect the observed conditions and delays along this section of the A140; the base year validation is dependent on the level of network detail and directly impacts the associated benefits of the proposed infrastructure scheme.

2.4.3. In summary, the LSTM was developed from the SCTM model. Subsequent checks and refinements of the network were completed to ensure the model was reflective of accurate information in the base year of 2016. More details can be found about the LSTM network in Chapter 4.

2.5 BASE YEAR

2.5.1. As the model is an enhancement of the SCTM to allow for assessment of the proposed bypass, the LSTM also has a base year of 2016 which is consistent with the data collection undertaken to inform the original model build. As noted within the Data Collection Report, all count data within the Long Stratton study area went through a detailed calibration and validation process specifically for the local model validation relevant to Long Stratton.

2.6 MODEL TIME PERIODS

2.6.1. The model has been developed for the following time periods:

- AM Peak Hour: 08:00 – 09:00;
- Average Interpeak Hour: 10:00 – 16:00; and
- PM Peak Hour: 17:00 – 18:00.

2.6.2. These time periods are consistent with the Mobile Network Data (MND) which is the primary input to the trip matrices and is only available in these pre-determined periods. To adjust to an alternative period would be difficult and lead to unverified modifications to the distribution and trip volumes. These hours also ensure consistency with forecast development trip rates.

2.6.3. Manual Classified Count (MCC) and Automatic Traffic Count (ATC) data has also been analysed to determine the peak hours. Total flow across all sites was used to obtain one hour rolling totals. The peak hours as identified from MCC data were 7:45-8:45 for AM peak and 16:30-17:30 for PM peak, and 7:30-8:30 and 16:30 - 17:30 respectively ATC data. The difference between the modelled hours and these peak hours is less than 2% so is not deemed significant.

2.6.4. The modelled hours therefore provide the most appropriate basis for the LSTM.

2.7 USER CLASSES

2.7.1. SATURN permits a multiple user class assignment in which combinations of vehicle type and journey purpose may be assigned onto the highway network. This enables different generalised cost equations to be used and provides additional granularity in any economic appraisal. The LSTM includes ten user classes:

- User Class 1: Cars Home Based Work - Inbound;
- User Class 2: Cars Home Based Work - Outbound;
- User Class 3: Cars Home Based Employer Business - Inbound;
- User Class 4: Cars Home Based Employer Business - Outbound;

- User Class 5: Cars Non-Home-Based Employer Business;
- User Class 6: Cars Home Based Others – Inbound;
- User Class 7: Cars Home Based Others – Outbound;
- User Class 8: Cars Non-Home-Based Others;
- User Class 9: Light Goods Vehicles; and
- User Class 10: Heavy Goods Vehicles.

2.7.2. The user class segmentation has been carried over from SCTM and has been done in this way to aid the conversion of highway assignment matrices in Origin-Destination format into Production-Attraction matrices in the SCTM Demand Model. The SCTM Demand Model needs to be able to distinguish which part of a trip is home-based, inbound; meaning an individual is heading towards their place of residence, and outbound; an individual is leaving their home at the start of the trip. This directionality of trips is available in the Mobile Network Data (MND) which was used to build the matrices and therefore this information was utilised rather than the SCTM Demand Model having to infer directionality of home-based trips artificially from user classes which combine the inbound and outbound direction of home-based trips.

2.7.3. Public Service Vehicles (PSVs) (buses) have not been included in the model as a distinct user class and have been modelled on the network as fixed flows. These are defined within the model input files for a specific route and with a defined frequency relevant to the hour modelled.

2.8 PASSENGER CAR UNIT FACTORS

2.8.1. Traffic models generally require trips specified in terms of Passenger Car Units (PCU) per hour and as such it is important to apply a conversion factor to vehicles to convert them to PCUs prior to assignment to allow a consistent approach to assess all User Classes. The vehicle types and their corresponding PCU factors used within the LSTM are detailed below:

- Car: 1.0;
- LGV: 1.0; and
- HGV: 2.3.

2.8.2. These are consistent with the PCU factors within TAG Unit M3.1 – D7 criteria for dual carriageways and motorways, and on other road types.

2.9 SOFTWARE PLATFORM

2.9.1. The existing SCTM has been developed within SATURN (Simulation and Assignment of Traffic to the Urban Road Network), which is a transport modelling software developed by Atkins and University of Leeds. As the LSTM is an enhancement of the 2016 SCTM, this model uses the latest version at the time of development of SATURN 11.4.07H MC. This allows for the utilisation of the latest improvements to SATURN, such as better convergence and use of the UFO in Multi Core Matrix Estimation.

2.9.2. The SCTM comprises a Highway Assignment Model (HAM) built in SATURN, as well as a Public Transport Assignment Mode (PTAM) and Variable Demand Model (VDM) development in VISUM. The development of the LSTM and subsequent assessment uses the HAM only as the focus of the proposal on how the highway network within South Norfolk and Mid Suffolk is affected by the proposed infrastructure. WSP have demonstrated that a VDM assessment was not required and this has been agreed with the DfT In January 2020, see separate document - **Appendix A**.

3 DATA COLLECTION

3.1 INTRODUCTION

3.1.1. An extensive data collection programme was undertaken in 2016 to support model development and provide sufficient data to enable the calibration and validation of the SCTM. As part of the model refinement to assess the proposed Long Stratton Bypass, supplementary data collection was commissioned in 2019.

3.1.2. The LSTM Data Collection Report (June 2020) provides a more in-depth analysis of the existing data sources and the data collected specifically for the enhancement of the modelled study area. This includes details of the count data collected within the vicinity of the proposed bypass and within the Long Stratton Study Area. More details of this can be found in the LSTM Data Collection Report (June 2020).

3.1.3. This section provides details on the data collected and its uses within the model.

3.2 EXISTING DATA

3.2.1. County wide survey data was commissioned in August 2015 and April 2016 as part of the SCTM update and a number of these surveys were located within the Long Stratton Study Area. All survey data that fell within the LSTM Study Area boundary was brought into the calibration and validation process and statistics.

3.2.2. Additional observed data was commissioned by Cannon – a consultant working for the Long Stratton Developer on the Transport Assessment – and undertaken by Advanced Transport Research in 2015, was supplied to WSP to support the Long Stratton Bypass strategic assessment. Cannon have provided WSP their Traffic Data Analysis Report that is included in the Data Collection Report.

3.2.3. Survey locations, undertaken as part of the county wide collection in 2016 or supplied from Cannon and undertaken in 2015, alongside those commissioned for the purpose of the LSTM are shown in **Figure 3-1**. All count data within the Long Stratton study area went through a detailed calibration and validation process specifically for the local model validation relevant to Long Stratton

3.2.4. **Table 3-1** identifies which surveys were commissioned as part of the original SCTM model build; the surveys were undertaken in January 2015, August 2015 and April 2016. A factor, specific to the local authority, was extracted from NTEM 7.2 in order to adjust the counts to 2016.

Table 3-1: LSTM Counts undertaken for SCTM development

Site Ref	Date	Data Type	Location	Direction
58	April 16	ATC	Harleston B1116 Harleston Road	Northbound / Southbound
67	April 16	ATC	Stuston A143 Old Bury Road	Eastbound / Westbound
69	April 16	ATC	Redgrave B1113	Northbound / Southbound
196	April 16	ATC	Bungay A144 Broad Street	Northbound / Southbound
197	April 16	ATC	Bungay Beccles Road	Eastbound / Westbound
198	April 16	ATC	Bungay Flixton Road	Northbound / Southbound
199	April 16	ATC	Bungay A144 St John's Road	Northbound / Southbound
200	April 16	ATC	Bungay Flixton Road	Eastbound / Westbound
201	April 16	ATC	Bungay Watch House Hill	Eastbound / Westbound
202	April 16	ATC	Bungay A144	Eastbound / Westbound
220	April 16	ATC	Scole A140 Scole Bridge	Northbound / Southbound
A11 TMU Site 6360/1	April 16	TRADS	A11 TMU Site 6360/1 On Link A11 Between A1075 And B111	Northbound / Southbound
Y056	April 16	ATC	North Of B1077 Stuston	Northbound / Southbound

Site Ref	Date	Data Type	Location	Direction
2	Aug 15	MCC	Ipswich Road South	Eastbound / Westbound
3	Aug 15	MCC	The Street North	Northbound / Southbound
3	Aug 15	MCC	The Street South	Northbound / Southbound
4	Aug 15	MCC	Norwich Road	Northbound / Southbound
4	Aug 15	MCC	Hill Farm Road	Eastbound / Westbound
4	Aug 15	MCC	The Street	Northbound / Southbound
5	Aug 15	MCC	Hill Farm Road	Eastbound / Westbound
8	Aug 15	MCC	Markshall Farm Road	Eastbound / Westbound
8	Aug 15	MCC	A140 Ipswich Road South	Northbound / Southbound
Site 1	Jan 15	ATC	A140	Northbound / Southbound
Site 2	Jan 15	ATC	A140	Northbound / Southbound
Site 3	Jan 15	ATC	B1113	Northbound / Southbound
Site 4	Jan 15	ATC	B1113	Northbound / Southbound
Site 5	Jan 15	ATC	Wymondham Road	Eastbound / Westbound
Site 6	Jan 15	ATC	The Street	Eastbound / Westbound
Site 7	Jan 15	ATC	Bunwell Street	Eastbound / Westbound
Site 8	Jan 15	ATC	The Turnpike	Eastbound / Westbound
Site 9	Jan 15	ATC	A140	Northbound / Southbound
Site 10	Jan 15	ATC	Hardwick Road	Northbound / Southbound
Site 11	Jan 15	ATC	The Street	Northbound / Southbound
Site 12	Jan 15	ATC	Broaden Lane	Northbound / Southbound
Site 13	Jan 15	ATC	Spring Lane	Northbound / Southbound
Site 14	Jan 15	ATC	Stoke Road	Northbound / Southbound
Site 15	Jan 15	ATC	A140	Northbound / Southbound
Site 16	Jan 15	ATC	B1134	Northbound / Southbound
Site 17	Jan 15	ATC	Tivitshall Road	Northbound / Southbound
Site 18	Jan 15	ATC	Short Green	Northbound / Southbound
Site 19	Jan 15	ATC	A146	Northbound / Southbound
Site 20	Jan 15	ATC	B1332	Northbound / Southbound
Site 21	Jan 15	ATC	B1527	Eastbound / Westbound
Site 22	Jan 15	ATC	B1332	Northbound / Southbound
Site 23	Jan 15	ATC	A11	Eastbound / Westbound
Site 1	Jan 15	ATC	Ipswich Road	Northbound / Southbound
Site 2	Jan 15	ATC	Hall Lane	Eastbound / Westbound
Site 3	Jan 15	ATC	Flowerpot Lane East of Manor	Eastbound / Westbound
Site 4	Jan 15	ATC	Flowerpot Lane West of Manor	Eastbound / Westbound
Site 6	Jan 15	ATC	Swan Lane East of Chequers	Eastbound / Westbound
Site 7	Jan 15	ATC	Swan Lane East of Manor	Northbound / Southbound
Site 8	Jan 15	ATC	Norwich Road South of Church Lane [30M]	Northbound / Southbound
Site 9	Jan 15	ATC	Church Lane	Eastbound / Westbound

Site Ref	Date	Data Type	Location	Direction
Site 10	Jan 15	ATC	Norwich Road North of Church Lane [50M]	Northbound / Southbound
Site 11	Jan 15	ATC	Norwich Road North of B1527	Northbound / Southbound
Site 12	Jan 15	ATC	B1135	Northbound / Southbound
Site 13	Jan 15	ATC	B1527	Eastbound / Westbound

3.3 COMMISSIONED DATA

3.3.1. WSP commissioned Nationwide Data Collection (NDC) to undertake a comprehensive traffic survey collection process of key highway links and junctions in and around Long Stratton, Norfolk. These surveys were designed to complement the existing traffic data already available, to provide a complete set of observed traffic counts in the Long Stratton area. This data will be used to ensure that the traffic model represents the observed data accurately.

3.3.2. **Table 3-2** summarises the data which was collected for the LSTM.

Table 3-2: LSTM Commissioned Surveys

Survey Type	Number of Surveys
Manual Classified Counts (MCCs)	2
Automatic Traffic Counts (ATCs)	23

AUTOMATIC TRAFFIC COUNTS

3.3.3. Automatic Traffic Counts (ATCs) were collected in 15-minute intervals on key links and screenlines within the model across a two-week period from Friday 15th June 2018 to remove day variation in traffic flow. The 2018 data has been adjusted to 2016 using TEMPro growth factors.

3.3.4. Vehicles were classified into seven vehicle types as follows:

- Cars (CAR);
- Taxi (TAXI);
- Light Goods Vehicles (LGV);
- Other Goods Vehicles type 1 (OGV1);
- Other Goods Vehicles type 2 (OGV2);
- Public Service Vehicle (PSV);
- Motorcycles (MCL); and
- Pedal Cycles (PCL).

3.3.5. The ATCs included in the calibration and validation process are listed in **Table 3-3** and presented in **Figure 3-1**, demonstrating which counts were undertaken in 2018.

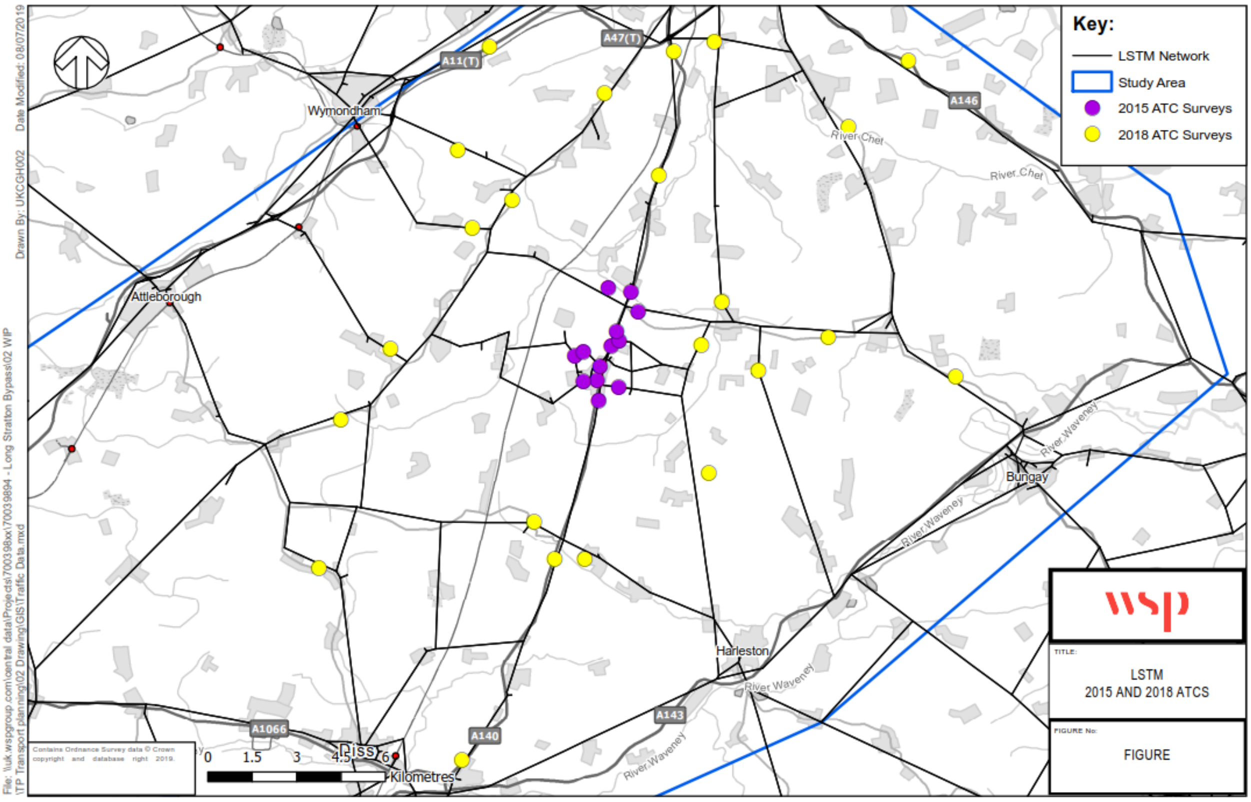

Figure 3-1: LSTM ATC Data

MANUAL CLASSIFIED TURNING COUNTS

3.3.6. MCCs were undertaken at various key junctions within the LSTM Study Area and were carried out on a single day, Wednesday 13th June 2018, during the two-week ATC period. Survey data was collected in fifteen-minute intervals between the hours of 07:00 and 19:00.

3.3.7. MCCs were undertaken at the following junctions:

- Site 1 – A140 Norwich Road / B1134 Tivetshall Road / Station Road; and
- Site 2 – A140 / A47.

3.3.8. **Table 3-2** presents a full list of ATC and MCC counts used in the LSTM validation and calibration.

Table 3-3: LSTM Commissioned Count Site Locations

Site Ref	Date	Data Type	Location	Direction
1	June 18	ATC	A140	Northbound / Southbound
2	June 18	ATC	A140	Northbound / Southbound
3	June 18	ATC	B1113	Northbound / Southbound
4	June 18	ATC	B1113	Northbound / Southbound
5	June 18	ATC	Wymondham Road	Eastbound / Westbound
6	June 18	ATC	The Street	Eastbound / Westbound
7	June 18	ATC	Bunwell Street	Eastbound / Westbound
8	June 18	ATC	The Turnpike	Eastbound / Westbound
9	June 18	ATC	A140	Northbound / Southbound
10	June 18	ATC	Hardwick Road	Northbound / Southbound
11	June 18	ATC	The Street	Northbound / Southbound
12	June 18	ATC	Broaden Lane	Northbound / Southbound
13	June 18	ATC	Spring Lane	Northbound / Southbound
14	June 18	ATC	Stoke Road	Northbound / Southbound
15	June 18	ATC	A140	Northbound / Southbound
16	June 18	ATC	B1134	Northbound / Southbound
17	June 18	ATC	Tivitshall Road	Northbound / Southbound
18	June 18	ATC	Short Green	Northbound / Southbound
19	June 18	ATC	A146	Northbound / Southbound
20	June 18	ATC	B1332	Northbound / Southbound
21	June 18	ATC	B1527	Eastbound / Westbound
22	June 18	ATC	B1332	Northbound / Southbound
23	June 18	ATC	A11	Eastbound / Westbound

JOURNEY TIMES

3.3.9. For LSTM development INRIX data was provided to WSP from NCC for the month of June 2016 excluding school holidays and bank holidays and the data was processed to provide an average weekday (Monday to Thursday) travel time by direction for each peak hour being modelled within the LSTM. It is worth noting that INRIX data sample size is approximately 2% of vehicles on the road, which is approximately 35 vehicles during the peak hours and is considered to represent a similar sample size to that of DfT TrafficMaster data or other similar data sources.

3.3.10. Journey Time data was collected for all strategic routes within the Long Stratton Study Area as indicated by the purple lines in **Figure 3-2**. The observed journey time information has been classified into 17 specific routes; the prior and post ME performance along these routes is described in Chapter 7.

