Sefton Council

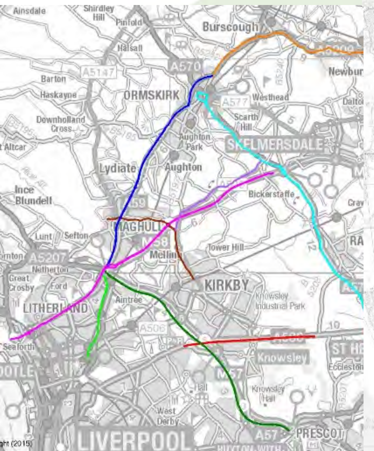
ATKINS

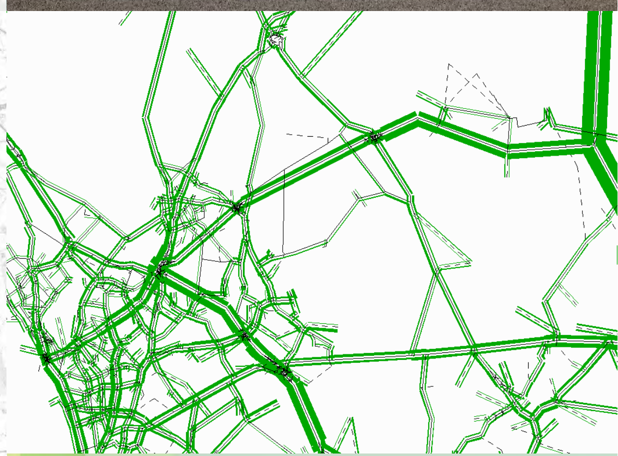
M58 Junction 1 improvement

Local Model Validation Report

Sefton Council

2 June 2015





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Document history

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Rev 1.0	Local Model Validation Report (LMVR) of the M58 Junction 1 improvement Scheme	J. Robinson J. Sarma	M. Mahmud	R. Kimber	N. Malik	30/06/15

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1. Introduction

1.1. Overview

ATKINS has been commissioned by Sefton Council to provide professional services to develop a traffic model, which will be used to develop a Major Scheme Business Case (MSBC) for the funding arrangement of the M58 Junction 1 improvement scheme. Currently the junction 1 has only two slip roads on the east side of the roundabout. Due to the lack of two west facing slip roads, the junction can only allow limited traffic movements. The junction is already important but it's importance will increase due to the proposed residential and commercial developments in Mughall. Sub-regional significance of this improvement has been uplifted due to the on-going Liverpool SUPERPORT programme, a high profile project to develop a major freight hub in six of the local authorities within Liverpool City Region (LCR), including Sefton.

The scheme is being promoted by Sefton Metropolitan Borough Council (SMBC) and it has made his first entry into the lists of priority schemes under Sefton Council's Draft local Plan in 2013. Capita Symonds, commissioned by the council, developed an outline engineering design and indicative cost estimate of the scheme in April 2013. The scheme is, however, yet to be submitted for the Programme Entry.

The existing grade separated junction is located in Maghull at the interchange with Maghull Lane and the M58. Figure 1-1 presents the location of the scheme in relation to the major road network and surrounding areas.

Figure 1-1 Location of the Scheme

At the immediate vicinity of the junction the area mainly consists of open farm lands. The junction provides traffic linkage between the M58 motorway and the local townships of Maghull and Kirkby, which are well within 5 km of the junction. The junction 1 is located to the east of the Switch Island Interchange that provides a crucial connection between some of the major links in and out of Liverpool, Sefton and Knowsley. It is heavily trafficked during the peak hours by bringing vehicles from the M58, M57, both the east-west links of A59 and A5036.

This report represents the Local Model Validation Report (LMVR) for the 2013 base highway model developed in support of the M58 Junction 1 improvement scheme. The report has been written in accordance with the requirements of the Highways Agency's Interim Advice Note 106 (IAN106), which specifies the required content of an LMVR for HA schemes.