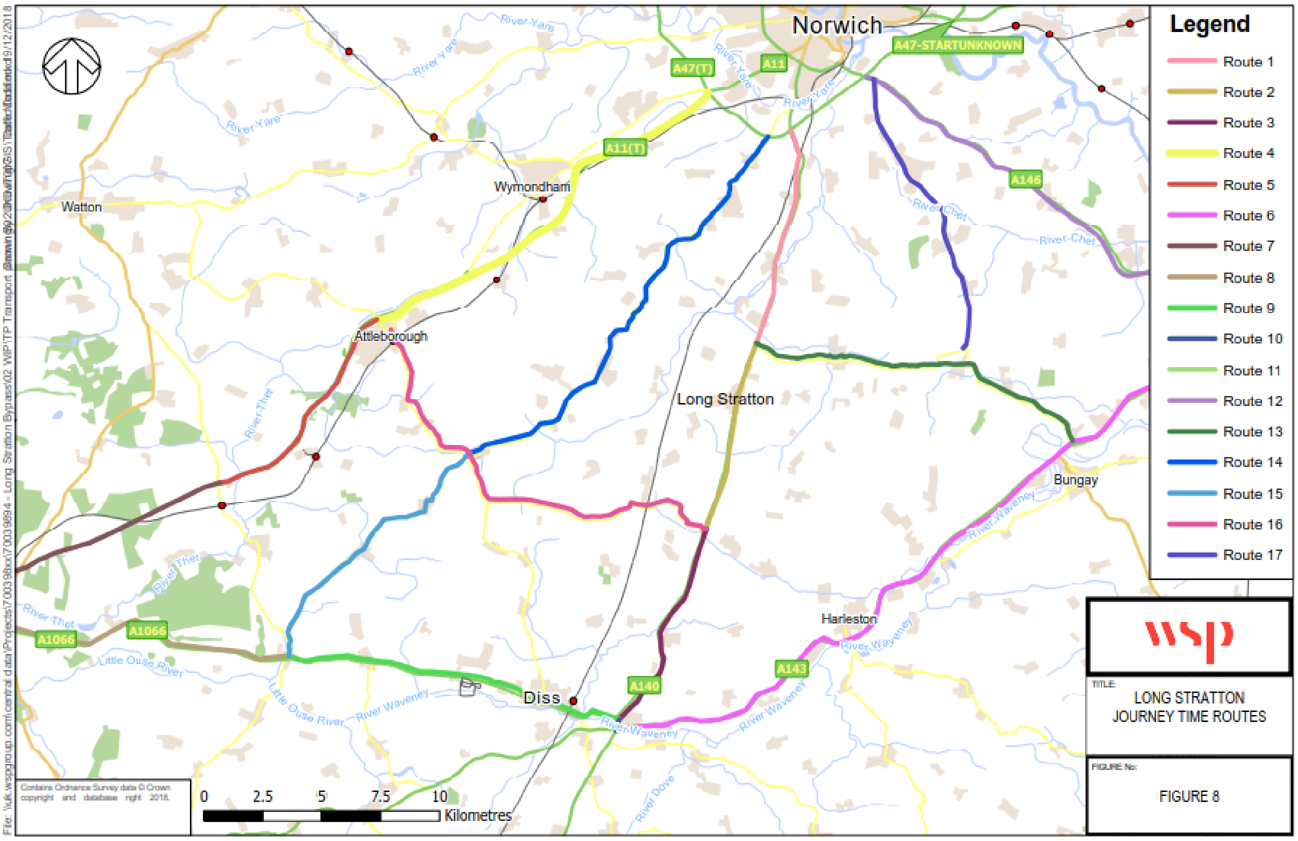

Figure 3-2: Journey Time Data Collection Routes

ROUTE 2 DETAILED ANALYSIS

3.3.11. In December 2019 / January 2020, WSP undertook journey time analysis along the A140, through Long Stratton, and more specifically Route 2 within the LSTM model. The purpose of this analysis was to thoroughly investigate the various data sources available to collect observed journey times and compare them to determine the most appropriate source for observed data within the LSTM validation exercise. The data sources discussed included INRIX Analytics, Google, WSP site visit, moving car observations undertaken by Cannon within their Transport Assessment and survey data commissioned by NCC. A detailed technical note was written to discuss WSP's findings and this can be found in the Data Collection Report June 2020.

3.3.12. The Long Stratton Journey Time analysis Technical Note, included as part of the Data Collection Report, notes that whilst INRIX data from June 2016 was used in the validation and development of the LSTM model, information for all years 2015 to 2019 was extracted for comparison and variability analysis. Following a review of the LSTM validation performance along Route 2 (A140 through Long Stratton) and despite the route meeting TAG criteria in both direction, in all three time periods (AM, IP and PM), it was deemed appropriate that INRIX data was extracted at the most segregated and finite detail level to ensure that the LSTM was accurate reflecting delays at the correct junctions along the routes entirety. As part of this process, the journey time variability was considered, and data extracted for Route 2 between 2015-2019 was compared and a review determined that journey times had remained relatively consistent; any fluctuations were able to be accredited to the construction period of the Hempnall Crossroads north of the scheme during 2019. Outliers were also removed when processing INRIX data for use in route validation.

3.3.13. The study into observed journey times demonstrated that INRIX data is the most appropriate means for data collection due to its accurate presentation of travel patterns both during a particular day, across the study month and over numerous recent years.

3.3.14. As a result of the detailed research, WSP re-extracted INRIX data along Route 2 in the smallest observed segments that the software allows; this meant that not only could we ensure that the overall route modelled time closely matched the observed, we could also ensure that the model matched the observed time at specific timing points along the A140 as often as possible. By having frequent timing points along the A140 route, WSP were able to ensure that the model reflected key points of delay or congestion along the route; most notably this was observed to occur at junctions with Hall Lane, Flowerpot Lane, Swan Lane and the pedestrian crossing just north of Swan Lane. The delays were caused by signalised junctions and queueing that occurred here; the council offices were also accredited to generating a large number of AM peak arrivals and PM departures which causes delay at A140 / Swan Lane with right turning vehicles queueing back along the A140 SB in the AM peak as reflected in the INRIX data and shown by the significantly reduced average speeds observed along these links. These observations and supporting delays and reductions in speed demonstrated by the INRIX data, were supported by the client's knowledge of the local area.

3.3.15. The validation statistics for Route 2, along with the other routes, is discussed in more detail in Chapter 6.

4 NETWORK DEVELOPMENT

4.1 INTRODUCTION

4.1.1. The 2016 SCTM has been refined within the Long Stratton Study Area to develop the LSTM. The refined network has been updated to take account of network detail that was previously included within the study area and, in the area within the vicinity of the proposed bypass scheme.

4.1.2. This section outlines the refinement of the SCTM and thus development of the LSTM for the 2016 base year for the purposes of assessing the LSB. This chapter covers the following elements:

- LSTM Network;
- LSTM Matrix;
- LSTM Assignments; and
- LSTM Counts.

4.2 LSTM NETWORK

4.2.1. The starting point for the LSTM was the SCTM which was developed by WSP in 2015 to provide a robust evidence base for a range of possible applications. Long Stratton, and the areas surrounding it, fell into the buffer network in the SCTM; for the LSTM model update the SCTM was reviewed and areas around the proposed Long Stratton bypass were identified for enhancement and were brought into the simulation area.

4.2.2. Traffic loads onto the model network from zones in the form of centroid connectors. The centroid zone connectors in the LSTM have been refined to realistically represent the way in which traffic joins the road network. In the ADM, specific access roads from residential and commercial areas have been used as a basis for connecting zones to the network via centroid connectors.

4.2.3. Zones in the External Area, which have a large geographical coverage and significant demand associated with them, have been generally connected to major routes to enter the network.

NETWORK ENHANCEMENT

4.2.4. The existing 2016 SCTM highway network has been updated to include significant more detail in the area of Long Stratton; within the area of detailed modelling this included a full review of all links and junctions to ensure sufficient link / junction detail were included, junctions were appropriate, turning movements adjusted to replicate road markings and signal timings and saturation flows were reviewed.

4.2.5. As Long Stratton is situated close to the edge of the SCTM simulation network. additional links and detail were added to the buffer network to ensure suitable route choice decisions could be made by vehicles entering the area of detailed modelling and to allow loading of traffic in the external areas and connect the simulation network to the long-distance zones.

4.2.6. The LSTM network was based on the SCTM network, with refinements incorporated within the LSTM study area. Whilst the SCTM included the A140 between Diss and Norwich, there were limited junctions and/or intersections with local road networks where vehicles could access or egress the A140. It was considered appropriate to add additional road network detail within South Norfolk in order to calibrate and validate link counts, screenlines and journey times and to ensure vehicle volumes, travel times and speeds within the model were reflective of the observed conditions.

4.2.7. Highway network detail was added to reflect the key routes between local towns and villages and in order to model zone refinements that mirrored the location of observed demand. Critically, additional network detail, a thorough review of coding and modelling of specific junctions was updated within Long Stratton itself in order to accurately reflect the observed conditions and delays along this section of the A140; the base year validation is dependent on the level of network detail and directly impacts the associated benefits of the proposed infrastructure scheme.

4.2.8. Network enhancements and refinements were verified using Google and OS maps, survey footage and aerial photography. Updates were made to the following:

- Node co-ordinates;
- Link length;
- Speed/flow relationship;
- Link type;
- Link capacity;
- One-way / two-way operation;
- Length and position of flares; and
- Access points.

4.2.9. Additional highway network was incorporated in the LSTM Study Area. The original highway network detail within the SCTM is shown in **Figure 4-1**; the highway network refinements made within the Long Stratton Study Area are demonstrated in **Figure 4-2**.

4.2.10. The enhancements made in the immediate area surrounding the proposed Long Stratton bypass are compared in **Figure 4-3** and **Figure 4-4** respectively.

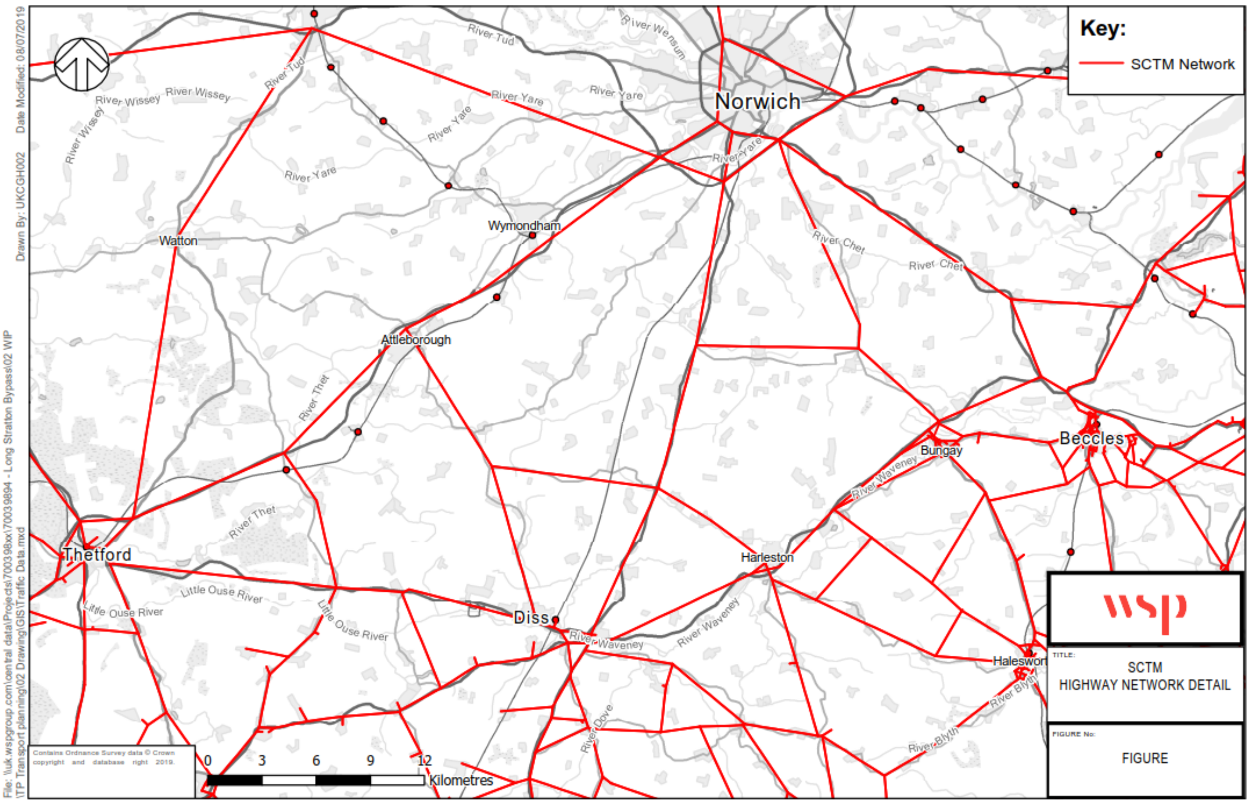

Figure 4-1: SCTM Highway Network Detail

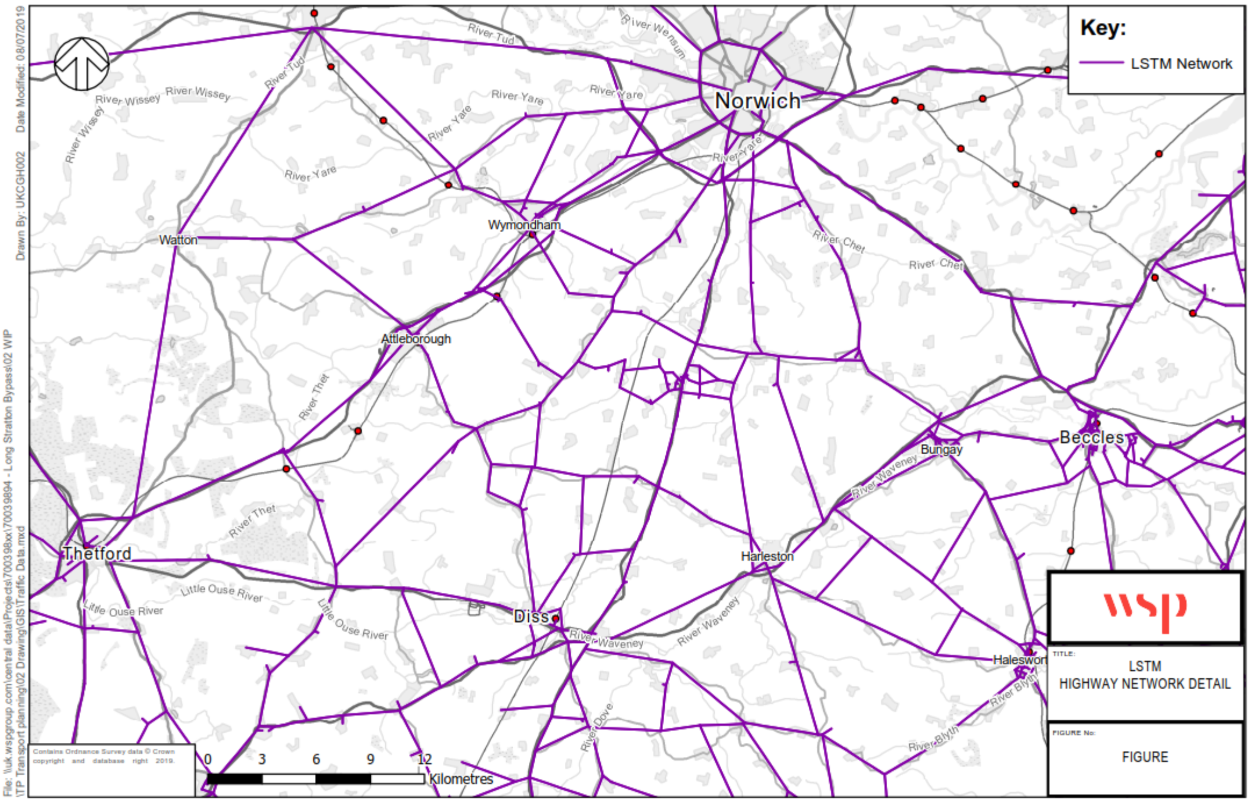

Figure 4-2: LSTM Highway Network Detail

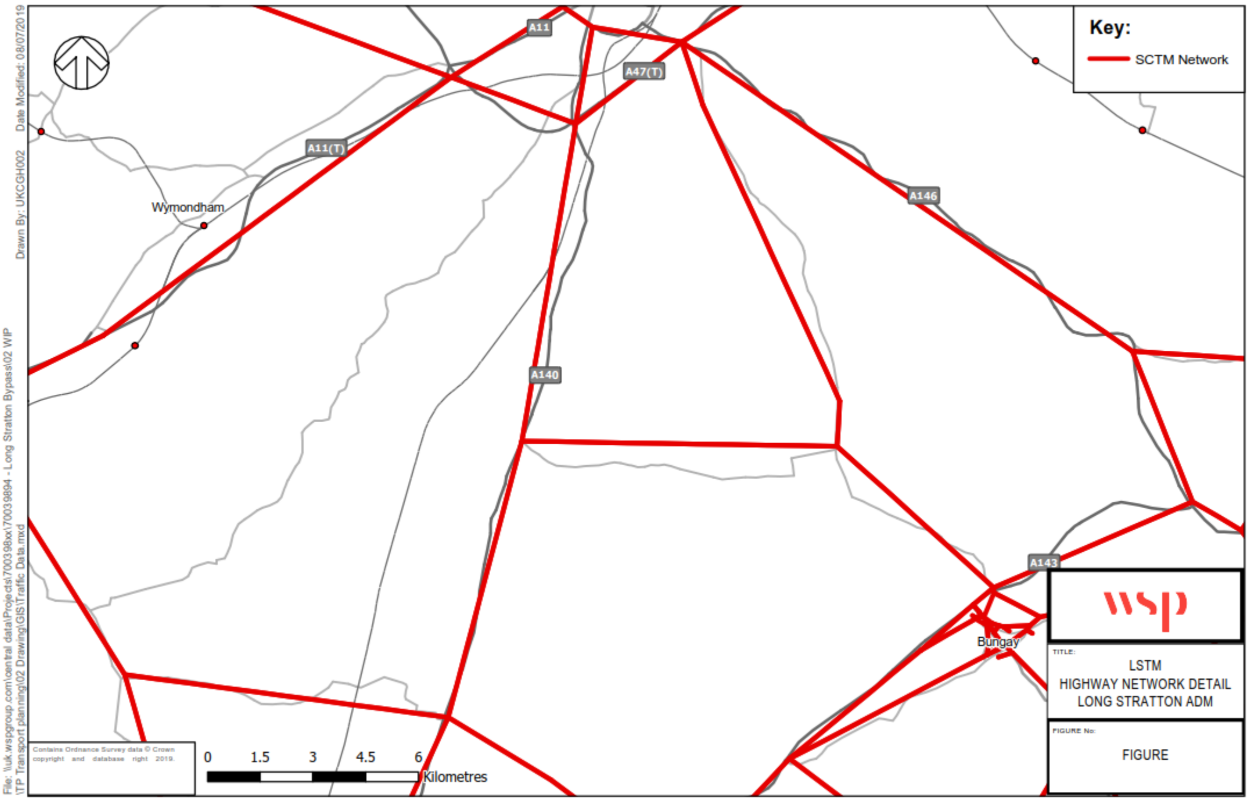

Figure 4-3: SCTM Highway Network Detail: Long Stratton ADM

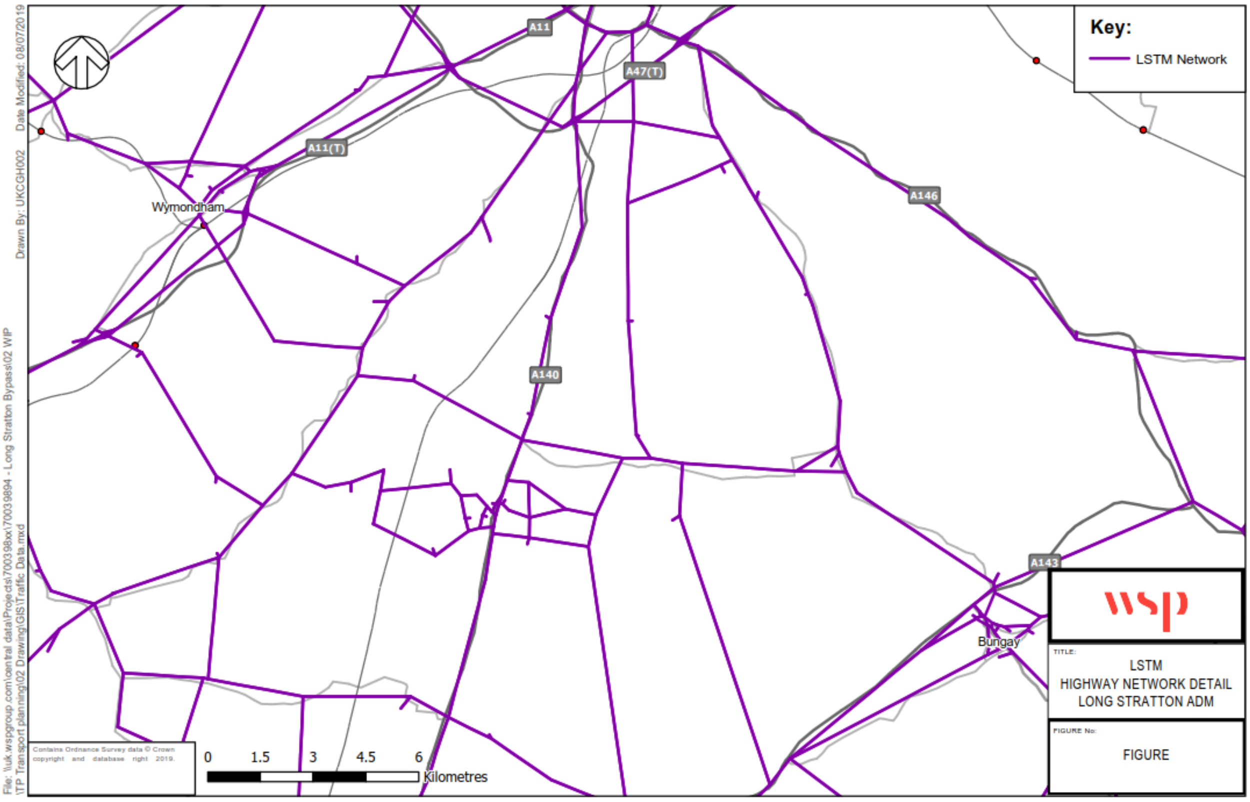

Figure 4-4: LSTM Highway Network Detail: Long Stratton ADM

JUNCTION CODING

4.2.11. To represent the effect of traffic interaction at junctions within the study area, the junctions were modelled in detail to take account of traffic flows and conflicts.

4.2.12. **Figure 4-5** shows the highway network and junctions which are coded in detail within the ADM for the LSTM. The level of junction detail has been extended and enhanced significantly to reflect the additional highway network data included as part of the LSTM model refinement.

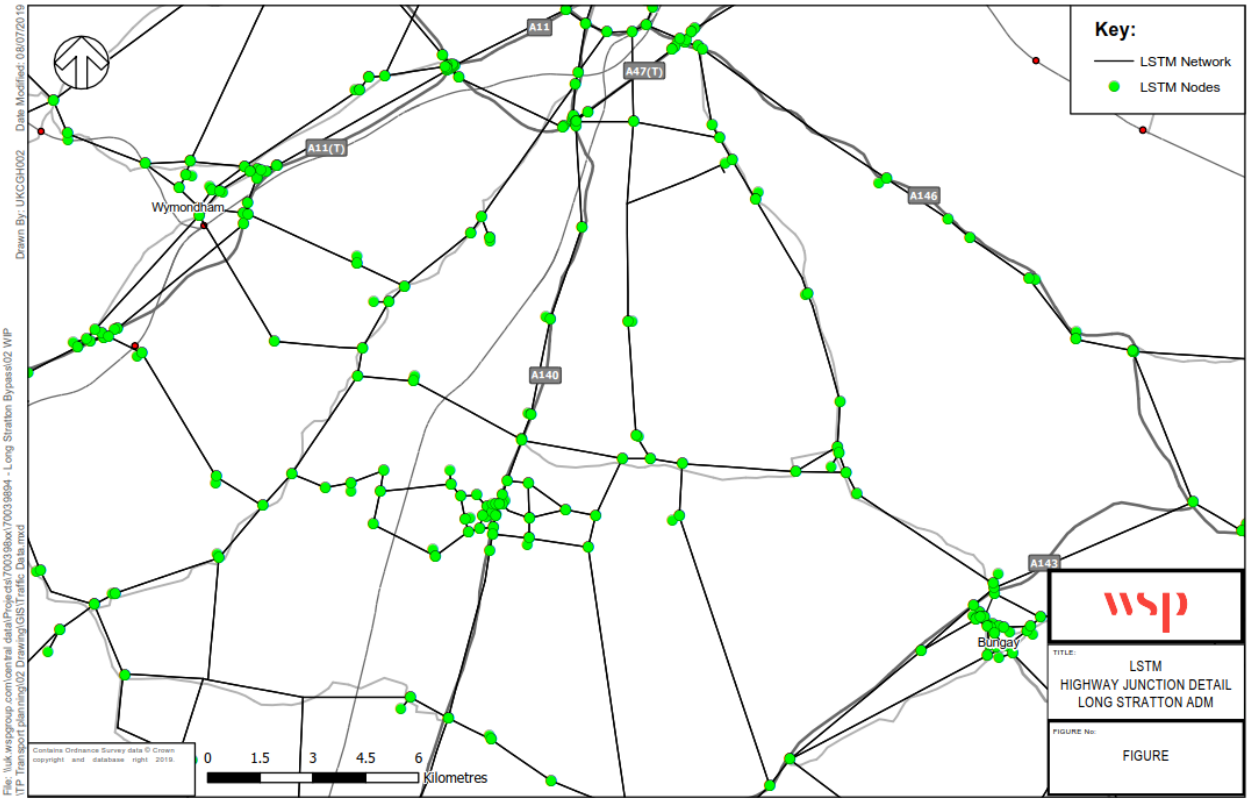

Figure 4-5: LSTM Highway Junction Detail: Long Stratton ADM

Lane Allocations

4.2.13. Lane allocations were checked using satellite and street level imagery to ensure the correct number of lanes and allowed turning movements (where lane markings and/or signage was apparent) were coded for the approaches at each junction in the model.

Junction Type

4.2.14. Checks were carried out for junction type using satellite imagery and street level data, with junctions split into the following types:

- Priority controlled junctions;
- Signal controlled junctions;
- Roundabouts (no U-turns allowed); and
- Roundabouts (U-turns allowed)

4.2.15. To represent the effects of traffic interaction at junctions within the study area, the junctions were modelled in detail to take account of traffic flows and conflicts.

4.2.16. Turning movement saturation flows at nodes have been calculated using TRL Research Report 67 (RR67) methodology. All junctions within the ADM are modelled in detail; the details of junction data collected for each junction was as follows:

- Number of arms, which need to be modelled;
- Type of junction control;
- Highway elements (Flare / Exploded);
- Lane allocations;
- Saturation flows;
- Gap times; and
- Signal data (if applicable).

4.2.17. The capacities of each turning movements were expressed in terms of PCUs per hour.

4.2.18. Only mini roundabouts were coded to not allow U-turns. For all other roundabouts coded as a single node, the junction type was coded as a roundabout which allows U-turns.

4.2.19. For roundabouts which had a mixture of priority controlled and signalised approaches, or where the junction was complex e.g. major 'A' road junction with slip roads, the junction was coded as an "exploded" roundabout. This means multiple nodes were used to code the junction in detail, with each approach separately modelled.

4.2.20. Signalised junctions were coded using traffic signal plans, and the stage timing information obtained from NCC. In case of pedestrian crossings and railway level crossings standard traffic and pedestrian / railway phase will be assumed for an hour timing.

Saturation Flows

4.2.21. The saturation flow values calculated for each junction type in the simulation network was reviewed during the calibration stage to ensure the junctions replicate observed behaviour. Where junction saturation flows were not directly calculated, default values adopted from those used in Highways England's Regional Transport Models have been used and are presented in **Table 4-1**.

Table 4-1: Default Saturation Flows - Priority Junctions

Movement Type	Saturation Flow (PCU / hr)
Major straight-ahead movement (unopposed)	1980
Major left turn movement (unopposed)	1500
Major right turn movement (opposed)	745
Minor left turn movement (opposed)	700
Minor straight ahead movement (opposed)	600
Minor right turn movement (opposed)	600

4.2.22. Signalised junctions were coded using traffic signal plans, where available, and the stage time information was obtained from NCC or estimated using on-street information. In the case of pedestrian crossings and railway level crossings, standard traffic and pedestrian / railway phase will be assumed for an hour timing. In the calculation of saturation flows, signalised junctions' movements are assumed to be unopposed by other traffic during each phase of the signal cycle. The default values for a signalised junction are shown in **Table 4-2**.

Table 4-2: Default Saturation Flows - Signalised Junctions

Movement Type	Saturation Flow (PCU / hr)
Straight ahead movement	1980
Left or right turn movement (including give-way)	1740

4.2.23. Roundabouts require special consideration. Unlike with other junction types, each turn needs to be given the total saturation flow for the approach e.g. if a roundabout has a two-lane approach, with one lane to turn left and one to turn right, each turn should be coded with a saturation flow of 2,200.

4.2.24. Saturation flows for roundabouts were calculated based on the geometry of the roundabouts using the relationships used in the ARCADY (Assessment of Roundabout Capacity and Delay) junction modelling suite. This program considers of the following physical characteristics of the junction:

- Inscribed circle diameter;
- Approach half width;
- Entry width;
- Flare length;
- Entry Angle; and
- Entry Radii.

4.2.25. Default saturation flows (PUC/Hr) adopted for roundabouts are given in **Table 4-3**. These values have been adopted to replicate typical ARCADY capacity estimates and have previously been utilised in a range of other models.

Table 4-3: Roundabout Entry Capacity Saturation Flows

Approach Lanes	1 Entry Lane	2 Entry Lanes	3 Entry Lanes	4 Entry Lanes
Single (3.5m)	1,130	1,670	2,030	
Single (5.0m)	1,510	1,940	2,250	2,450
Dual 2-lane		2,200	2,780	3,190
Dual 3-lane			3,330	3,940

4.2.26. For roundabouts coded as a single node, the overall circulatory saturation flow was set to be the same as the highest saturation flow on the approach arms of the roundabout.

4.2.27. For roundabouts which had a mixture of priority controlled and signalised approaches, or where the junction was complex e.g. major "A" road junctions with slip road, the junction was coded as an "exploded" roundabout. For these roundabouts, the saturation flow for circulatory movements on the roundabout was assumed to be 1,600 PCUs per hour per lane. The saturation flows for the give-way approaches were coded using values in **Table 4-1**. Large gyratory systems were also coded as a series of priority junctions for a better representation of journey times through the junction.

Gap Times

4.2.28. Gap acceptance parameters in seconds applied to individual roundabouts are provided in **Table 4-4**.

Table 4-4: Roundabout GAP Acceptance Parameters (seconds)

Approach Lanes	1 Entry Lane	2 Entry Lanes	3 Entry Lanes	4 Entry Lanes
Single (3.5m)	1.8	1.3	1.2	
Single (5.0m)	1.4	1.2	1.1	1.1
Dual 2-lane		1.1	1.0	0.9
Dual 3-lane			0.9	0.8

4.2.29. Global gap parameters were also defined as shown in **Table 4-5** and were used in the absence of values being explicitly coded at junctions.

Table 4-5: Global Gap Acceptance Parameters

SATURN Parameter	Junction Type	Gap Acceptance (seconds)
GAP	Priority / Signalised	1.5
GAPM	Merge	1.0

4.2.30. During calibration, junction capacities and gap times were altered from the default values listed above where appropriate. This occurred in instances where the modelled flows were found to match well in comparison to the observed flows, however the level of delay present in the Trafficmaster GPS data was not being emulated.

LINK CODING

4.2.31. Roads are represented by links in a traffic model. All A and B class roads as well as a number of minor roads within the study area have been included in the traffic model. All link lengths were compared against Google Maps / GIS layers of the area.

4.2.32. Information on roads was gathered from maps, plans and aerial photography. Speed flows relationships were then allocated to links based on the following criteria:

- Location and the type of road;
- Type of carriageways;
- Number of lanes;
- Class of roads;
- Quality of roads;
- Speed limits;
- Capacity of roads; and
- Level of frontage development.

Distance

4.2.33. Distances in both the simulation and buffer network consider the actual alignment of modelled road. Distances were measured using GIS incorporated detailed mapping and satellite imagery. Distances were also applied to zone connectors in the buffer network to better represent the travel time into the simulation network from the external zones.

Speed

4.2.34. Within the urban area for links below 1km the use of the model speed flow curves were deemed not to be necessary due to capacity restraints from the junctions at either end of the link. Speed flow curves applied within the SCTM were retained in the LSTM even if the distance was reduced to the splitting of a link.

4.2.35. The speed-flow curves are used to describe a link in terms of its capacity and associated traffic speeds and therefore they are used to determine the link speed based on the traffic flow on that link. When the flow reaches the critical point Qc (i.e. the flow is equal to the maximum capacity of the link) vehicle speeds start to decrease dramatically up to the point where speed becomes constant. The speed flow curves within the LSTM remained consistent with those in the SCTM and a list of the speed flow curves used is presented in separate document - **Appendix B**.

Number of Lanes

4.2.36. Checks were made to ensure the correct number of lanes were allocated to links in the model. It was ensured the coding of the number of lanes for a link matched the speed flow curve for instances where these capacity restraints were applied.

Penalties / Bans

4.2.37. During auditing and building of the network, instances where there were restrictions in terms of the vehicle types allowed along links were considered. Height and weight restrictions on roads were taken into account by banning the HGV user class in the matrix from using these links.

5 MATRIX DEVELOPMENT

5.1 INTRODUCTION

5.1.1. The 2016 refinement of the SCTM to generate the LSTM has involved changes to the trip matrices to generate trips reflective of the updated zoning system. The underlying data has remained the same and comes from the MND although also includes the development of a synthetic matrix to fill in missing short distance trips that are not captured within the MND. This section sets out the methodologies applied as part of the update.

5.2 PRIOR MATRICES

5.2.1. Traffic loads onto the model network from zones in the form of centroid connectors. The centroid zone connectors in the LSTM have been refined to realistically represent the way in which traffic within Long Stratton joins the local road network. In the ADM, specific access roads from residential and commercial areas have been used as a basis for connecting zones to the network via centroid connectors. The zone system for the LSTM has been based on the SCTM zone system with refinements only in South Norfolk.

5.2.2. The prior matrix development process, originally undertaken for the SCTM and detailed within the SCTM LMVR Section 6.4 (included in separate document - **Appendix J**), was informed by a number of data sources, with each data source carefully considered to make the matrix development process robust as far as possible. The data sources used include the following:

- Mobile Network Data (MND) provided by Telefonica for April 2015;
- National Travel Survey (NTS) 2015 for the East of England;
- National Trip End Model (NTEM) 7.2;
- Census 2011 data including the following elements:
- Proportion of bus users compared to all road users from JtW data
- JtW data for car/bus/rail users
- Adults and Employed Persons numbers (Census Output Area basis)
- Workplace population (Workplace Zones basis)
- Car ownership data
- Values for vehicle occupancy from the WebTAG Databook (July 2017 edition); and
- Land area per Zone.

5.2.3. The initial zone system used by the mobile network data and used for generating the synthetic matrix data is at a Lower Super Output Area level within Suffolk, with external areas using Middle Super Output Area, District, or regional areas to represent the zones, with 755 zones in total. The mismatch in the number of zones between this initial system and the transport model system means that a correspondence process was carried out in order to assign each of the initial zones into the transport model zones within it.

5.2.4. The correspondence process was applied to the SCTM matrices using several datasets. These datasets are:

- Number of Adults from Census 2011;
- Number of Employed People from Census 2011;
- Workplace Population from Census 2011; and
- Land area per zone information from GIS.

5.2.5. For the SCTM prior matrix development, the Census 2011 data was proportioned out to the relevant zones that intersect the Census features.

5.2.6. In some cases, the Census data was manually adjusted after this intersect process to ensure that populations are in the correct places e.g. the workplace population associated with Ipswich Hospital would have been assigned to the transport network in the wrong place if it had been left in the original assignment position from the intersect, so this workplace population has been moved to an adjacent zone to correct this.

5.2.7. The zoning system for the MND which underpins the traffic demand within the original SCTM and as such the LSTM, are based on the following boundaries:

- 2011 Census Lower Super Output Areas (LSOA);
- 2011 Census Wards;
- 2011 Census Middle Super Output Area (MSOA); and
- Districts.

5.2.8. The new zones are consistent with the current census geographies wherever possible to minimise the manipulation of datasets and reduce the number of assumptions regarding the disaggregation of data.

5.2.9. The process that was used for the SCTM prior trip development was very recently updated at the time of the prior matrix for Long Stratton being developed, as parts of the matrix development process were still being refined when the Long Stratton work was carried out. Therefore, there was not a review of how appropriate the matrix development methodology was at the time because it was up-to-date.

5.2.10. Journey to work data was not used for the distribution; the distribution patterns for the prior are based on two sources: the MND uses the distribution inherent in the MND (we have not directly changed this but there are indirect effects as a result of having a road matrix at the start and splitting out bus / car / LGV which then each have their own distribution patterns dependent on the splitting methodology), and the synthetic uses the a gravity model distribution that uses costs based on crow-flies distances with the gravity function calibrated to match NTS data. The matrix is then a hybrid of these two sources so uses these distributions for the relevant part of the matrix.

5.2.11. The LSTM model network and zoning system has primarily been refined within South Norfolk, where the scheme lies, and as such MND provided by Telefonica which was used as the basis of the matrices for the SCTM has been disaggregated – based 2011 Census information – to represent the zoning system enhancements shown in **Figure 2-3**.

5.3 ASSIGNMENT

5.3.1. Model assignment of trips to the highway network was undertaken using a standard approach based on a 'Wardrop User Equilibrium', which seeks to minimise travel costs for all vehicles in the network. The Wardrop User Equilibrium is based on the following proposition:

"Traffic arranges itself on congested networks such that the cost of travel on all routes used between each origin-destination pair is equal to the minimum cost of travel and unused routes have equal or greater costs."

5.3.2. The Wardrop User Equilibrium as implemented in SATURN is based on the 'Frank-Wolfe Algorithm', which employs an iterative process. This process is based on successive 'All or Nothing' iterations, which are combined to minimise an 'Objective Function'. The travel costs are recalculated after each iteration and compared to those from the previous iteration. The process is terminated once successive iteration costs have not changed significantly. This process enables multi-routeing between any origin-destination pair.

GENERALISED COST FORMULATIONS AND PARAMETER VALUES

5.3.3. Generalised cost is defined in keeping with the guidance in section 2.8 of TAG Unit M3.1 (January 2014), and is as follows:

$$Generalised\ cost = Time + \left(\frac{Vehicle\ operating\ cost}{Value\ of\ time}\right) Distance$$

5.3.4. Value of time is calculated in pence per minute (PPM) and vehicle operating cost is calculated in pence per kilometre (PPK). The adopted parameters were calculated from the TAG data book (November 2018). The value of time (PPM) for the HGVs was doubled from the value provided in the TAG data book. This is in line with TAG Unit A1.3 which advises for HGV that the driver's time does not take account of the influence of owners on the routing of these vehicles.

5.3.5. The DfT TAG Databook (November 2018) provided suitable values of time (VOT) and vehicle operating costs (VOC) to calculate cost function coefficients for different vehicle types. The parameters adopted for a 2016 base year are shown in **Table 5-1**.

Table 5-1: Generalised Cost Parameters 2016

DEMAND SEGMENT	AM PEAK		INTER PEAK		PM PEAK	
	VOT	VOC	VOT	VOC	VOT	VOC
Car Commuting	20.27	5.96	20.60	5.96	20.34	6.44
Car Work	30.22	10.01	30.97	10.01	30.66	10.01
Car Other	13.98	5.96	14.89	5.96	14.64	5.96
LGV	21.36	13.36	21.36	13.36	21.36	13.36
HGV	21.69	43.27	21.69	43.27	21.69	43.27

5.3.6. A more complete model of car generalised cost includes a weighted element representing the walk distance to the car. However, since these distances tend to be very short, and do not feature in drivers' interpretations of the cost of travel, they were excluded.

5.4 MATRIX ESTIMATION

5.4.1. Matrix estimation was used on all calibration screenlines, cordons and counts. Within the matrix estimation procedure in SATURN it is possible to use both screenlines and individual links for matrix estimation. This was undertaken once to the prior matrix to derive the final LSTM results. The impacts of matrix estimation were assessed to ensure that the matrix estimation process did not distort the trip matrix. The analysis of this can be found in Chapter 7, Section 7.4.

Within the matrix estimation SATPIJA file, the parameters IVC and TURBO are defined. TURBO is set to true and when used in conjunction with IVC, which is the user class level, the matrix estimation process follows the steps outlined in the SATURN manual Chapter 13, Section 13.4.6.1 where the individual purposes are aggregated at the beginning of the process and the constituent levels of the output matrix are calculated proportionately as per Section 13.4.6.1.There are 112 counts of which 86 calibration. The remaining 26 counts are validation link counts. Of these 86 calibration counts, we have grouped 38 counts into 8 calibration screenlines which are fed in to matrix estimation via the SATME2 files and there are an additional 48 counts which are fed in to matrix estimation via the SATPIJA files. There are also 2 additional validation screenlines which are made up of the 26 validation link counts.

Screenlines were defined to capture key movement across South Norfolk in the vicinity of the proposed bypass scheme. The matrix estimation process looks at the total observed and total modelled vehicles, by user class, when summing together the individual link counts that fall within this screenline.

6 MODEL CALIBRATION AND VALIDATION

6.1 INTRODUCTION

6.1.1. This chapter of the LMVR outlines the calibration and validation of the LSTM; the link counts identified for calibration and validation have been presented in addition to the acknowledged journey time routes and screenlines.

6.1.2. Criteria against each of these elements has been summarised within this section followed by the LSTM calibration and validation results for both the prior and final assignments for all time periods. All the results include all the links counts within the Long Stratton area, the junction turning movements, journey times and screenlines.

6.2 LINK COUNTS

6.2.1. Link calibration is undertaken to ensure the model accurately reflects vehicle routing, traffic flow and vehicle speeds throughout the study area. Extensive work to improve the prior performance was undertaken through a full review of the prior matrix, zone loading points and zone - and matrix - disaggregation.

6.2.2. To improve the final fit between the model flow and observed flow it was necessary to use specific traffic counts to factor the matrices, through Matrix Estimation using the SATME2 module; in contrast the draft submission of this document, refinement to the base year validation of LSTM included using only 3 loops of matrix estimation. This was undertaken as a result of comments from the DfT to improve the matrix regression statistics in Long Stratton – these are discussed in more detail in Chapter 7. The XAMAX function was also reduced from 5 to 2 to further improve the matrix regression statistic. It is noted that the significant improvements journey time Route 2 and the changes to both the number of loops and XAMAX in the matrix estimation process, have meant that the link calibration and validation presented in this chapter differs to that in the draft OBC. It is also noted however that the link counts along the A140 in Long Stratton validate to TAG criteria in all time periods – this is essential to the appraisal of the proposed scheme.

6.2.3. The LSTM contains 86 one-way link count locations which are used in the calibration process. The location of these counts is shown in **Figure 6-1**.