1.2. Background

The M58 Junction 1 Link SATURN[1] model was originally based on the Thornton Link model developed by Atkins for Sefton Council for the Thornton to Switch Island Link project. In 2001, SMBC commissioned Atkins to undertake a series of transport and economic assessments for the Thornton to Switch Island Link Road scheme. A total of six schemes were appraised. In 2004, Atkins were once again commissioned by SMBC to undertake a further set of assessments for the Thornton Switch Island Link Road scheme. As part of that commission, the original model was updated to a 2004 base year. The model subsequently went through a number of updates including a major update in 2007 to support a Major Scheme Business Case submission for Programme Entry to the Department for Transport. Traffic forecasts and economic assessments were undertaken for the proposed Thornton Switch Island Link scheme and a low-cost alternative option. The scheme obtained Programme Entry status in September 2008.

The base model described in this document has been built on the Thornton Link model but with a significant update on the spatial coverage and a major improvement to base matrix. This report presents our approach to improve the model to fit for purpose in assessing the M58 Junction 1 scheme. It also presents the relevant calibration and validation results of the model.

1.3. Report Structure

Following this introduction, the remainder of the report is structured as follows:

- **Chapter Two** describes the **scope and specification** of the M58 Junction 1 traffic model;
- **Chapter Three** provides details on the **data collected** for use in the development of the traffic model;
- **Chapter Four** describes the development of the **model networks**;
- **Chapter Five** provides an overview of the model assignment process;
- **Chapter Six** describes the process used to develop the **matrices**;
- **Chapter Seven** discusses the model **calibration process**, including the results of this process;
- **Chapter Eight** presents the results of the model validation; and
- Finally, the **conclusions** of the report are presented in **Chapter Nine**.

[1] **S**imulation and **A**ssignment of **T**raffic in **U**rban **R**oad **N**etworks

Model Specification

2. Model Specification

2.1. Background

The Thornton Link model has been updated for the M58 scheme assessment. This chapter presents the architecture of the model and also describes the level of updates that have been done to make the model fit for purpose in assessing the scheme.

2.2. Wider Local Model

On behalf of the Liverpool Combined Authority, Mott Macdonald has developed a City Region Wide Traffic Model (LCRTM), which includes road network within the City Region Boundary. This model is being used to develop several other local major Scheme Business Cases. The model is however very strategic in nature and does not contain enough detail near the area of influence of the M58 Junction 1. Our M58 J1 model therefore provides better representation of the scheme and its area of influence.

It is equally critical that our model is in line with the wider model so that all the regional schemes can ensure consistent approach of appraisal. Atkins sourced different data from Mott Macdonald, including LCRTM zone structure, traffic count and Origin-Destination data, which are described in the later sections of this report.

2.3. Spatial Coverage

The simulation area of the Thornton link model was concentrated on the area around Switch Island and the Liverpool city centre. The Junction 1 is however located right at the edge of the Thornton Link model simulation network. In order to capture the accurate area of influence of the Junction 1 scheme, the simulation area has been extended to further east. Additional links have been added to the simulation area. Subsequently the buffer area has also be extended by a similar proportion. Figure 2-1 presents our proposed extension of the model spatial coverage.

Figure 2-1 Extended Simulation Area

The model simulation area is primarily focused on the area near South Sefton, which includes Crosby, Litherland, Netherton, Maghull and Thornton. To the south the model includes Liverpool, Bootle Knowsley and St. Helens, while to the north the coverage extends as far as Ormskirk. Key routes represented in the model include the M57, M58, M62, A59, A570 and A5036.

The zone system has been developed in a way that all the M58 model zones are well nested within LCRTM zones. The zones near the scheme needed further disaggregation compared to LCRTM zones, whilst zones away from the scheme required some aggregation, maintaining the appropriate granularity. The model has a total of 343 zones which are distributed across the Greater Merseyside area. Table 2-1 presents the zones distribution across different key geographical boundaries and Figure 2-2 presents the zone boundary in the simulation area.