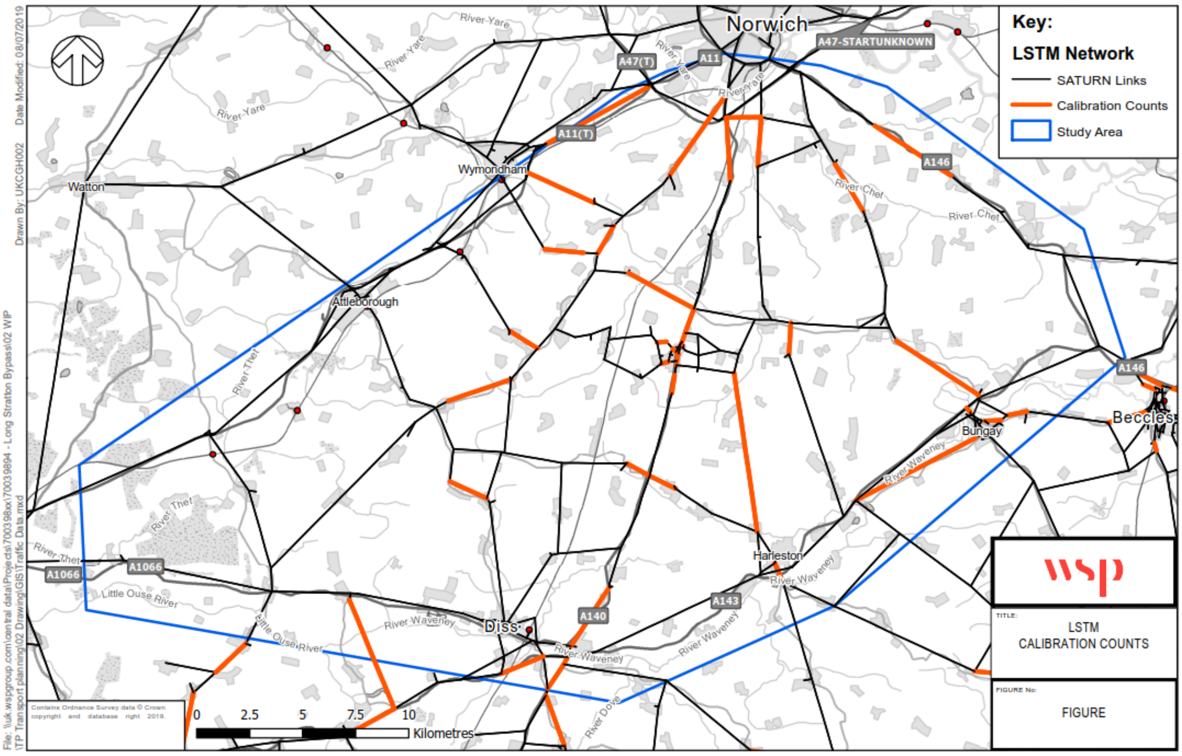

Figure 6-1: LSTM Calibration Counts

6.2.4. Model validation refers to the independent observed count data which has not been used for calibration. The LSTM contains 26 one-way count locations which are used in the validation process. The location of these counts is shown in **Figure 6-2**.

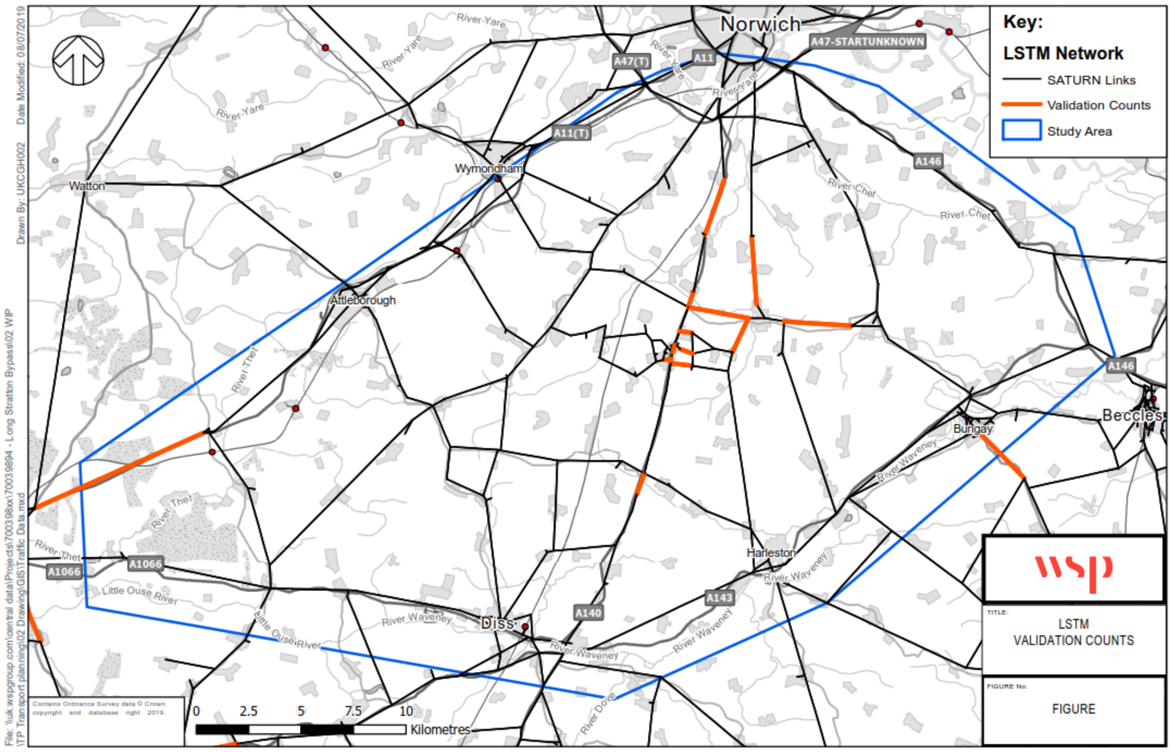

Figure 6-2: LSTM Validation Counts

6.3 JOURNEY TIMES

6.3.1. Specific identified journey times area assessed to ensure that the time taken to travel along key strategic routes within the LSTM closely matches observed times provided by NCC and derived from INRIX Highways Analyst.

6.3.2. The Journey time data was filtered to only include data from June 2016 and as such School holidays and bank holidays were excluded from the data used to derive the average travel times.

6.3.3. The data was processed to provide an average weekday (Monday to Wednesday) travel time by direction for each peak hour being modelled within the LSTM.

6.3.4. Travel time data was process for a total of 17 additional routes across South Norfolk in both directions. Following the guidance in TAG unit M1.2 it has been ensured the journey time routes were kept between 3km and 15km.

6.3.5. A summary of the journey time routes is given in **Table 6-1**.

Table 6-1: LSTM Journey Time Routes Summary

Route	Description
1	A140, Long Stratton to Norwich
2	A140, Pulham to Long Stratton
3	A140, Waterloo to Pulham
4	A11, Attleborough to A11 / A47 Junction
5	A11, Larling to Attleborough
6	A143, Diss to Beccles
7	A11, Thetford to Larling
8	A1066, Thetford to Garboldisham
9	A1066, Garboldisham to Diss
10	A140, A143 to A1066
11	A146, A143 to Loddon
12	A146, Loddon to Norwich
13	Tasburgh to Bungay
14	New Buckenham to Norwich
15	Garboldisham to New Buckingham
16	Attleborough to A140
17	Woodton to Norwich

6.3.6. The 17 journey time routes which have been assessed within the LSTM validation and calibration process are presented in **Figure 6-3**. Each of the routes has been determined to best compare modelled journey times to observed times along strategic routes within the Long Stratton Study Area.

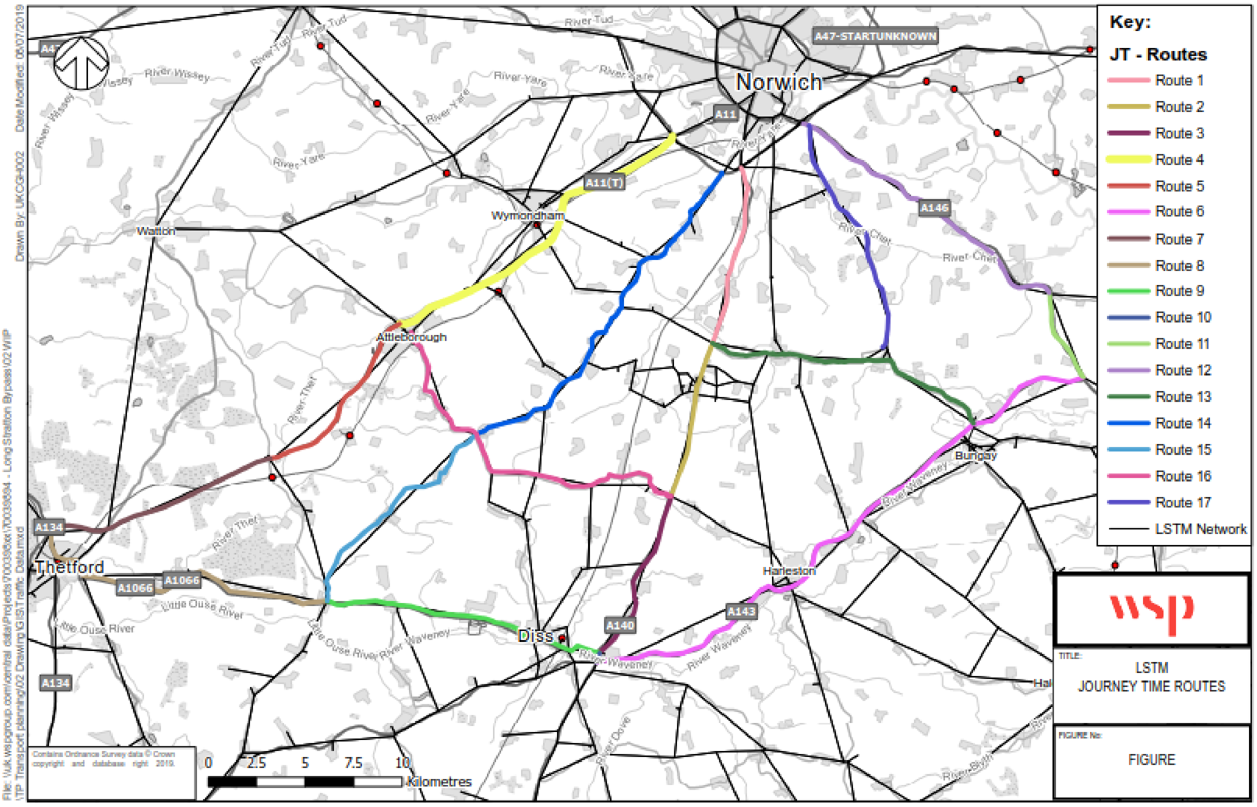

Figure 6-3: LSTM Journey Time Routes

6.3.7. The modelled journey times was re-calibrated and validated in 2020 to improve the validation along the A140, which goes through Long Stratton. Further data analysis was undertaken to determine the best source of observed journey time data. This involved a more detailed approach in obtaining journey time data from Google by using smaller segments as well as undertaking a site visit in December 2019 to obtain additional data. The INRIX data was extracted in the smallest available segments to ensure that this route was validated most appropriately at each interval along the route.

6.4 SCREENLINES

6.4.1. Screenlines are assessed to ensure that volumes of vehicles moving across them are in accordance with the observed conditions recorded as part of the ATC and MCC data collection.

6.4.2. The locations of the 10 Screenlines which have been assessed within the LSTM are shown in **Figure 6-4**. The Screenline running north to south east of Long Stratton has been set as validation and has been left out of the matrix estimation process; the remaining 8 screenlines have been set as calibration and are brought into the matrix estimation process.

6.4.3. Of the 86 link calibration counts, we have grouped 38 counts into 8 calibration screenlines which are fed in to matrix estimation via the SATME2 files and there are an additional 48 link counts which are fed in to matrix estimation via the SATPIJA files. There are also 2 additional validation screenlines which are made up of the 26 validation link counts.

6.4.4. Screenlines were defined to capture key movement across South Norfolk in the vicinity of the proposed bypass scheme. The matrix estimation process looks at the total observed and total modelled vehicles, by user class, when summing together the individual link counts that fall within this screenline. The final results of the screenlines are discussed in more detail in Chapter 7, Section 7.3.

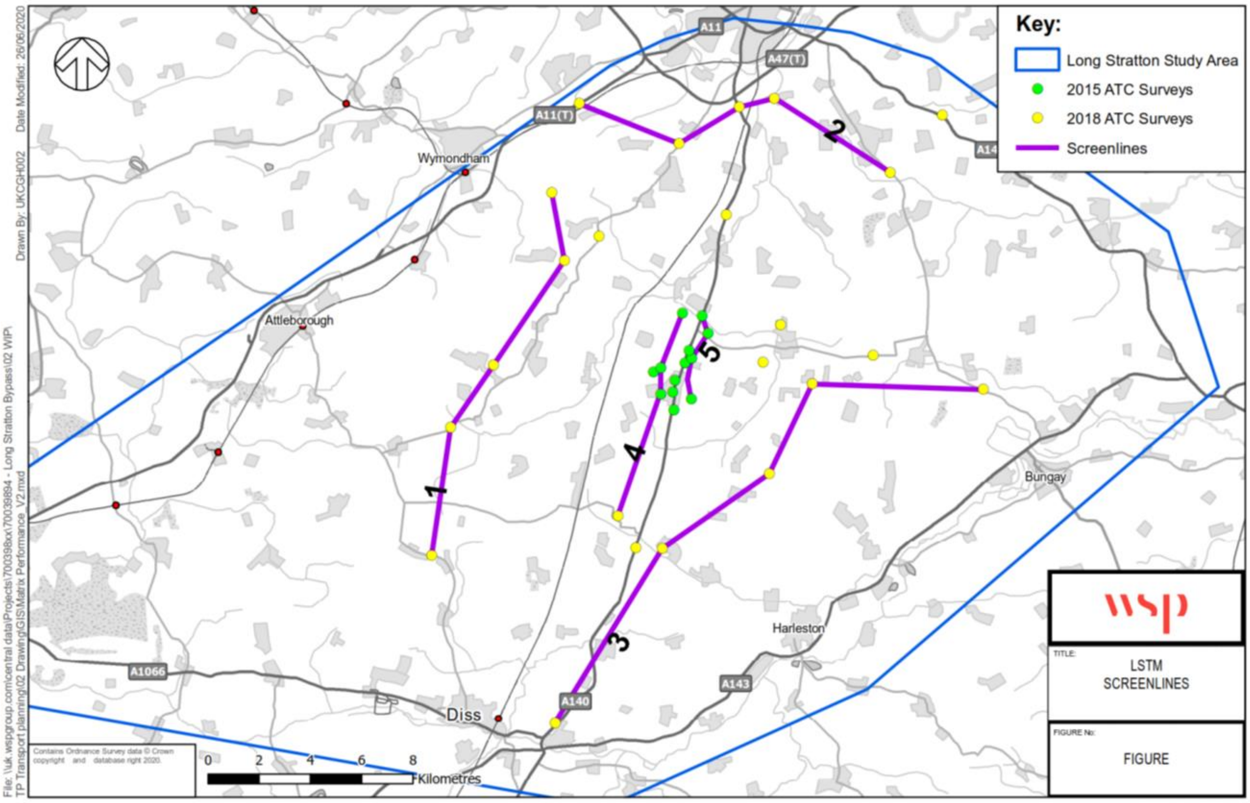

Figure 6-4: LSTM Screenlines

6.4.5. The screenline IDs labelled in **Figure 6-4** correspond to the names in **Table 6-2**.

Table 6-2: LSTM Screenline Descriptions

Screenline ID	Description	Calibration / Validation
1	Long Stratton West	Calibration
2	Long Stratton North	Calibration
3	Long Stratton South-East	Calibration
4	Long Stratton West Inner	Calibration
5	Long Stratton East Inner	Validation

7 MODEL PERFORMANCE

7.1 CALIBRATION AND VALIDATION CRITERIA

LINK COUNTS

7.1.1. Transport models should be developed in accordance with the DfT TAG guidance and links should meet the criteria shown in **Table 7-1**.

Table 7-1: TAG Model Calibration and Validation Criteria: Links

Measure	Criteria	Acceptability Guideline
Flow Criteria		
Observed Flow < 700 vph	Modelled flow within ±100 vph	> 85 % of links
Observed Flow 700 – 2,700 vph	Modelled flow within ±15%	> 85 % of links
Observed Flow > 2,700 vph	Modelled flow within ±400 vph	> 85 % of links
Total screenline flows (normally > 5 links) to be within ±5%		All (or nearly all) screenlines
GEH Criteria		
GEH Statistic for individual links < 5		> 85 % of links
Differences between modelled flows and counts should be less than 5% of the counts		All (or nearly all) screenlines

7.1.2. More than 85% of links are required to meet either the 'GEH' or the 'Flow criteria, and 'all or nearly all' screenlines within 5% of the counts.

7.1.3. Model calibration refers to traffic count data which has been used as part of the model and matrix calibration, therefore has been input into the matrix estimation process.

7.1.4. Model validation refers to independent observed count data which has not been used for calibration. TAG guidance advises that validation screenlines should be used which are positioned so that at least one or two major junctions lie between the validation screenlines and other types of screenlines. This is adhered to with the LSTM screenlines.

7.1.5. Both sets of traffic count data (for calibration and validation) are subject to the criteria defined in **Table 7-1**; a comparison of the individual counts is made as well as for a set of screenlines. The prior matrix performance is discussed and presented in Section 7.2 whilst the results of final model calibration and validation are discussed and presented in Section 7.3.

7.1.6. In addition to individual flows, the criterion for passing the assessment will be based upon a GEH comparison between modelled and observed flow. GEH is a modified Chi-squared statistic comparing relative differences between observed and modelled flows and a value of less than 5 is considered a close match. Using the GEH parameter ensures that the test is appropriate for both small and large flows within the matrix.

7.1.7. TAG Unit M3.1 (January 2014) states that these two measures are broadly consistent and link flows that meet either criterion should be regarded as satisfactory.

JOURNEY TIMES

7.1.8. Transport models should be developed in accordance with the DfT TAG guidance and journey times should meet the criteria shown in **Table 7-2**.

Table 7-2: TAG Model Criteria: Journey Times

Measure / Criteria	Acceptability Guideline
Journey Times	
Modelled journey time within ±15% (or 1 minute, if higher than 15%) of observed journey time	> 85% of routes

7.1.9. Journey times are compared to check the modelled speeds and levels of delay are in accordance with observed conditions.

7.1.10. In addition to the link flow and journey time criteria shown in **Table 7-1** and **Table 7-2**, the following checks must be made of the changes brought about by matrix estimation (ME):

- Assessment of the change in trip volumes between Prior (pre-ME) matrix and Final (post-Me) matrix
- Assessment of the change in trip length distribution between the Prior matrix and Final matrix

7.1.11. These comparisons of the Prior and Final traffic demand matrices are described in Section 7.4.

SCREENLINES

7.1.12. Transport models should be developed in accordance with the DfT TAG guidance and screenlines should meet the criteria shown in **Table 7-3**.

Table 7-3: TAG Model Criteria: Screenlines

Measure / Criteria	Acceptability Guideline
Screenlines	
Total screenline flows (normally >5 links) to be within ±5%	> 85% of routes

7.1.13. Screenlines are assessed to ensure that volumes of vehicles moving across them are in accordance with the observed conditions recorded as part of the ATC and MCC data collection.

ROUTING VALIDATION

7.1.14. Sense checks were carried out on a number of strategic and local routes across the study area. Route choice along key A-roads was checked so that strategic routes were chosen rather than localised short-cuts.

7.1.15. Following assignment of the initial highway matrices, 'select link' analysis was carried out on numerous links to sense-check the paths of trips traversing these links. Select links are an analysis option within strategic modelling software to identify where traffic is originating from and leaving the network.

7.1.16. The links included are:

- A140;
- A146; and
- A11.

7.1.17. These checks were undertaken throughout the calibration process. Select link analysis on the roads listed above from the final base year model, for all time periods, are presented in separate document - **Appendix C**.

7.2 PRIOR MATRIX PERFORMANCE

7.2.1. Significant work and investigations were undertaken to ensure the prior matrix performance within the LSTM was as good as possible prior to using matrix estimation. The aim was to ensure calibration counts achieved around 60% of counts meeting flow or GEH criteria.

7.2.2. **Table 7-4** to **Table 7-6** present the LSTM prior matrix performance for the three time periods, with **Figure 7-1** to **Figure 7-3** graphically presenting the performance.

7.2.3. All counts meeting either flow or GEH criteria are coloured in green, those not meeting flow criteria but have a GEH between 5 and 10 are orange and those with a GEH > 10 are red. Separate document - Appendix D includes figures presenting the prior matrix performance specifically within the detailed area of modelling.

Table 7-4: LSTM AM Peak Prior Matrix Performance

Calibration Counts		
Vehicle Class	**Number of Counts**	**GEH < 5**
Car	86	49
LGV	86	73
HGV	86	84
Total Vehicles	86	46
Total Traffic Count	**Observed**	**Modelled**
Total Vehicles	33,541	35,651

Validation Counts			
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**
Car	26	16	21
LGV	26	24	25
HGV	26	24	26
Total Vehicles	26	15	21

Screenlines		
Number of Screenlines	**GEH < 4**	**% GEH < 4**
10	3	30%

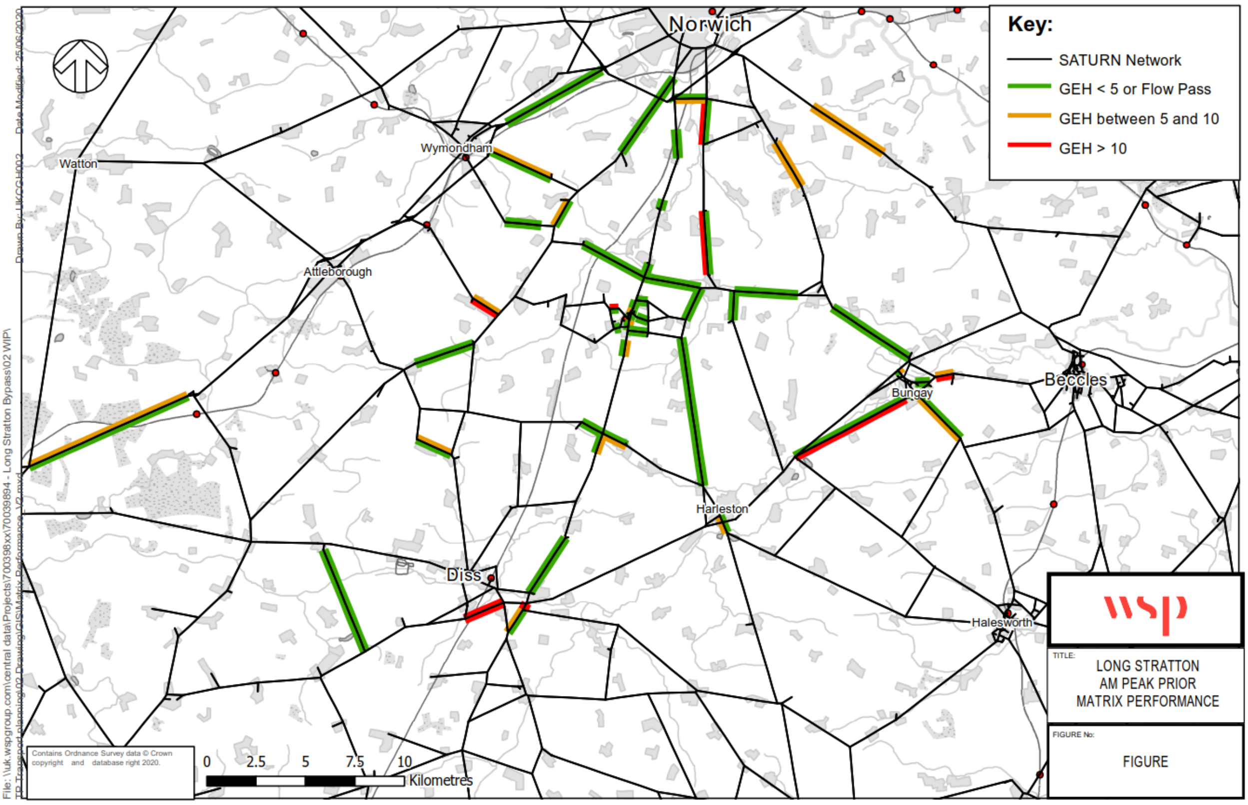

Figure 7-1: LSTM AM Peak Prior Performance

Table 7-5: LSTM Inter Peak Prior Matrix Performance

Calibration Counts		
Vehicle Class	**Number of Counts**	**GEH < 5**
Car	86	56
LGV	86	80
HGV	86	85
Total Vehicles	86	54
Total Traffic Count (all sites)	**Observed**	**Modelled**
Total Vehicles	24,749	26,187

Validation Counts			
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**
Car	26	25	24
LGV	26	24	25
HGV	26	26	26
Total Vehicles	26	23	24

Screenlines		
Number of Screenlines	**GEH < 4**	**% GEH < 4**
10	5	50%

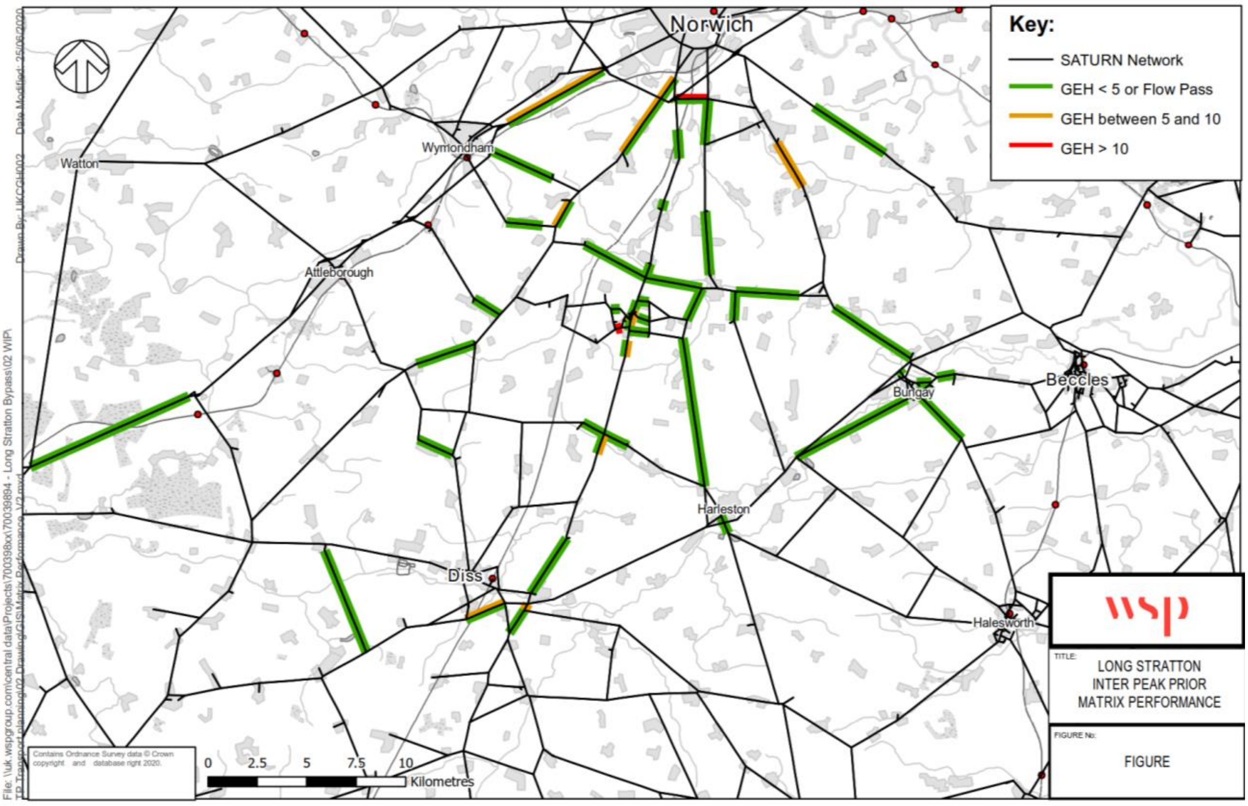

Figure 7-2: LSTM Inter Peak Prior Performance

Table 7-6: LSTM PM Peak Prior Matrix Performance

Calibration Counts		
Vehicle Class	**Number of Counts**	**GEH < 5**
Car	86	44
LGV	86	73
HGV	86	84
Total Vehicles	86	44
Total Traffic Count (all sites)	**Observed**	**Modelled**
Total Vehicles	35,177	40,008

Validation Counts			
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**
Car	26	20	21
LGV	26	24	25
HGV	26	25	26
Total Vehicles	26	20	20

Screenlines		
Number of Screenlines	**GEH < 4**	**% GEH < 4**
10	5	50%

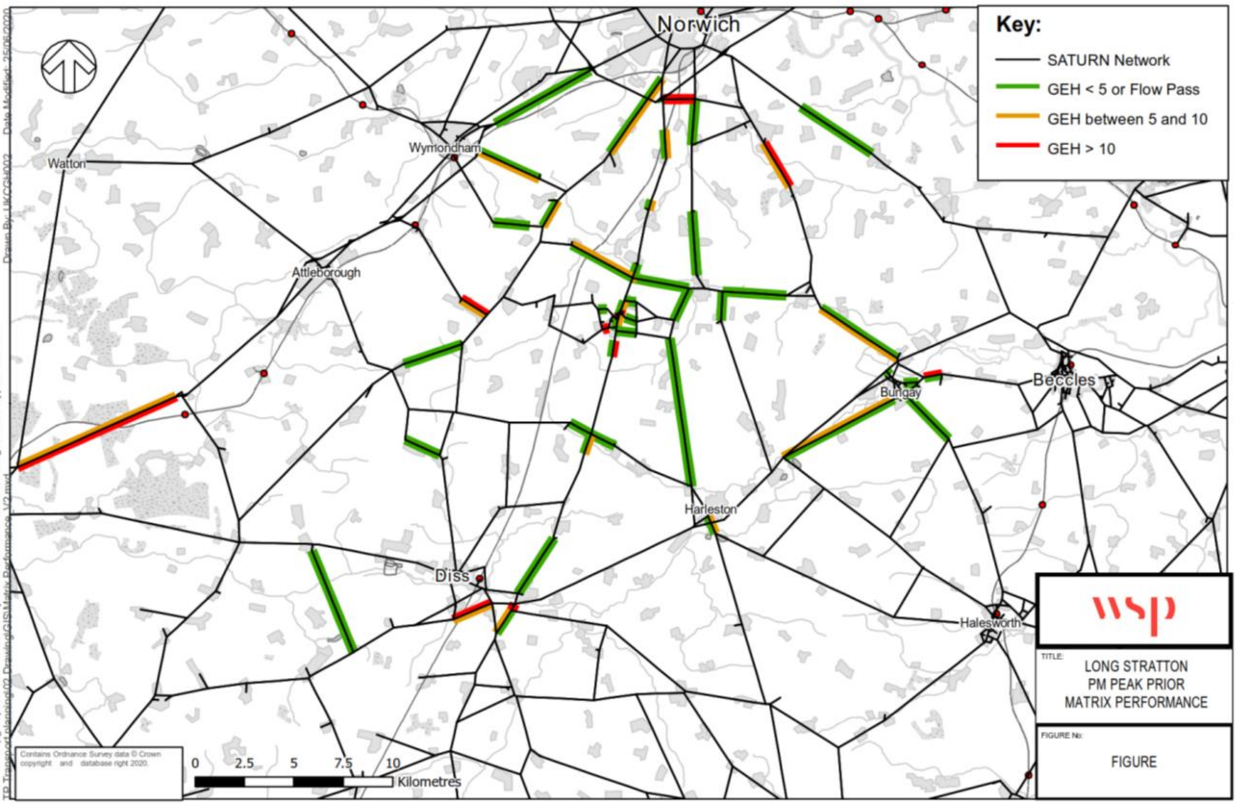

Figure 7-3: LSTM PM Peak Prior Performance

7.3 FINAL PERFORMANCE

7.3.1. The prior performance of the LSTM demonstrated that 68% of AM peak, 81% of Inter peak and 67% of PM peak link counts (calibration and validation combined) had a GEH less than 5 or met the flow criteria specified within TAG guidance. Section 7.2 also presented that 30% of AM screenlines and 50% of Inter peak and PM peak screenlines had a GEH less than 4.

7.3.2. It is considered sufficient network refinements can been undertaken and that the prior performance of the model was the best it could be; once we reached this point, Matrix Estimation was used on all calibration screenlines, cordons and counts to ensure the link counts and screenlines met TAG criteria. There are 112 link counts of which 86 calibration. The remaining 26 link counts are validation link counts. Of these 86 calibration link counts, we have grouped 38 counts into 8 calibration screenlines which are fed in to matrix estimation via the SATME2 files and there are an additional 48 counts which are fed in to matrix estimation via the SATPIJA files. There are also 2 additional validation screenlines which are made up of the 26 validation link counts.

7.3.3. This section of the report presents the LSTM final performance post matrix estimation; this is split into the following sections:

- Count Calibration;
- Count Validation;
- Screenlines and Cordons;
- Journey Times; and
- Matrix Estimation Impacts.

COUNT CALIBRATION

7.3.4. **Table 7-7** and **Figure 7-4** show the final calibration performance of the LSTM AM Peak. **Table 7-7** shows that TAG criteria is met for all individual vehicles types with greater than 85% of counts meeting flow criteria or having a GEH less than 5. Whilst 85% of total vehicle counts meet flow criteria or have a GEH less than 5, which is less than TAG criteria, one count has a GEH of 5.042 and therefore 85% of total vehicle counts pass flow criteria or have a GEH less than 5.4.

Table 7-7: LSTM AM Peak Calibration Final Matrix Performance

Calibration Counts					
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**	**% GEH or Flow Criteria Met**	**GEH > 10**
Car	86	66	69	**86%**	3
LGV	86	85	86	**100%**	0
HGV	86	86	86	**100%**	0
Total Vehicles	86	65	71	**84%**	3
Total Traffic Count	**Observed**	**Modelled**		**% Difference**	
Total Vehicles	33,541	35,845		6.87%	

7.3.5. **Figure 7-4** presents the calibration performance graphically for total vehicle counts; all counts meeting either flow or GEH criteria are coloured in green, those not meeting flow criteria but have a GEH between 5 and 10 are orange and those not meeting flow criteria and a GEH greater than 10, are red. Separate document - **Appendix E** contains the tables of individual link performances during the AM peak, Inter peak and PM peak.

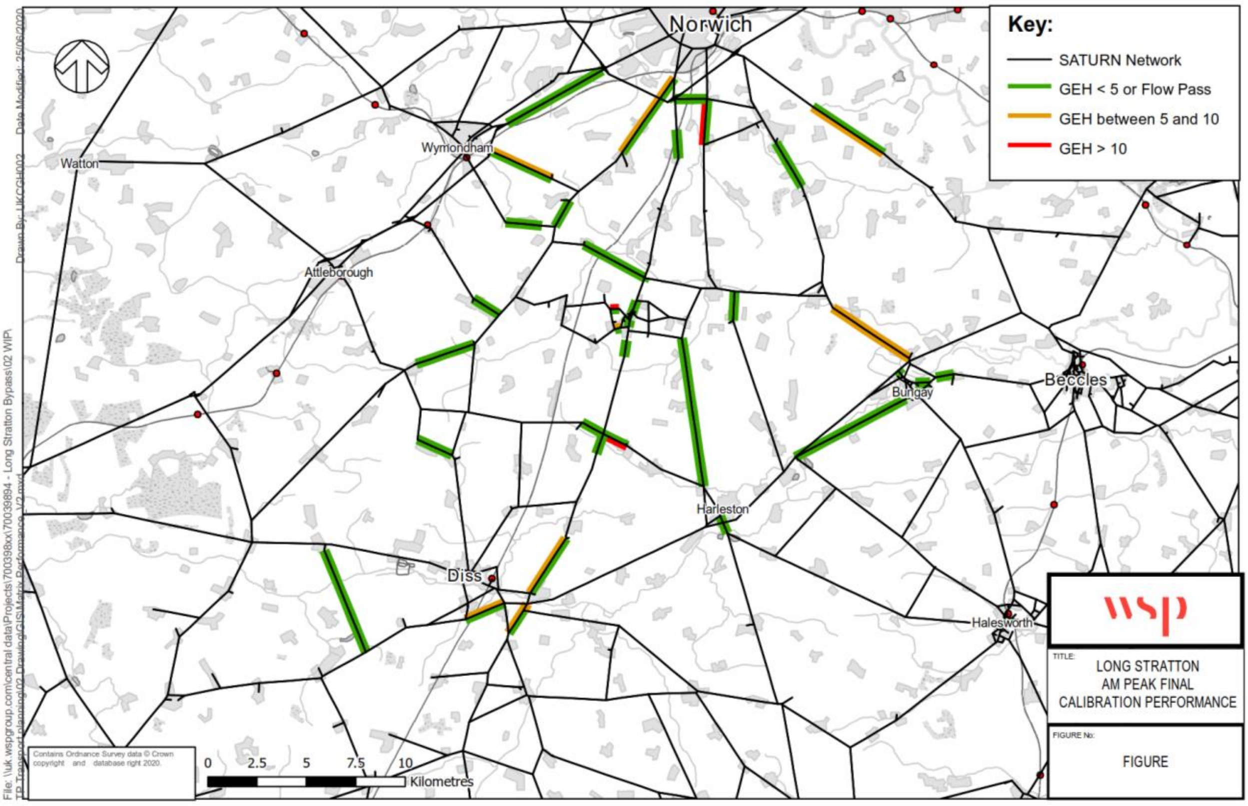

Figure 7-4: LSTM AM Peak Calibration Final Performance

7.3.6. **Figure 7-4** graphically illustrates the AM performance of the model against calibration counts within the Long Stratton study area with 84% of counts meeting criteria. Counts along the A140 within Long Stratton are shown to all meet flow criteria or have a GEH less than 5; this is accredited to significant improvements to the journey time that were made along the A140 as part of the revalidation of the base year model.

7.3.7. **Table 7-8** and **Figure 7-5** show the final calibration performance of the LSTM HAM Inter Peak. **Table 7-8** shows that TAG criteria is met for all vehicle types and total vehicles, with more than 85% of counts meeting flow criteria or having a GEH less than 5. There are three car and thus total vehicle counts with a GEH exceeding 10 in the Inter Peak model within the Long Stratton study area.

Table 7-8: LSTM Inter Peak Final Matrix Performance

Calibration Counts					
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**	**% GEH or Flow Criteria Met**	**GEH > 10**
Car	86	70	84	**98%**	3
LGV	86	86	86	**100%**	0
HGV	86	88	86	**100%**	0
Total Vehicles	86	69	80	**95%**	3
Total Traffic Count	**Observed**	**Modelled**		**% Difference**	
Total Vehicles	24,749	24,484		-1.07%	

7.3.8. **Figure 7-5** graphically presents the Inter Peak calibration performance. All counts meeting either flow or GEH criteria are coloured in green and those not meeting flow criteria but have a GEH between 5 and 10 are orange. As the Inter Peak model doesn't contain any links with a GEH greater than 10, there are no red links.

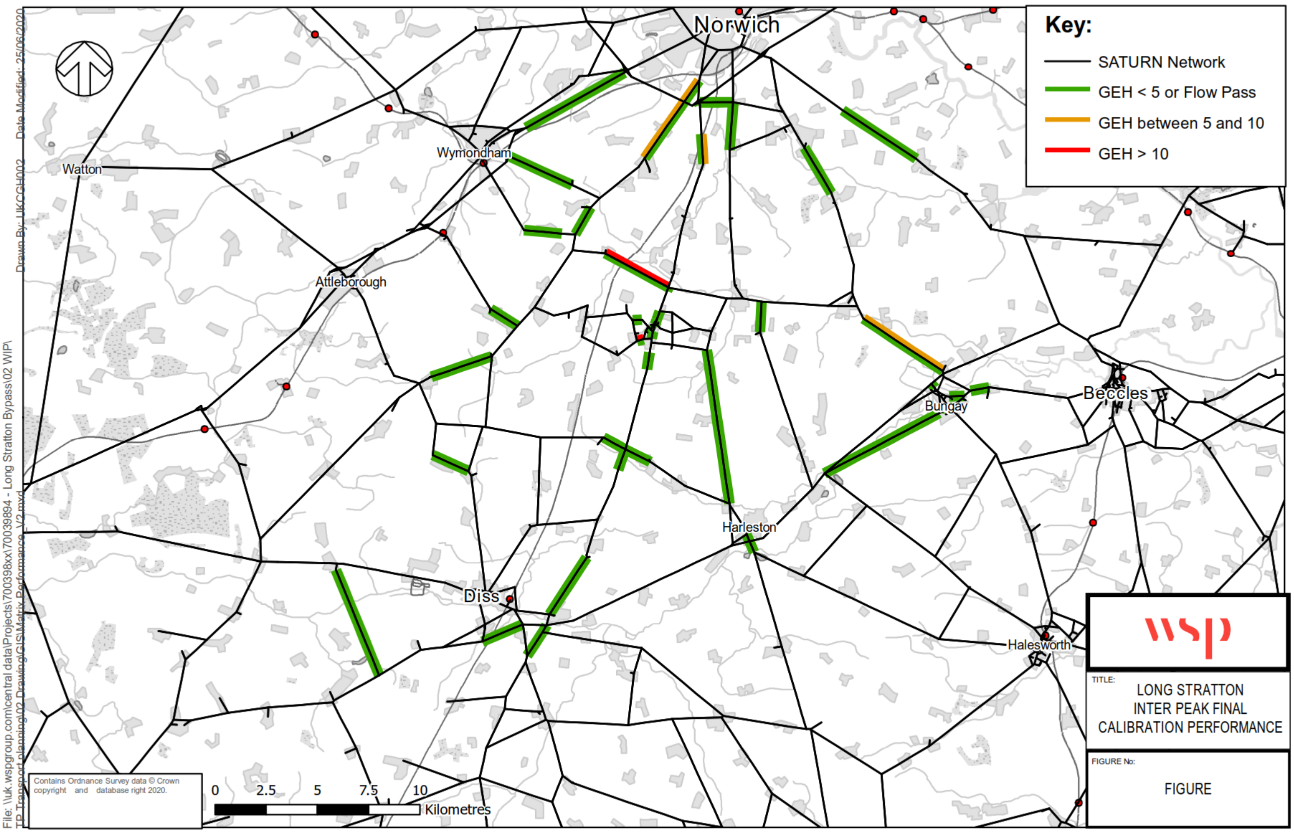

Figure 7-5: LSTM Inter Peak Calibration Final Performance

7.3.9. **Figure 7-5** shows that 95% of total counts meet required flow criteria or have a GEH of less than 5 as indicated by the green links. It shows all counts within along the A140 within Long Stratton criteria demonstrating that the model is accurately representing traffic flows in this area. Two counts are showing GEH of greater than 10, these are located on Flowerpot Lane and eastbound along the B1135 at Hempnall crossroads.