Table 2-1 Zone Distribution of the M58 model

Area	Number of Zones
South Sefton	108
Liverpool	91
Knowsley	37
St. Helens	32
Outer Merseyside	34
Rest of UK	41

Figure 2-2 M58 Model Zone Boundary-Buffer & External Zones

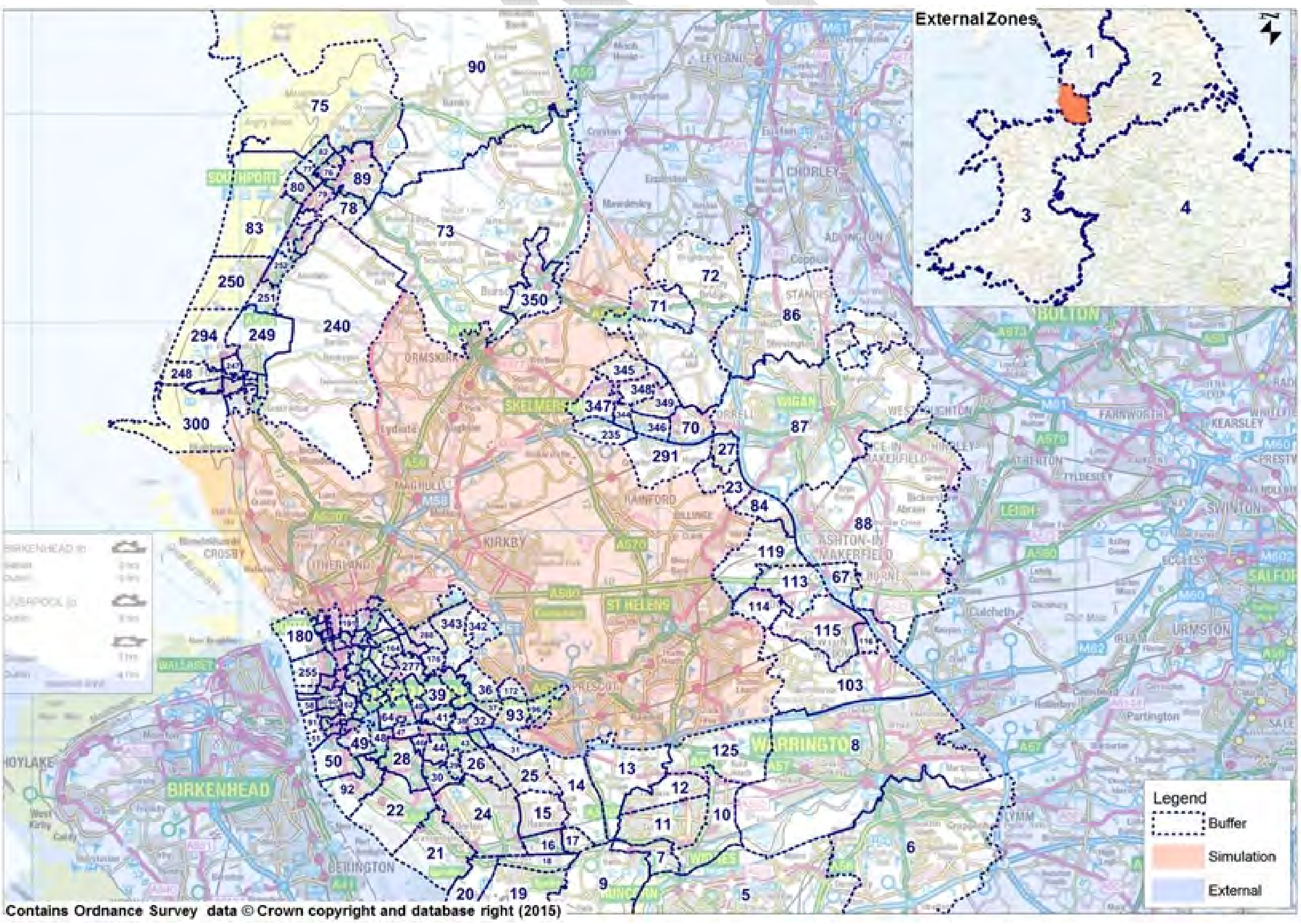
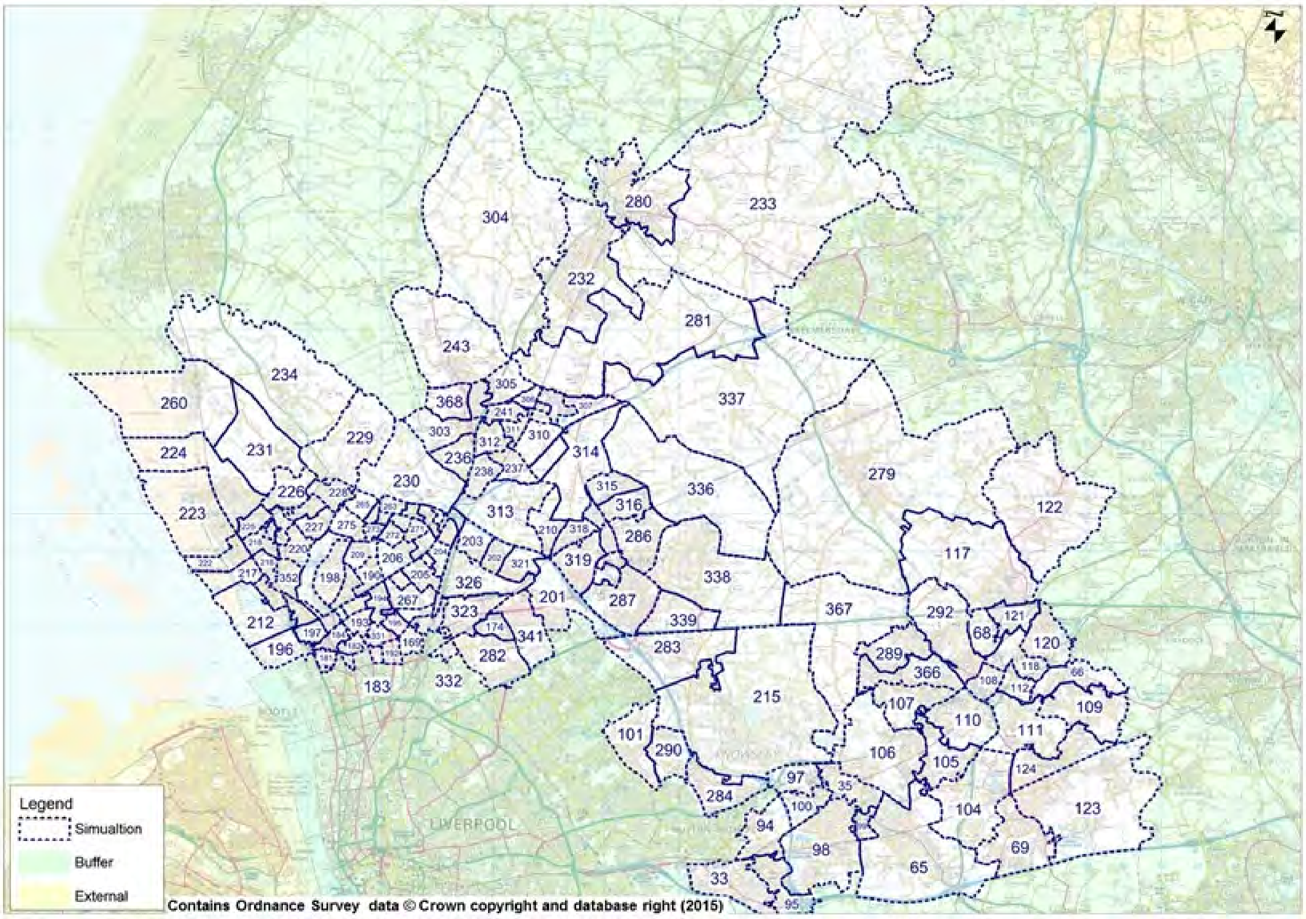