7.3.10. **Table 7-9** and **Figure 7-6** show the final calibration performance of the LSTM PM Peak. **Table 7-9** shows that TAG criteria is met for LGV an HGVS. TAG criteria is not met for Car or Total vehicles however the model has fives total vehicle counts with a GEH less than 6.3 and therefore 85% of PM peak counts have a GEH less than 6.3 or meet flow criteria.

Table 7-9: LSTM PM Peak Calibration Final Matrix Performance

Calibration Counts					
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**	**% GEH or Flow Criteria Met**	**GEH > 10**
Car	86	62	68	**79%**	3
LGV	86	86	86	**100%**	0
HGV	86	86	86	**100%**	0
Total Vehicles	86	63	67	**79%**	5
Total Traffic Count (all sites)	**Observed**	**Modelled**		**% Difference**	
Total Vehicles	35,177	38,588		9.70%	

7.3.11. **Figure 7-6** graphically presents the PM Peak calibration performance. All counts meeting either flow or GEH criteria are coloured in green, those not meeting flow criteria but have a GEH between 5 and 10 are orange and those with a GEH greater than 10, and not meeting flow criteria, are red.

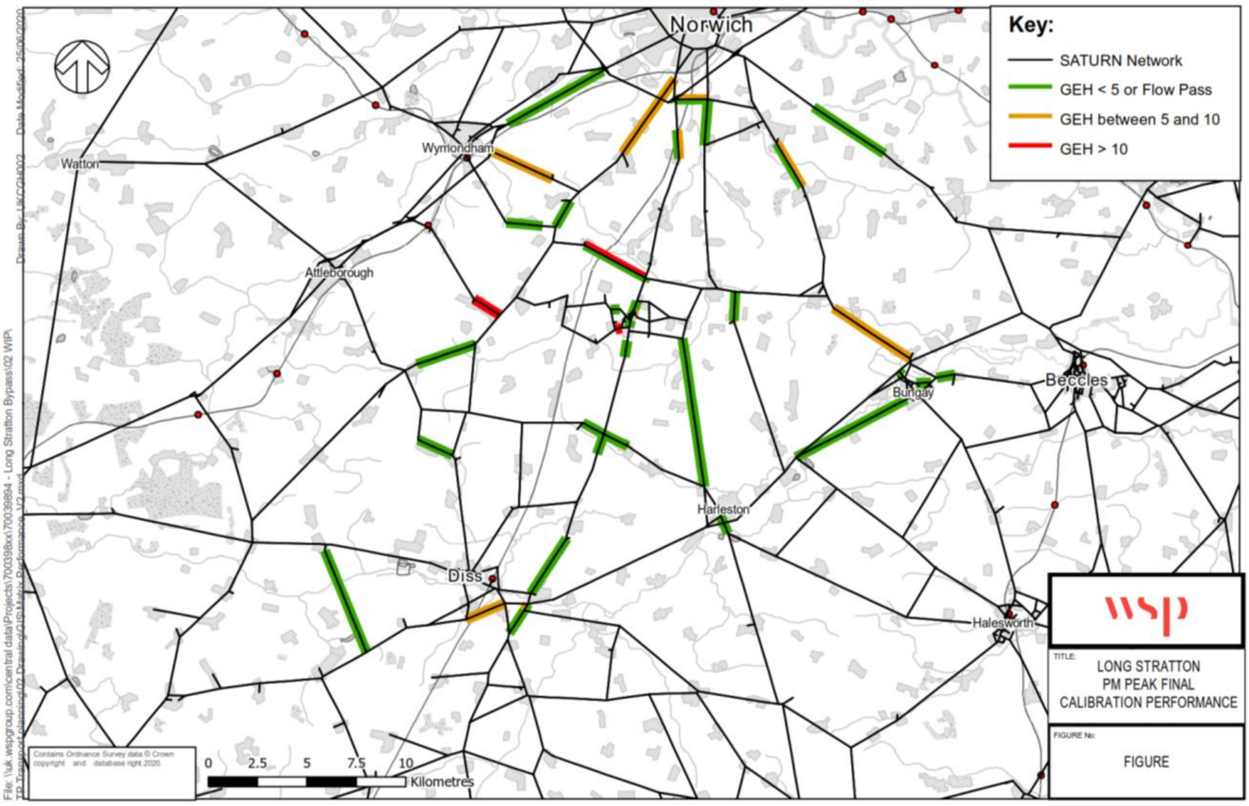

Figure 7-6: LSTM PM Peak Calibration Final Performance

7.3.12. The links in **Figure 7-6** present 79% of total counts meeting flow criteria or having a GEH less than 5. All counts along the A140 within the vicinity of the scheme meet TAG criteria; links with GEH greater than 10 are Flowerpot Lane, B1135 and Bunwell Street. There are two two-way counts on Flowerpot Lane which demonstrate contradicting flows; the level of network detail means that both could not be calibrated in the Inter and PM Peaks.

7.3.13. The proposed bypass is predicted to benefit predominantly through-routing traffic along the A140 by offering a quicker and less congested alternative around the village of Long Stratton. With the exception of two NB links in Diss in the AM peak which have a GEH of 5 and 7 respectively, a SB link near Norwich in the Inter Peak and PM which has a GEH of 7 and 6 respectively – all link counts along the A140 have a GEH of less than 4 or pass flow criteria in all three time periods.

COUNT VALIDATION

7.3.14. **Table 7-10** and **Figure 7-7** show the final validation performance of the LSTM AM Peak. **Table 7-10** shows that TAG criteria is met for all individual vehicles types and total vehicles with at least 85% of counts having a GEH less than 5 or meeting flow criteria. There is only one validation count in the AM Peak model that has a GEH exceeding 10.

Table 7-10: LSTM AM Peak Validation Matrix Performance

Validation Counts					
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**	**% GEH or Flow Criteria Met**	**GEH > 10**
Car	26	18	22	**88%**	1
LGV	26	25	26	**100%**	0
HGV	26	26	26	**100%**	0
Total Vehicles	26	18	23	**92%**	1

7.3.15. **Figure 7-7** graphically presents the AM Peak validation performance. All counts meeting either flow or GEH criteria are coloured in green, those not meeting flow criteria but have a GEH between 5 and 10 are orange and those with a GEH greater than 10 are red. Separate document - **Appendix F** contains the tables of individual validation link performances during the AM peak, Inter peak and PM peak.

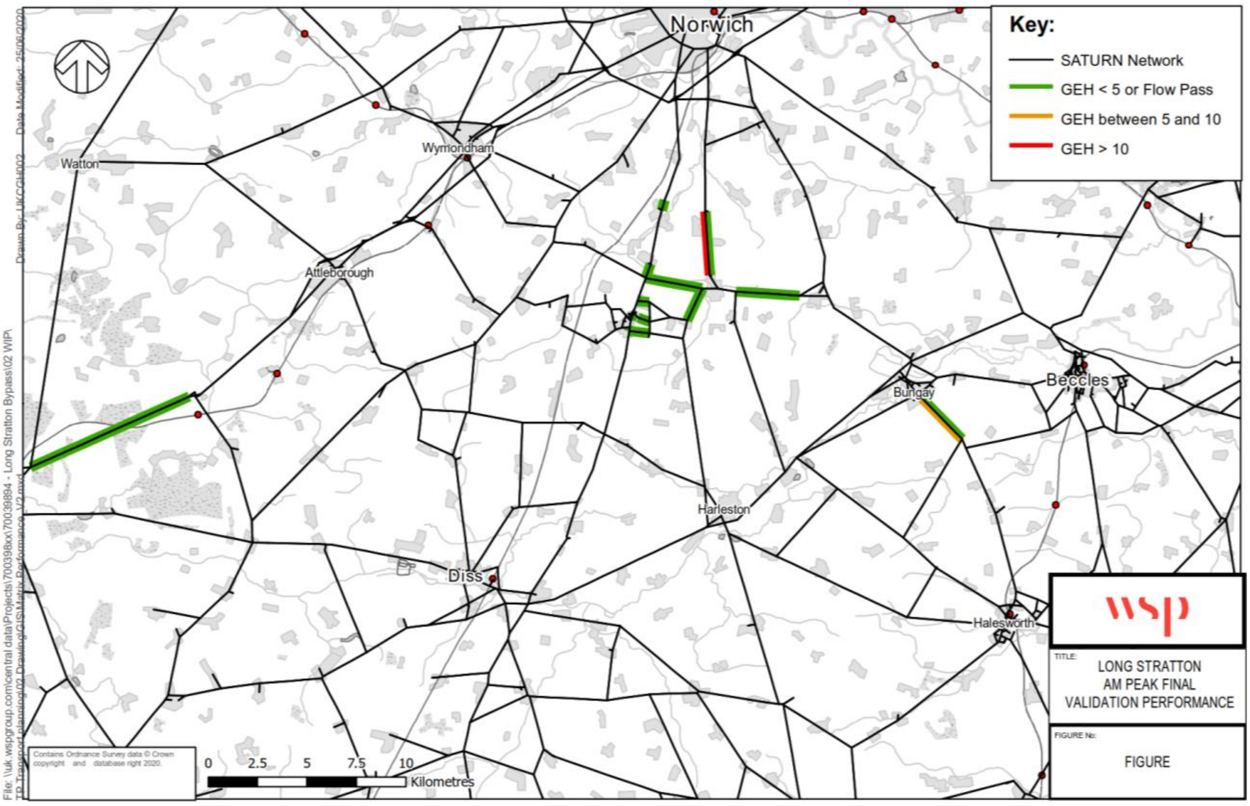

Figure 7-7: LSTM AM Peak Validation Performance

7.3.16. **Figure 7-7** shows that 23 of the 26 validation counts meet TAG flow or GEH criteria; the location of the majority of validation links within the immediate vicinity of the infrastructure scheme means that the AM Peak model therefore validates well within this area.

7.3.17. **Table 7-11** shows that TAG criteria is met for all individual user classes and total vehicles, with 100% of Car, LGV and HGV counts meeting flow criteria or having a GEH less than 5. There are no validation counts within the Inter Peak model that have a GEH greater than 10.

Table 7-11: LSTM Inter Peak Validation Matrix Performance

Validation Counts					
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**	**% GEH or Flow Criteria Met**	**GEH > 10**
Car	26	24	25	**96%**	0
LGV	26	24	26	**100%**	0
HGV	26	26	26	**100%**	0
Total Vehicles	26	23	25	**96%**	0

7.3.18. **Figure 7-8** graphically presents the final Inter Peak validation performance. All counts meeting either flow or GEH criteria are coloured in green, those not meeting flow criteria but have a GEH between 5 and 10 are orange. As the Inter Peak model doesn't contain any links with a GEH greater than 10, there are no red links.

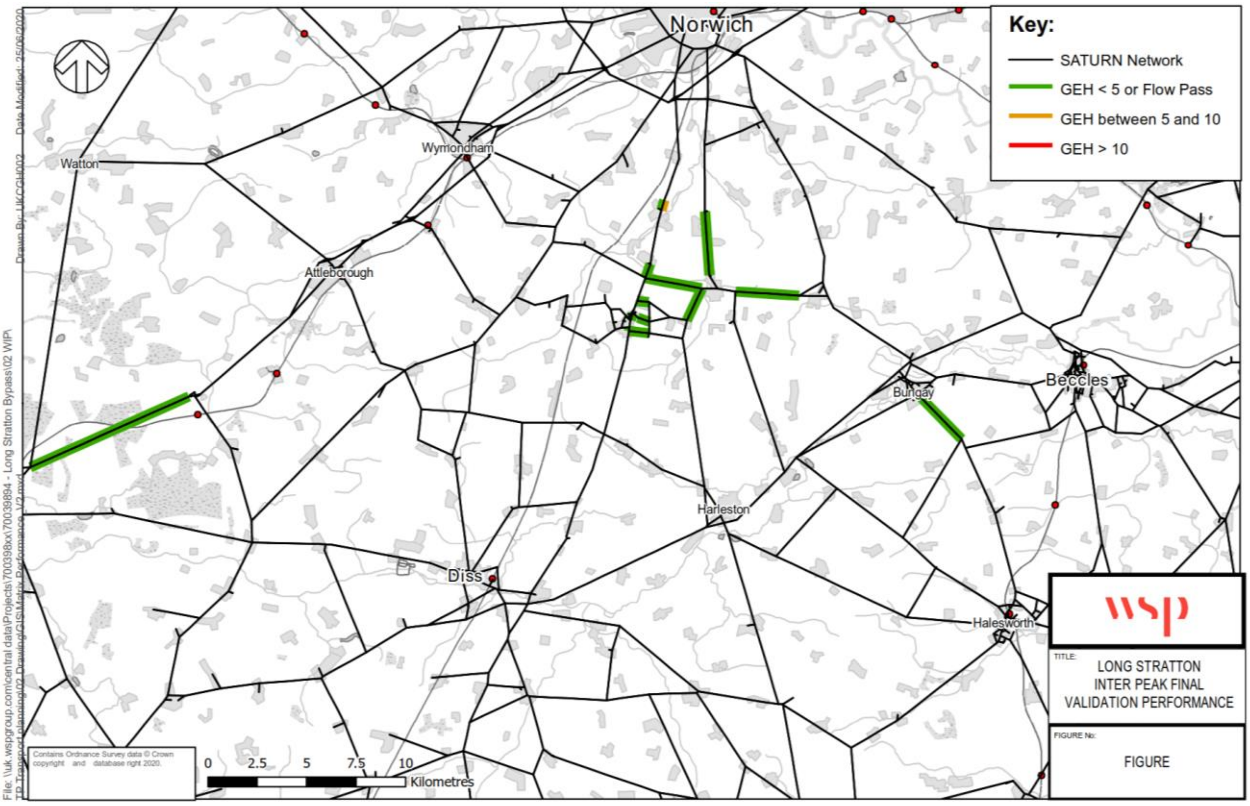

Figure 7-8: LSTM HAM Inter Peak Validation Performance

7.3.19. **Figure 7-8** further demonstrates that 96% of total counts within the Long Stratton study area have a GEH less than 5 or meet flow criteria for their link type. There is only a single count that doesn't meet criteria, with a GEH between 5 and 10, as shown by the orange link; it is therefore considered that the Inter Peak model validates well.

7.3.20. **Table 7-12** shows that TAG criteria is met for LGV and HGV user classes, with 100% of counts meeting flow criteria or having a GEH less than 5. TAG criteria is also met for Total Vehicles as the % of counts meeting flow criteria or having a GEH greater than 5 is 88%. Whilst 81% of car counts meet TAG criteria, one count has a GEH less than 5.51 and therefore 85% of counts meet flow criteria or have a GEH less than 5.5.

Table 7-12: LSTM PM Peak Validation Matrix Performance

Validation Counts					
Vehicle Class	**Number of Counts**	**GEH < 5**	**Flow Criteria Met**	**% GEH or Flow Criteria Met**	**GEH > 10**
Car	26	17	21	**81%**	1
LGV	26	25	26	**100%**	0
HGV	26	25	26	**100%**	0
Total Vehicles	26	18	22	**88%**	0

7.3.21. **Figure 7-9** graphically presents the PM Peak validation performance. All counts meeting either flow or GEH criteria are coloured in green, those not meeting flow criteria but have a GEH between 5 and 10 are orange. As the PM Peak model doesn't contain any validation links with a GEH greater than 10, there are no red links.

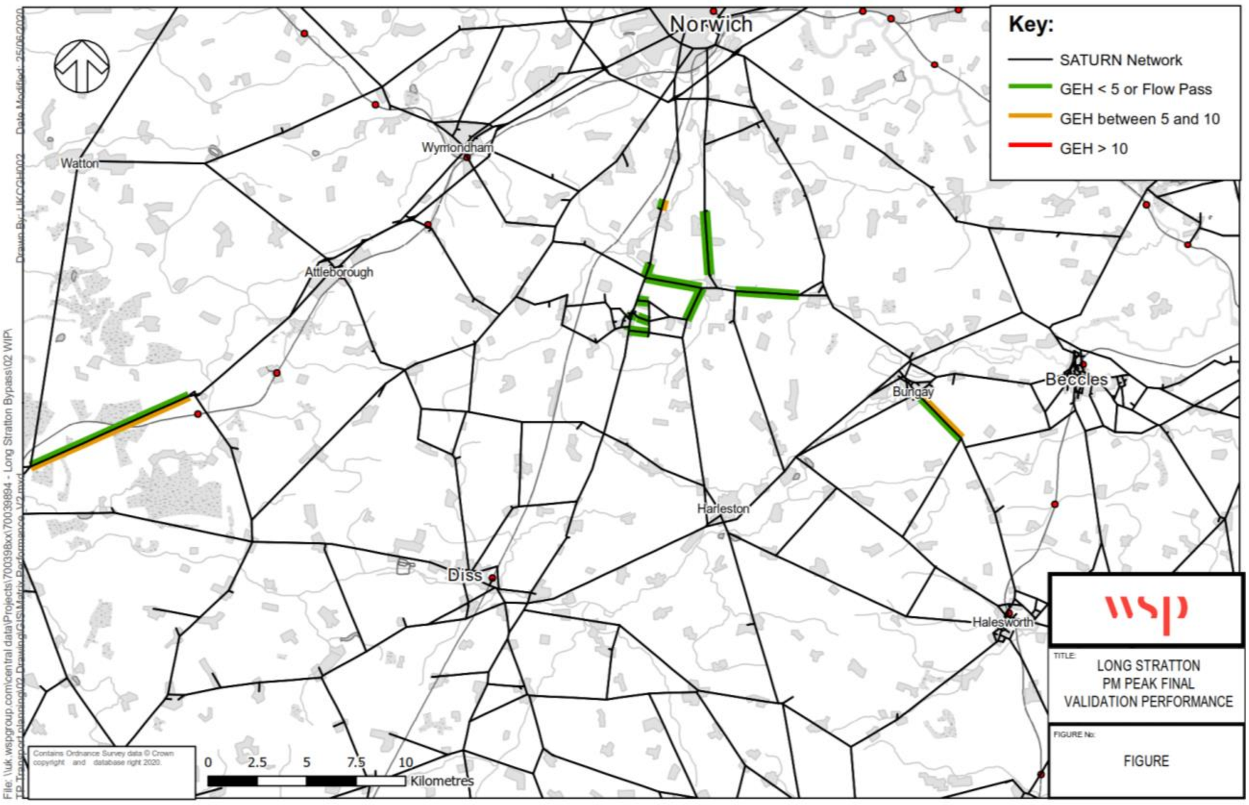

Figure 7-9: LSTM PM Peak Validation Performance

7.3.22. **Figure 7-9** shows that 88% of total PM counts within the Long Stratton area have a GEH less than 5 or meet flow criteria for their link type. There are 3 counts that have a GEH between 5 and 10, demonstrated by the orange links, however it can be seen that no counts had a GEH exceeding 10. it is therefore considered that the PM Peak model validates well.

JOURNEY TIMES

7.3.23. The journey time routes are presented in **Figure 6-3**, all of which were incorporated into the LSTM model as part of the refinement and re-validation within the Long Stratton Study Area. The performance of these journey time routes is shown in **Table 7-13**, these present the journey times which meet TAG criteria (within +/- 15% of observed value).

Table 7-13: LSTM Journey Time Performance

Journey Time Routes	AM Peak	Inter Peak	PM Peak
LSTM	**94%**	**91%**	**97%**

7.3.24. A detailed summary of the modelled and observed times for each of the routes within the LSTM in addition to their pass criteria is shown in **Table 7-14** to **Table 7-16**. The graphs for these journey times, for each time period and in both directions, are presented in separate document **- Appendix G**.

7.3.25. As part of the base year refinement, significant attention was paid to the journey time route along the A140 through Long Stratton; as mentioned in **Chapter 6**, a study was undertaken to determine the most appropriate and accurate data source for validating journey times within the mode and concluded that INRIX data, which has been used, was most appropriate. Data was extracted at the most refined segment level for route and **Table 7-14** to **Table 7-16** demonstrate the enhancements in overall journey time validation of the base year model in the AM, Inter and PM peaks.

Long Stratton Analysis

7.3.26. The journey time graphs, included in Error! Reference source not found., demonstrate that whilst the model is s lightly underestimating the overall time of Route 2 in the AM peak, the NB route is shown to be within the DMRB guidance range along the routes entirety in all three time periods. The SB modelled journey time reflects the general trend of time shown by the observed data with the delays and queues represented in the correct locations. A critical point of delay is Swan Lane and the pedestrian signals just to the north of this; the strategic model is unable to accurately represent the pedestrian signals and the number of times they might be called within an hour – which can also differ each day.

7.3.27. Route 2 through Long Stratton meets TAG criteria in both directions in the Inter Peak and the graphs demonstrate that the modelled time closely follows the observed time along the majority of the route NB and SB, with the modelled slightly under representing the observed delays southbound between Hall Lane and Stony Lane however the modelled time falls within the TAG range at all times.

7.3.28. In the PM peak, the journey time graphs for Route 2 demonstrate that the modelled time falls within the TAG range at all points along the route however the delays between Lime Tree Avenue and Hall Lane aren't represented to the degree that they are within the observed data and as such the increase in time at this timing point is reflected quite as steeply on the graph of modelled time. Southbound, the PM graphs shows that the modelled journey time broadly follows the same pattern as the observed data and reflects the delay in accurate places, with the modelled consistently trending slightly quicker times than the observed.

7.3.29. By having frequent timing points along the A140 Route 2, WSP were able to ensure that the model reflected key points of delay or congestion along the route; most notably this was observed to occur at junctions with Hall Lane, Flowerpot Lane, Swan Lane and the pedestrian crossing just north of Swan Lane. The delays were caused by signalised junctions and queueing that occurred here; the council offices were also accredited to generating a large number of AM peak arrivals and PM departures which causes delay at A140 / Swan Lane with right turning vehicles queueing back along the A140 SB in the AM peak as reflected in the INRIX data and shown by the significantly reduced average speeds observed along these links. These observations and supporting delays and reductions in speed demonstrated by the INRIX data, were supported by the client's knowledge of the local area. The model is considered a good representative of the average conditions along Route 2 in all time periods.

7.3.30. In addition, journey time Route 2 meets TAG criteria in both direction in all three time periods which is critical when capturing time saving benefits associated with the proposed scheme; the journey time graphs also demonstrate that the modelled times broadly follow the same patterns as the observed data, keeping within the DMRB range as much as possible, capturing delays at junctions with Flowerpot Lane and Swan Lane as a result of traffic signals, arrivals and departures to significant trip generators (such as the council offices) and the pedestrian crossing.

Table 7-14: LSTM AM Journey Time Routes

Routes	34	
Passed	32	94%

	AM Peak				
Name	Observed (s)	Modelled (s)	Diff	%	Pass?
Route 1 -SB	507	498	-9	-2%	Yes
Route 1 - NB	528	626	98	19%	No
Route 2 - SB	646	641	-5	-1%	Yes
Route 2 - NB	628	644	16	3%	Yes
Route 3 - SB	413	441	28	7%	Yes
Route 3 - NB	410	440	30	7%	Yes
Route 4 - SB	645	672	27	4%	Yes
Route 4 - NB	799	658	-141	-18%	No
Route 5 - SB	348	353	5	2%	Yes
Route 5 - NB	372	339	-33	-9%	Yes
Route 6 - EB	1435	1532	97	7%	Yes
Route 6 - WB	1433	1438	5	0%	Yes
Route 7 - SB	510	443	-67	-13%	Yes
Route 7 - NB	454	428	-26	-6%	Yes
Route 8 - EB	838	774	-64	-8%	Yes
Route 8 - WB	914	805	-109	-12%	Yes
Route 9 - EB	1003	941	-62	-6%	Yes
Route 9 - WB	1005	987	-18	-2%	Yes
Route 10 - SB	29	28	-1	-3%	Yes
Route 10 - NB	30	27	-3	-10%	Yes
Route 11 - SB	225	249	24	11%	Yes
Route 11 - NB	222	255	33	15%	Yes
Route 12 - SB	788	855	67	9%	Yes
Route 12 - NB	849	934	85	10%	Yes
Route 13 - EB	962	921	-41	-4%	Yes
Route 13 - WB	927	926	-1	0%	Yes
Route 14 - NB	1278	1326	48	4%	Yes
Route 14 - SB	1325	1165	-160	-12%	Yes
Route 15 - NB	929	846	-83	-9%	Yes
Route 15 - SB	977	867	-110	-11%	Yes
Route 16 - EB	1282	1123	-159	-12%	Yes
Route 16 - WB	1307	1165	-142	-11%	Yes
Route 17 - SB	870	853	-17	-2%	Yes
Route 17 - NB	888	849	-39	-4%	Yes

7.3.31. The routes that fail to meet TAG criteria in the AM peak are: Route 1 NB along the A140 from Long Stratton to Norwich where the model is shown to be slower and Route 4 NB along the A11 from Attleborough to Norwich where the modelled time is slower than the observed. As 94% of routes meet TAG criteria, journey times within the Long Stratton area, in the AM Peak, are considered to represent observed conditions and therefore are fit for purpose in assessing the scheme proposals.

Table 7-15: LSTM IP Journey Time Routes

Routes	34	
Passed	31	91%

ID	Name	Interpeak Observed (s)	Modelled (s)	Diff	%	Pass?
209	Route 1 -SB	488	466	-22	-5%	Yes
210	Route 1 - NB	485	482	-3	-1%	Yes
211	Route 2 - SB	488	496	8	2%	Yes
212	Route 2 - NB	493	478	-15	-3%	Yes
213	Route 3 - SB	412	421	9	2%	Yes
214	Route 3 - NB	415	430	15	4%	Yes
215	Route 4 - SB	645	658	13	2%	Yes
216	Route 4 - NB	665	650	-15	-2%	Yes
217	Route 5 - SB	346	341	-5	-2%	Yes
218	Route 5 - NB	364	338	-27	-7%	Yes
219	Route 6 - EB	1436	1391	-45	-3%	Yes
220	Route 6 - WB	1436	1380	-56	-4%	Yes
221	Route 7 - SB	479	428	-50	-11%	Yes
222	Route 7 - NB	451	429	-21	-5%	Yes
223	Route 8 - EB	842	754	-87	-10%	Yes
224	Route 8 - WB	869	741	-128	-15%	Yes
225	Route 9 - EB	1058	921	-137	-13%	Yes
226	Route 9 - WB	1081	919	-162	-15%	Yes
227	Route 10 - SB	29	28	-2	-6%	Yes
228	Route 10 - NB	30	27	-3	-10%	Yes
229	Route 11 - SB	225	235	10	4%	Yes
230	Route 11 - NB	220	218	-2	-1%	Yes
231	Route 12 - SB	786	797	12	2%	Yes
232	Route 12 - NB	814	811	-2	0%	Yes
233	Route 13 - EB	968	896	-72	-7%	Yes
234	Route 13 - WB	927	895	-32	-3%	Yes
235	Route 14 - NB	1291	1198	-93	-7%	Yes
236	Route 14 - SB	1345	1158	-187	-14%	Yes
237	Route 15 - NB	954	828	-126	-13%	Yes
238	Route 15 - SB	996	838	-158	-16%	No
239	Route 16 - EB	1323	1104	-219	-17%	No
240	Route 16 - WB	1343	1134	-209	-16%	No
241	Route 17 - SB	868	977	109	13%	Yes
242	Route 17 - NB	802	782	-19	-2%	Yes

7.3.32. The routes that fail to meet TAG criteria in the Inter peak are: Route 15 SB from Garboldisham to New Buckeham and Route 16 in both directions, EB and WB, between Attleborough and the A140. In all three routes, the model is shown to be quicker than the observed journey time data. As 91% of routes meet TAG criteria, journey times within the Long Stratton area, in the Inter Peak, are considered to represent observed conditions and therefore are fit for purpose in assessing the scheme proposals.

Table 7-16: LSTM PM Journey Time Routes

Routes	34	
Passed	33	97%

Name	PM Peak				
	Observed (s)	Modelled (s)	Diff	%	Pass?
Route 1 -SB	569	598	29	5%	Yes
Route 1 - NB	486	535	49	10%	Yes
Route 2 - SB	564	554	-10	-2%	Yes
Route 2 - NB	587	533	-54	-9%	Yes
Route 3 - SB	399	436	37	9%	Yes
Route 3 - NB	401	465	64	16%	No
Route 4 - SB	631	670	39	6%	Yes
Route 4 - NB	741	681	-60	-8%	Yes
Route 5 - SB	331	337	6	2%	Yes
Route 5 - NB	349	347	-2	-1%	Yes
Route 6 - EB	1401	1515	114	8%	Yes
Route 6 - WB	1413	1479	66	5%	Yes
Route 7 - SB	459	426	-33	-7%	Yes
Route 7 - NB	428	443	15	3%	Yes
Route 8 - EB	822	825	3	0%	Yes
Route 8 - WB	860	761	-99	-12%	Yes
Route 9 - EB	1075	991	-84	-8%	Yes
Route 9 - WB	1098	958	-140	-13%	Yes
Route 10 - SB	31	28	-3	-9%	Yes
Route 10 - NB	29	27	-2	-7%	Yes
Route 11 - SB	223	269	46	21%	Yes
Route 11 - NB	216	250	34	16%	Yes
Route 12 - SB	839	964	125	15%	Yes
Route 12 - NB	833	911	78	9%	Yes
Route 13 - EB	951	943	-8	-1%	Yes
Route 13 - WB	927	941	14	2%	Yes
Route 14 - NB	1298	1217	-81	-6%	Yes
Route 14 - SB	1310	1218	-92	-7%	Yes
Route 15 - NB	825	849	24	3%	Yes
Route 15 - SB	902	859	-43	-5%	Yes
Route 16 - EB	1270	1139	-131	-10%	Yes
Route 16 - WB	1307	1164	-143	-11%	Yes
Route 17 - SB	959	1065	106	11%	Yes
Route 17 - NB	811	794	-18	-2%	Yes

7.3.33. The route that fail to meet TAG criteria in the PM peak is Route 3 NB along the A140 between the villages of Scole and Pulham Market where the model is slower than the observed times. As 97% of routes meet criteria, it is considered that the PM Peak model is representative of observed conditions.

SCREENLINES AND CORDONS

7.3.34. The LSTM has 10 screenlines and cordons of which 8 are calibration and 2 are validation, the number of screenlines and cordons which meet criteria for all vehicles in the LSTM prior and final model performance is summarised in **Table 7-17**.

Table 7-17: LSTM Screenline and Cordon Performance

	AM Peak		Inter Peak		PM Peak	
	Prior	**Final**	**Prior**	**Final**	**Prior**	**Final**
Calibration	1	5 **(63%)**	3	8 **(100%)**	3	3 **(38%)**
Validation	2	2 **(100%)**	2	2 **(100%)**	2	2 **(100%)**

7.3.35. Whilst 63% (5 out of 8) of calibration screenlines meet the criteria in the AM Peak, which is less than the TAG specified criteria of 85%, all 8 screenlines have GEH of less than 5.1 meaning that 100% of screenlines have a GEH of 5.1 or less and 88% of screenlines have a GEH of 4.4 or less. The validation screenlines in the AM peak both have a GEH of less than 4 and meet TAG criteria.

7.3.36. All calibration and validation screenlines have a GEH less than 4.0 in the Inter Peak and as such 100% of screenlines, calibration and validation, meet the TAG criteria.

7.3.37. Similar to the AM Peak, 38% of PM Peak calibration screenlines meet the TAG criteria of having a GEH less than 4 however 1 screenline has a GEH of 4.09 and the remaining 4 calibration screenlines have a GEH of 5.25 or less, meaning that 100% of screenlines have a GEH of 5.25 or less and 75% have a GEH of 5 or less. The validation screenlines in the PM peak both have a GEH of less than 4 and meet TAG criteria.

7.3.38. A summary of total vehicle performance for each of the peaks is shown in **Table 7-18**. Detailed performance of each calibration and validation screenline, for each time period, by vehicle class can be found in separate document - **Appendix H**.

Table 7-18: LSTM Final Screenline and Cordon Total Vehicle Summary

Screenline		AM Peak				Interpeak				PM Peak			
		All				All				All			
Name	Type	Observed	Modelled	Difference	GEH	Observed	Modelled	Difference	GEH	Observed	Modelled	Difference	GEH
Long Stratton SE Northbound	Calibration	1176	1359	16%	5.140	881	895	2%	0.482	1246	1431	15%	5.040
Long Stratton SE Southbound	Calibration	1163	1308	12%	4.113	874	889	2%	0.509	1285	1436	12%	4.093
Long Stratton North Northbound	Calibration	4045	4332	7%	4.423	2709	2639	-3%	1.353	3512	3815	9%	5.011
Long Stratton North Southbound	Calibration	3042	3179	4%	2.453	2736	2604	-5%	2.552	4150	4496	8%	5.253
Long Stratton West Eastbound	Calibration	678	759	12%	3.028	399	419	5%	1.004	631	766	21%	5.114
Long Stratton West Westbound	Calibration	657	699	7%	1.643	403	412	2%	0.468	645	670	4%	0.979
Long Stratton West Inner Eastbound	Calibration	610	677	11%	2.639	341	339	0%	0.088	520	565	9%	1.949
Long Stratton West Inner Westbound	Calibration	467	509	9%	1.908	352	357	1%	0.259	510	491	-4%	0.830
Long Stratton East Inner Eastbound	Validation	1106	1159	5%	1.578	767	729	-5%	1.391	1080	1155	7%	2.228
Long Stratton East Inner Westbound	Validation	975	953	-2%	0.695	779	715	-8%	2.339	1147	1139	-1%	0.229

7.3.39. Long Stratton SE Northbound screenline fails to meet TAG criteria in the AM and PM peak due to a NB count on Tivetshall Road where the model significantly overestimates the total vehicles (+98%/ up to 170 vehicles in the peak hour). **Figure 7-4** demonstrates that all other link counts at this junction have a GEH less than 5 or pass the flow criteria. Similarly, link counts east of Tivetshall Road also pass GEH and/or flow criteria meaning that the matrix estimation process was unable to meet the criteria on this one link and it deteriorates the performance of the overall screenline. All other counts meet GEH/flow criteria and if the Tivetshall count was excluded from the screenline, it would also meet TAG criteria.

7.3.40. Calibration screenlines Long Stratton West Inner (Eastbound/Westbound) and validation screenlines London Stratton East Inner (Eastbound/Westbound) are the 4 screenlines closest to the scheme and all meet TAG criteria in the AM, IP and PM peaks with a GEH < 4. This means that the movement of vehicles across the immediate vicinity within which the scheme is located is considered an accurate representation of the observed movements and conditions.

MODEL CONVERGENCE

7.3.41. Each user class is assigned over a number of iterations until a level of stability or 'convergence' is achieved. The TAG-recommended convergence criteria, which is pre-set set within VISUM, is set out in **Table 7-19**.

Table 7-19: TAG Convergence Criteria

Measure of Convergence	Acceptable Value
'Delta' and % Gap	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow changes < 1% ('P')	Four consecutive iterations greater than 98%

7.3.42. A summary of the assignment results is shown in **Table 7-20** for each of the three assessed time period in the LSTM. These demonstrate that the vehicle classes converge 'naturally', i.e. according to the settings defined within the model. A more detailed breakdown of converge by time period is shown in **Table 7-21** to **Table 7-23** for the AM Peak, Inter Peak and PM Peak respectively.

Table 7-20: LSTM HAM Convergence Results

Saturn Parameter	Required Value	AM Peak	Interpeak	PM Peak
PCNEAR	1	1	1	1
RSTOP	98	98	98	98
STPGAP	0.1	0.1	0.1	0.1
NISTOP	4	4	4	4
KONSTOP	5	5	5	5

Table 7-21: AM Peak Convergence Results

Iteration	Delta	%Flow	%Gap
29	0.0048	98.8	0.0085
30	0.0039	99.1	0.0059
31	0.0069	99.3	0.0080
32	0.0044	99.1	0.0097

Table 7-22: Inter Peak Convergence Results

Iteration	Delta	%Flow	%Gap
12	0.0026	98.2	0.0016
13	0.0007	98.4	0.0013
14	0.0006	98.6	0.0009
15	0.0004	98.8	0.0006

Table 7-23: PM Peak Convergence Results

Iteration	Delta	%Flow	%Gap
20	0.0133	98.1	0.0320
21	0.0133	98.6	0.0270
22	0.0135	98.4	0.0230
23	0.0174	98.9	0.0200

7.4 MATRIX ESTIMATION IMPACTS

GRADIENT, SLOPE and R2

7.4.1. **Table 7-24** presents the AM, Inter Peak and PM prior and post matrix estimation statistics. TAG Guidance suggests that the following criteria is met between the prior and post matrix estimation matrix zonal trip ends:

- Gradient within 0.99 and 1.01;
- Intercept is near zero; and
- R2 in excess of 0.98.

7.4.2. Guidance suggested that the following criteria are met for matrix zonal cell values

- Gradient within 0.98 and 1.02;

- Intercept is near zero; and
- R2 is in excess of 0.95.

7.4.3. The instances where criteria are not met are highlighted in orange and red. Orange indicates the instance is just outside the criteria, whilst red indicates the instance is far outside the criteria. This demonstrates that matrix estimation is distorting the prior trip matrix.

Table 7-24: Peak Period Prior and Post Matrix Estimation Statistics, Full Model

Matrix	Measure	Requirement	AM Peak	Interpeak	PM Peak
Cells	Gradient	Within 0.98 and 1.02	**0.99**	**1.00**	**0.99**
	Intercept	Near 0	**0.004**	**0.004**	**-0.001**
	R2	> 0.95	**0.93**	**0.95**	**0.92**
Rows	Gradient	Within 0.98 and 1.01	**0.99**	**0.98**	**0.97**
	Intercept	Near 0	**4.85**	**5.82**	**2.93**
	R2	> 0.98	**0.95**	**0.93**	**0.95**
Columns	Gradient	Within 0.98 and 1.01	**1.01**	**1.00**	**0.95**
	Intercept	Near 0	**2.63**	**4.44**	**4.45**
	R2	> 0.98	**0.95**	**0.93**	**0.95**

7.4.4. The LSTM model coverage extend to South Norfolk and the entirety of Suffolk County; it was deemed appropriate to summarise the matrix regression for the sectors within the immediate vicinity of the scheme only by applying a masking process to eliminate any external to external sector movements from the calculation.

7.4.5. The matrix estimation statistics, for the internal area only, are shown in **Table 7-25**.

Table 7-25: Peak Period Prior and Post Matrix Estimation Statistics, Internal Area Only

Measure	Requirement	AM Peak	Interpeak	PM Peak
Gradient	Within 0.98 and 1.02	**1.02**	**1.02**	**1.04**
Intercept	Near 0	**0.02**	**0.00**	**0.00**
R2	> 0.95	**0.97**	**0.98**	**0.97**

TRIP LENGTH DISTRIBUTION

7.4.6. The trip length distribution for the prior and final matrix for each demand segment within each time period has been calculated. The trip distribution graphs are shown in **Figure 7-10** to **Figure 7-12**. All the graphs show that there are mainly small changes in trip length distribution between the prior and final matrices. The greatest change is in the short distances trips which increase in all scenarios as a result of matrix estimation. This is because the mobile phone data used to derive the prior matrices do not fully capture short distance trips and therefore matrix estimation is infilling these trips into the matrices.