Figure 2-3 M58 Model Zone Boundary-Simulation Area



2.4. Temporal Scope

The model represents an average neutral month weekday for a base year of 2013 for the following time periods:

- Morning or AM peak hour (0800-0900);
- Average inter-peak hour (1000-1600); and
- Evening or PM peak hour (1700-1800).

2.5. Demand Segmentation

User classes (UC or UCs) are used to depict the differing characteristics of vehicle users within the model. It is important that appropriate demand segmentation is applied to the assignment because their vehicle operating cost and value of time varies by different user classes. It impacts the generalised cost by different user classes and influence their route choices in the network. Further details of the demand segments are presented in Chapter 6 of this report. A total of five user classes have been used to represent different trip purposes. The first three are sub-categories of car users and the last two represents the trip characteristics of goods vehicles. Table

Table 2-2 User Class Definition

User Class	Vehicle Type	Purpose
1	Car	Employers Business (EB)
2	Car	Home Based Work (HBW)
3	Car	Other

User Class	Vehicle Type	Purpose
4	Light Goods Vehicles	
5	Heavy Goods Vehicles	

Bus services operate along fixed routes. These are defined in the model as individual bus services with an associated level of frequency. Bus flows appear within the model as part of the 'fixed flow', commonly known as Pre-load, on a given link.

2.6. Passenger Car Units (PCU)

Passenger Car Unit (PCU) is a unit used to assess traffic flow rate. PCUs are introduced to allow for differences in the degree of interference to other traffic by the addition of one extra vehicle to the traffic, according to the type of the vehicle. There are established conversion factors that can be applied to convert any type of vehicle to the equivalent number of passenger car units. This allows mixed traffic streams to be assessed more accurately than if it was assumed that all vehicles have an equal impact on the highway network. For the purpose of the M58 Junction 1 model, the following PCU values were used:

Light vehicles = 1.0pcu;
HGV (Heavy Vehicles) = 2.3pcu; and
Buses = 2.0 pcu (fixed flow).

The PCU factors for the light and heavy vehicles are the recommended best practise values.

2.7. Modelling Suite

The M58 Traffic Model has been built in Version 11.3.10E of the SATURN highway modelling suite. SATURN is a proprietary software suite able to encompass strategic modelling at a regional level down to the assessment of individual junctions at the simulation level. As a simulation modelling tool, SATURN is capable of analysing relatively minor changes in the network such as traffic management and provides detailed analysis of traffic behaviours at junctions. SATURN is an industry respected assignment modelling tool used widely for the assessment of highways schemes and can provide robust analysis of small to large infrastructure developments. Accordingly, it is ideally suited to the assessment of development and transport proposal for the M58 Junction 1 improvement scheme.

Data Collection

3. Data Collection

3.1. Overview

A range of data types have been used in the development of the M58 model. The different types of data were,

- Roadside Interview (RSI) Origin-Destination data;
- Trafficmaster Origin-Destination data;
- 2011 Journey to Work National Census Data
- Manual Classified Count (MCC) data;
- Automatic Traffic Count (ATC) data;
- Automatic Traffic Count data from Highways England's monitoring sites (commonly known as TRADS sites); and
- Trafficmaster Travel Time data.

All the data have been collected from various sources. A significant amount of data, including RSI, Trafficmaster OD and Traffic Counts, have been sourced from Mott Macdonald, which were collected for the development of their Liverpool City Region Traffic Model (LCRTM). The Trafficmaster data in West Lancashire area, beyond the City Region's jurisdiction, were sourced from DfT with appropriate license agreement between Atkins, West Lancashire Council and DfT.

In addition to the LCRTM data, some of the traffic counts were sourced from the data that Atkins previously collected for other model development works in the area, including Southport Model and Thornton Link Model.

The following sections provide a summary of the collated data in each of the above categories; detailing any key findings and commenting on the suitability of the data for development of the traffic models.

3.2. Roadside Interview (RSI) Data

The actual trip distribution pattern can be obtained from roadside origin-destination survey. We have collected RSI data from Mott Macdonald which were used in LCRTM model development as well as our previous work in the area. Most of the RSI data were available in the area covering Liverpool City centre, Knowsley, Kirkby and Maghull. The age of the data ranged from 2005 to 2013. We have explored all the available data and made the best use of them

RSI data from 27 sites were used for creating partially observed demand matrices. These sites provide origin/destination interview data, along with bi-direction MCC data on the survey day. Bi-directional ATC data was also obtained at each RSI site to provide continuous traffic profile. The RSI data was used for the OD trip patterns and expanded to ATC and MCC counts to 2013. This data enables interview direction and (by transposition) non-interview direction demand matrices to be compiled for all RSI sites. These RSI sites form the inner cordon of the study area as explained later in this section.