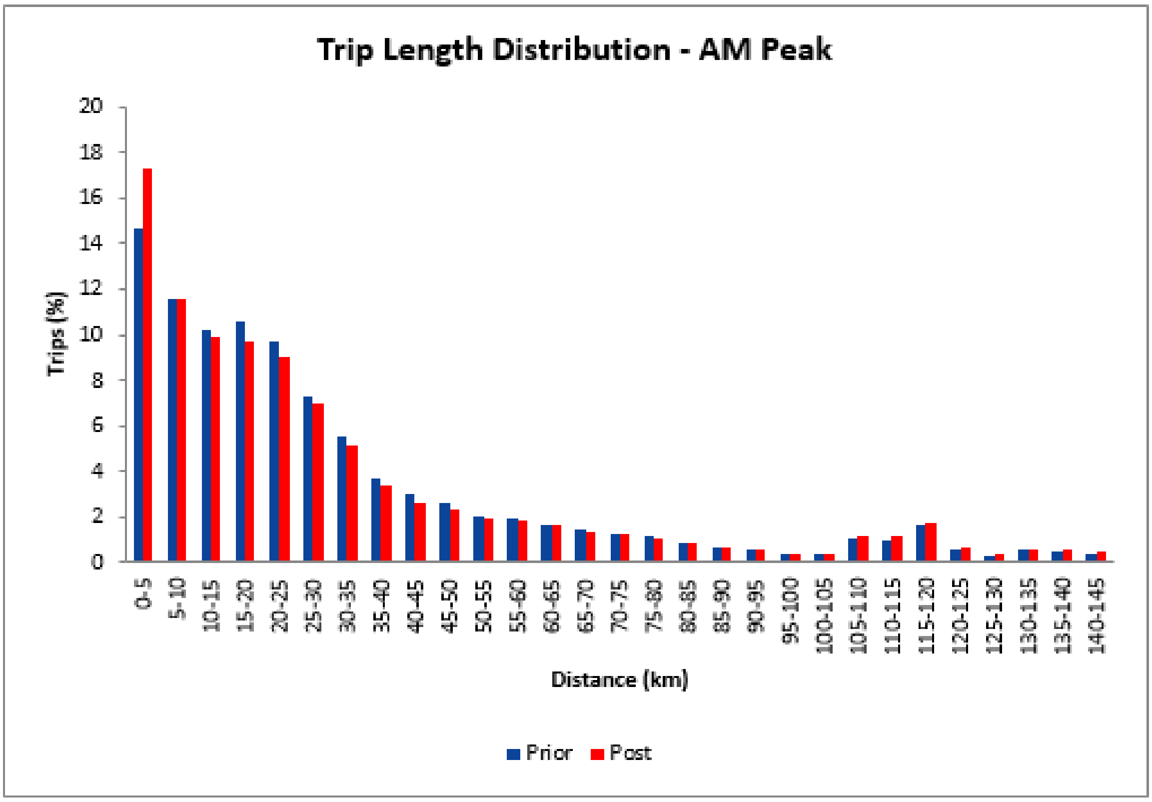

Figure 7-10: AM Peak Length Distribution All User Classes

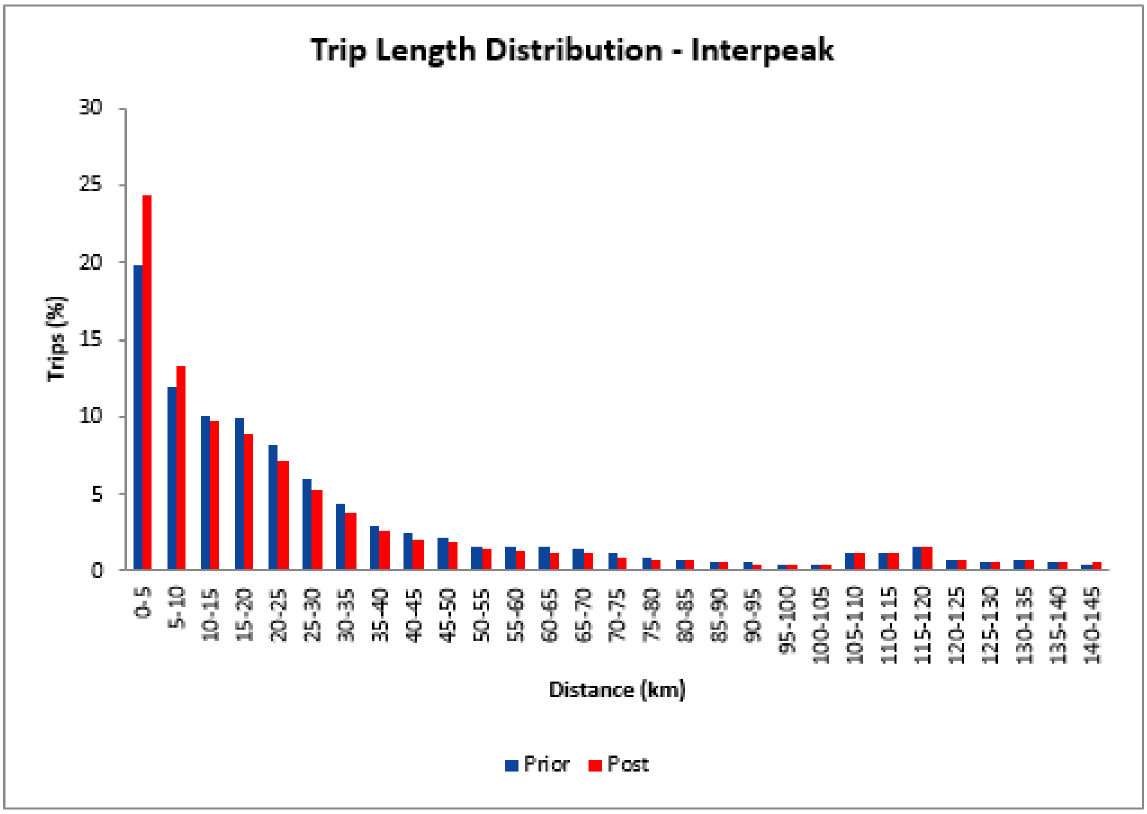

Figure 7-11: Inter Peak Trip Length Distribution All User Classes

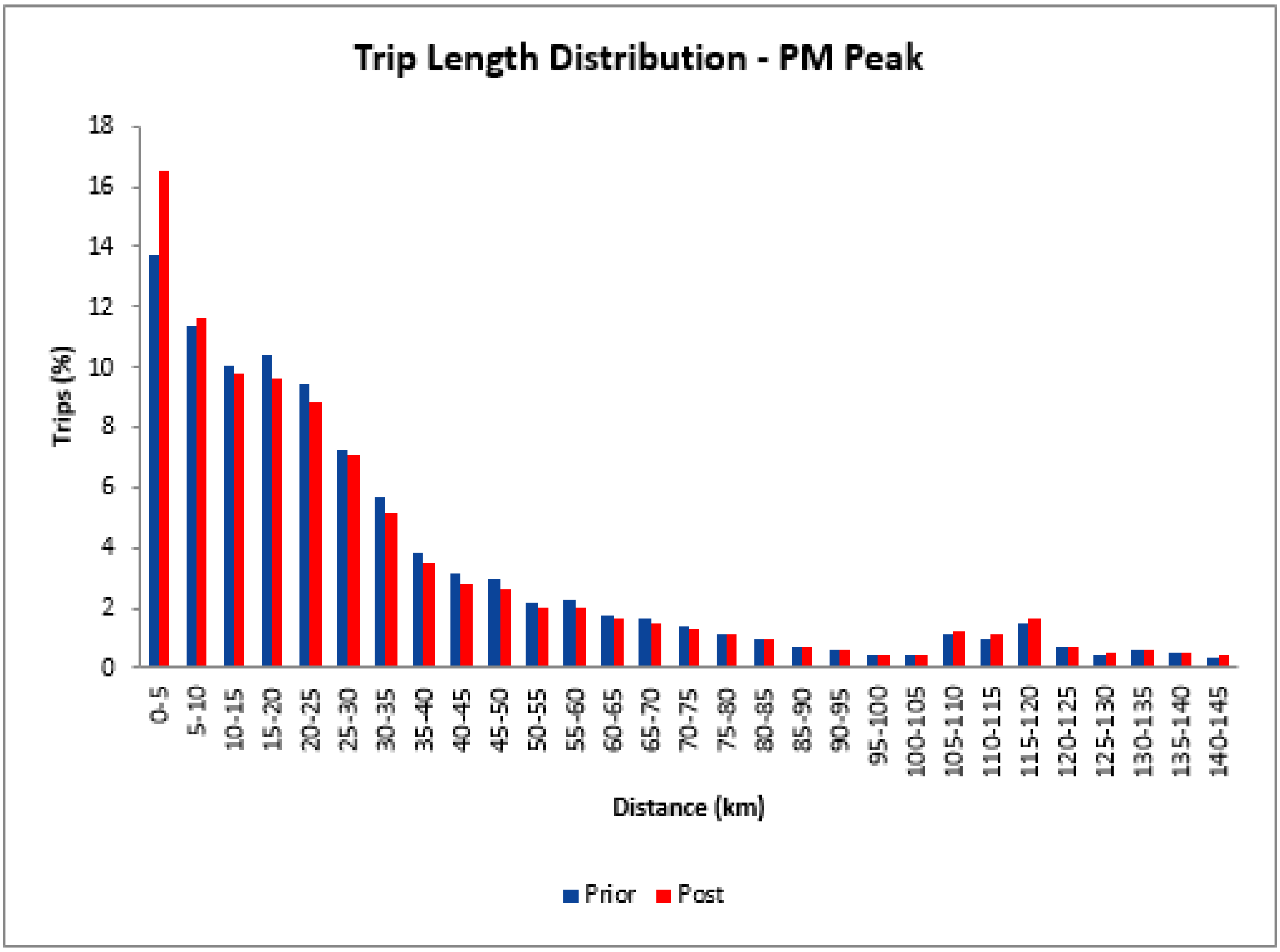

Figure 7-12: PM Peak Trip Length Distribution All User Classes

7.4.7. A comparison between prior and post ME matrix totals for each of the time periods and user classes is presented in **Table 7-26** to **Table 7-28** showing the overall percentage change as being 3% for the AM peak, 5% for the Inter Peak and -1% for the PM peak respectively.

Table 7-26: LSTM AM Peak Prior and Final Matrix Totals

Demand Segment	Prior Matrix	Final Matrix	% Change
UC1	859	988	15%
UC2	69,530	66,757	-4%
UC3	403	451	12%
UC4	3,688	3,769	2%
UC5	3,907	4,219	8%
UC6	6,566	7,405	13%
UC7	44,300	46,118	4%
UC8	10,115	11,015	9%
UC9	16,983	15,983	-6%
UC10	5,317	9,071	71%
TOTAL	**161,669**	**165,775**	**3%**

Table 7-27: LSTM Inter Peak Prior and Final Matrix Totals

Demand Segment	Prior Matrix	Final Matrix	% Change
UC1	8,088	8,013	-1%
UC2	6,295	6,186	-2%
UC3	874	903	3%
UC4	870	897	3%
UC5	3,574	3,800	6%
UC6	34,012	35,129	3%
UC7	26,327	27,347	4%
UC8	12,015	12,691	6%
UC9	12,731	11,705	-8%
UC10	5,491	8,780	60%
TOTAL	**110,276**	**115,451**	**5%**

Table 7-28: LSTM HAM PM Peak Prior and Final Matrix Totals

Demand Segment	Prior Matrix	Final Matrix	% Change
UC1	67,333	63,285	-6%
UC2	1,155	1,319	14%
UC3	2,712	2,700	0%
UC4	1,024	1,119	9%
UC5	2,932	3,031	3%
UC6	41,822	41,493	-1%
UC7	16,656	18,380	10%
UC8	12,650	13,101	4%
UC9	13,372	12,387	-7%
UC10	5,679	6,289	11%
TOTAL	**165,334**	**163,102**	**-1%**

SECTOR TO SECTOR MOVEMENTS

7.4.8. Within the LSTM, there are 46 sectors covering South Norfolk and the entirety of Suffolk County; the internal sectors, closest to the proposed bypass scheme are presented in **Figure 7-13** and presented by the blue highlighted boundary. Sector 736 represents Long Stratton and would contain the proposed scheme.

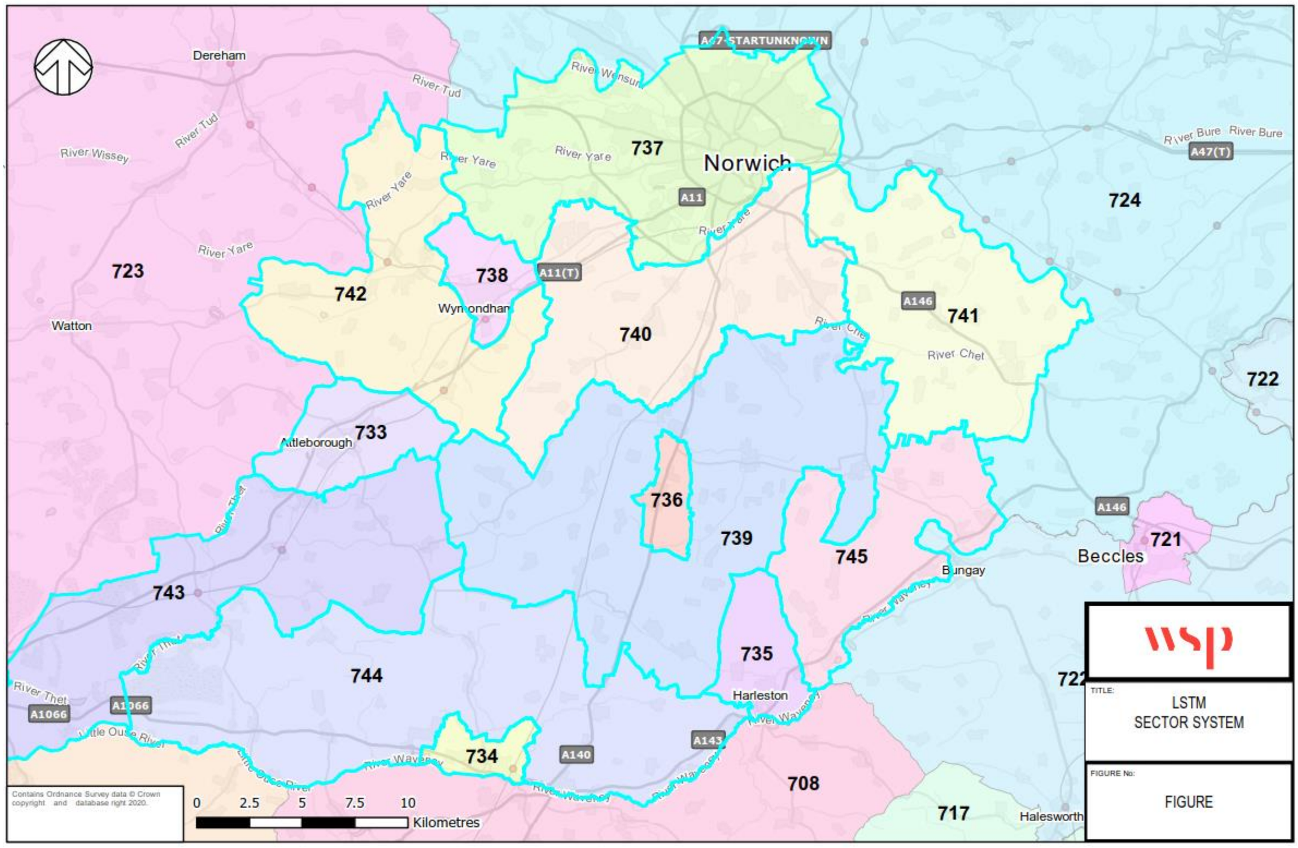

Figure 7-13: LSTM Sector System, Internal Sectors

7.4.9. The prior and post matrix estimation matrices by user class have been compared at sector to sector level by the actual differences shown in separate document - Appendix I.

7.5 BASE YEAR FLOWS

7.5.1. The modelled flows for the final base year model for all time periods are shown in separate document - Appendix J. The flows are shown in the scheme area and the other relevant corridors around the scheme.

7.5.2. It can be anticipated that the impact of the bypass scheme on Norwich city centre is not expected to attract significant amounts of strategic traffic from alternative adjacent or parallel routes, the impacts on traffic flows in Norwich are expected to be minimal. Flow difference plots included within the updated Forecasting Report will demonstrate changes in vehicle volumes around Norwich, which are not expected to exceed +/- 20 vehicles.

7.5.3. Norwich city centre is within the SATURN buffer network and as such minimal network detail has been included to model only core access and egress routes such as A11, A47, A140 and A146.

8 SUMMARY AND CONCLUSIONS

8.1 SUMMARY

8.1.1. WSP has been commissioned by NCC to undertake transport modelling to support the Outline Business Case (OBC) for a proposed bypass near Long Stratton, Norfolk. The SCTM is a model developed for Suffolk County Council (SCC) for their scheme appraisal and forecast modelling; the SCTM includes network detail within South Norfolk and in particular, Long Stratton. The appraisal of the proposed bypass, and thus development of the base year model presented within this report, is an extension of the SCTM, enhanced within the vicinity of the proposed scheme to form the LSTM.

8.1.2. This LMVR details the enhancing of the 2016 SCTM, within the Long Stratton Study Area, and reports on observed counts and journey times commissioned and validated for the purpose of the LSTM update, ensuring that specified TAG criteria have been met. The validated LSTM base model will be used to develop two forecast years that will represent the scheme opening (2024) and design year of the proposed bypass, 15 years after scheme opening (2039). The forecast years will be developed using committed developments and background (housing and job) growth between 2016 and 2024 and 2039 respectively. For each of the future assessment years, a Do Minimum (without the proposed bypass) and a Do Something (with the proposed bypass) scenario will be built.

8.1.3. The model has been developed and validated for the AM Peak (08:00 – 09:00), the average Inter Peak (10:00 – 16:00) and the PM Peak (17:00 – 18:00), which is consistent with the Mobile Network Data; the primary input to the origin-destination matrices.

8.1.4. To assist with the enhancement of the SCTM within South Norfolk, WSP commissioned NDC to undertake a comprehensive traffic survey collection consisting of 23 ATCs and 2 MCCs in the Long Stratton Study Area. In addition, WSP requested the extraction of INRIX data along 17 identified routes, in both directions, to assess the models fit for purpose in assessing journey times within Long Stratton.

8.1.5. To assess the Long Stratton Bypass, the zone structure within South Norfolk has been refined and the highway network detail enhanced to ensure the model is reflective of accurate on-street network detail in the base year of 2016. LSTM development included the incorporation of junction coding, lane allocation, saturation flows, gap times, distance and speed.

8.1.6. Generalised cost parameters were defined to determine the overall cost of each available path between an origin-destination pair, based on user-class.

8.1.7. The LSTM contains 86 one-way count locations which are used in the calibration process and 26 one-way links that are brought into the model validation. 34 one-way journey time routes were defined for analysis and comparison in the model and 10 screenlines.

8.1.8. Prior matrix performance demonstrated that 64% of AM Peak calibration link counts met TAG criteria for GEH or Flow, 88% in the Inter Peak and 63% in the PM Peak. Validation statistics for the prior matrices showed 81% of AM and PM Peak counts met criteria whilst 92% of counts met criteria in the Inter Peak.

8.1.9. Matrix estimation was undertaken on all calibration links and screenlines and resulted in:

- 84% of total AM Peak counts meeting flow criteria or having a GEH less than 5;
- 95% of total Inter Peak counts meeting flow criteria or having a GEH less than 5; and
- 79% of total PM Peak counts meeting flow criteria or having a GEH less than 5.

8.1.10. Final Count validation statistics for link counts showed that:

- 92% of total AM Peak counts meet flow criteria or had a GEH less than;
- 96% of total Inter Peak counts meeting flow criteria or having a GEH less than 5; and
- 88% of total PM Peak counts meeting flow criteria or having a GEH less than 5.

8.1.11. Journey time performance post matrix estimation demonstrated that 95% of journey time routes passed criteria in the AM Peak, 91% in the Inter Peak and 97% PM Peak respectively. As this exceeds the TAG criteria required for journey time validation, it is reasonable to assume that the model accurately represents observed journey time data in both the AM Peak, Inter Peak and PM Peak.

8.1.12. Both validation screenlines meet criteria in all time periods whilst 68% of calibration screenlines met criteria in the AM Peak, 100% in the Inter Peak and 38% in the PM Peak. Whilst 68% of calibration screenlines meet the criteria in the AM Peak, which is less than the TAG specified criteria of 85%, all 8 screenlines have GEH of less than 5.1, which means that 100% of screenlines have a GEH of 5.1 or less and 88% of screenlines have a GEH of 4.4 or less. Similar to the AM Peak, 38% of PM Peak calibration screenlines meet the TAG criteria of having a GEH less than 4 however, 1 screenline has a GEH of 4.09 and the remaining 4 calibration screenlines have a GEH of 5.25 or less, meaning that 100% of screenlines have a GEH of 5.25 or less and 75% have a GEH of 5 or less. It is noted that the two screenlines immediately adjacent to the scheme meet TAG criteria in all of the three time periods.

8.1.13. Calibration screenlines Long Stratton West Inner (Eastbound/Westbound) and validation screenlines London Stratton East Inner (Eastbound/Westbound) are the 4 screenlines closest to the scheme and all meet TAG criteria in the AM, IP and PM peaks with a GEH < 4. This means that the movement of vehicles across the immediate vicinity within which the scheme is located is considered an accurate representation of the observed movements and conditions.

8.1.14. Model convergence statistics presented within the LMVR show that the criteria for each of the five SATURN parameters (PCNEAR, RSTOP, STPGAP, NISTOP and KONSTP) is met within the AM, Inter and PM Peak model time periods within the LSTM 2016 base year.

8.1.15. The matrix regression statistics demonstrate that for the internal area, the Intercept, Slope and R squared value meet TAG criteria for all peaks other than the PM peak where the slope is marginally outside criteria.

8.1.16. Comparisons between overall matrix totals, by user class, present a growth in total trips by 3% in the AM Peak post matrix estimation, 5% in the Inter Peak and 1% in the PM Peak.

8.2 CONCLUSIONS

8.2.1. It is considered the LSTM highway model has been shown to provide a reasonable match to observed traffic count and journey time data. Local validation undertaken within Long Stratton and the area of detailed modelling shows that the required flow, GEH and journey time performance is achieved. The LSTM highway model provides a robust basis from which to create forecast assignments for future scheme and development testing.

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