The figure below presents the RSI sites, which have been used in the M58 model development.

Figure 3-1 RSI Sites Used for the Model Development

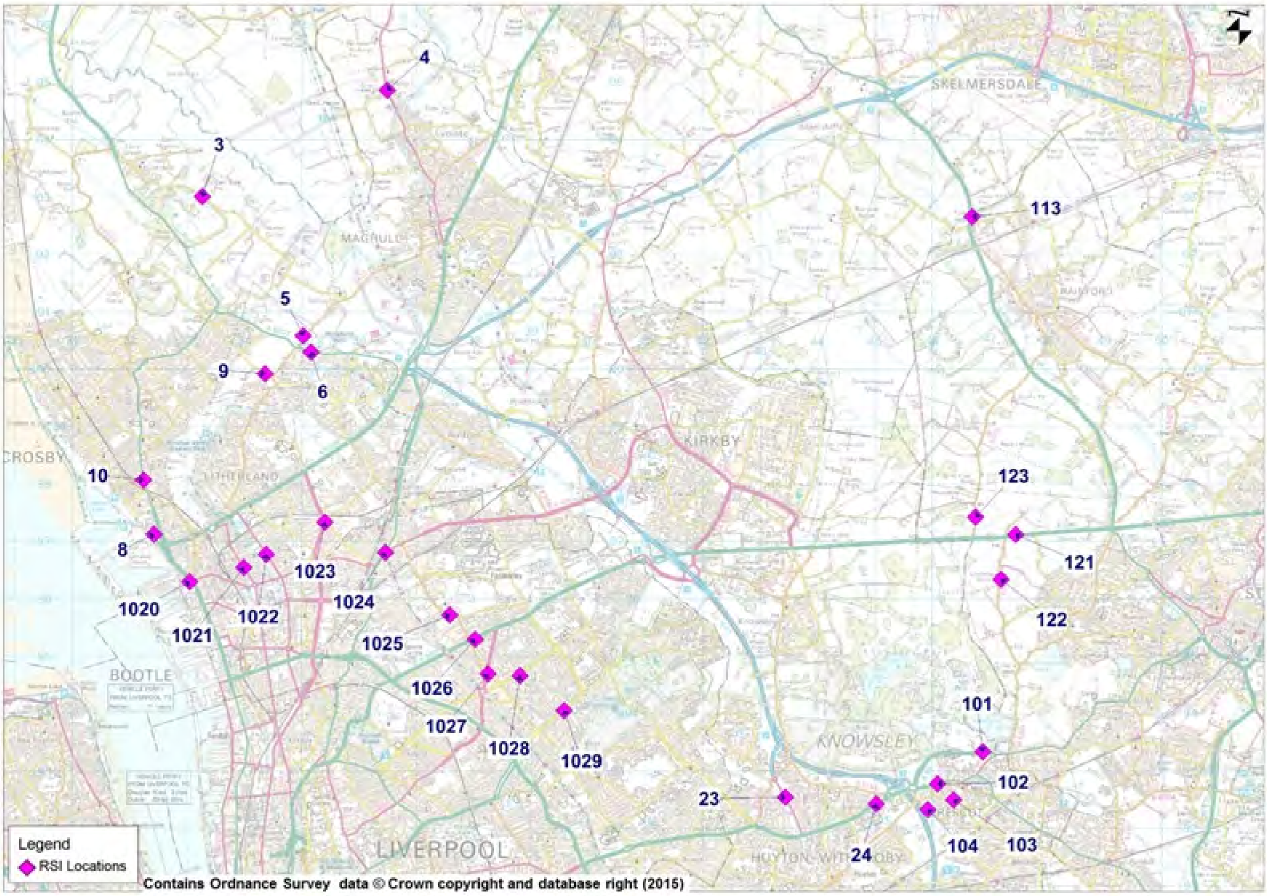


Table 3-1 presents the list of RSI sites by different years used for building partially observed matrices.

Table 3-1 RSI Sites Used for Developing Partially Observed Matrices

M58_J1 Site ID	Area	Location	Interview Direction	Year
3	Sefton	Park Wall Road	SB	2009
4	Sefton	A5147 Southport Road	SB	2009
5	Sefton	Brickwall Lane	SB	2009
6	Sefton	Northern Perimeter Road	EB	2009
8	Sefton	Seaforth	NB	2009
9	Sefton	Edge Lane	SB	2009
10	Sefton	A565 Crosby Road North	SB	2009
1024	Liverpool	A59 Walton Vale	SB	2009
1023	Sefton	A5038 Bailey Drive	SB	2009
1022	Sefton	A5090 Hawthorne Road	SB	2009
1021	Sefton	A567 Stanley Road	SB	2009
1020	Sefton	A565 Primrose Road	SB	2009
1027	Liverpool	A580 Townsend Avenue	SB	2009
1028	Liverpool	Utting Avenue East	WB	2009
1029	Liverpool	Muirhead Avenue East	WB	2009
1025	Liverpool	B5167 Stopgate Lane	SB	2009

M58_J1 Site ID	Area	Location	Interview Direction	Year
1026	Liverpool	A580 East Lancs Road	WB	2009
104	St Helens	Carr Lane	SB	2008
101	St Helens	A58 Prescot Bypass	EB	2008
113	St Helens	A570 Rainford Rd	SB	2008
102	St Helens	A57 Derby Road	EB	2008
103	St Helens	Manchester Road	EB	2008
121	St Helens	A580 East Lancs Rd	EB	2008
122	St Helens	Gillars Lane	SB	2008
123	St Helens	Blind Foot Rd	NB	2008
23	Knowsley	Seth Powell Way	SB	2013
24	Knowsley	A57 Liverpool Road	WB	2013

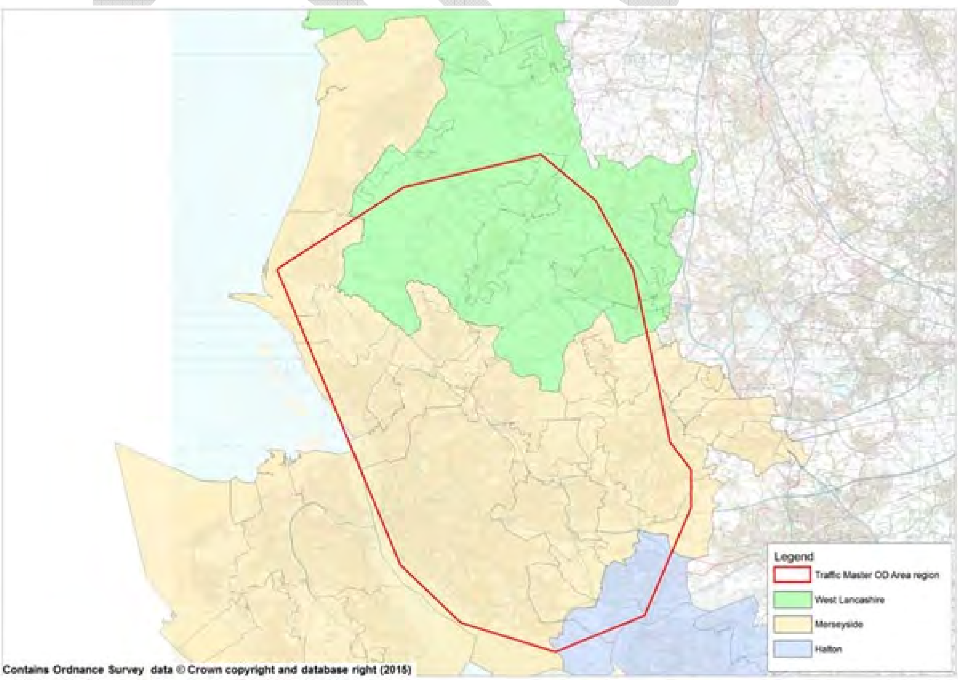
Further information on how this data have been used to develop the trip matrix are described in Chapter 6 of this report.

3.3. Trafficmaster OD data

While the RSI data from different sources provided a good source of the origin-destination information, the spatial coverage in relation to the M58 model was limited. It was further constraint by the age limitation of the available data. In order to supplement the gap left by the RSI data, we have collected Trafficmaster OD data. We have collected two types of Trafficmaster OD data,

- **Area-wide OD**: It provided all the origin-destination data bounded by a designated area. The boundary included both simulation and buffer area of the model. This data provided the basis of any internal-internal movements within the simulation area, buffer to simulation movements and any buffer to buffer movements. The Traffic Master Area OD data has been obtained from Merseyside, Halton and West Lancashire. Figure 2 shows the boundary of the Traffic Master area wide OD collected for this model development.

Figure 3-2 Traffic Master OD Area Region

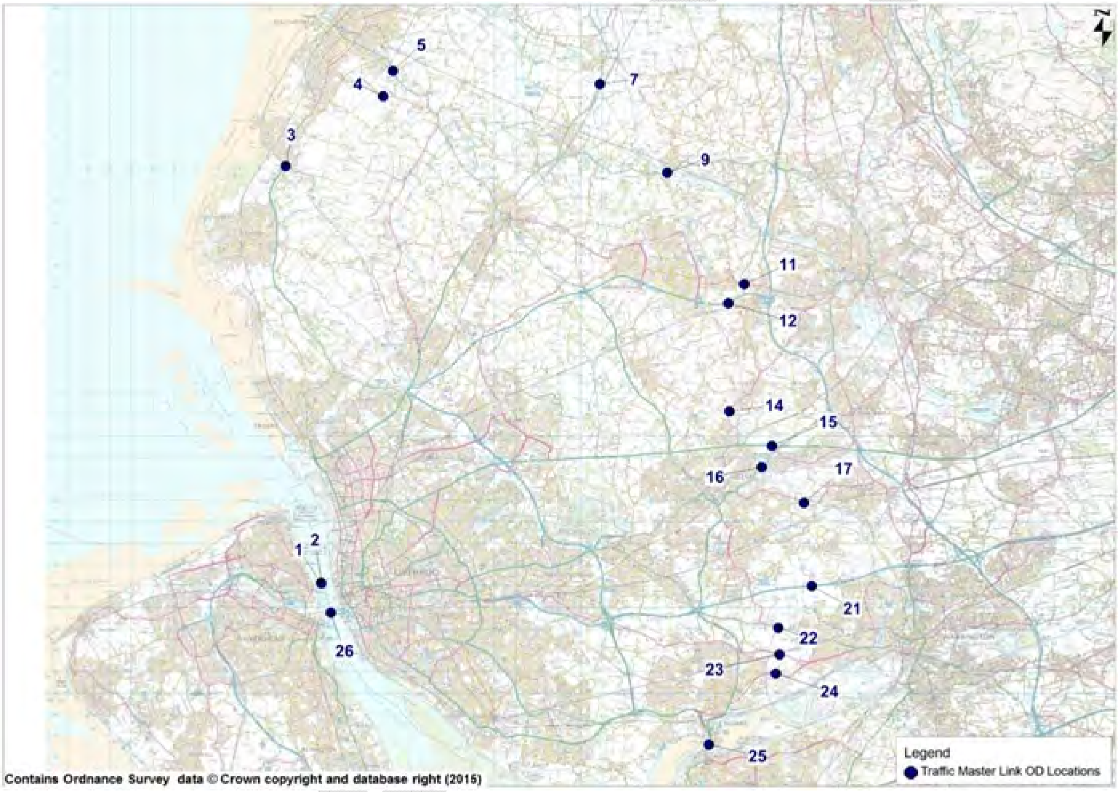


- **Link based OD**: It is similar to any roadside interview except the data source is Trafficmaster. The Trafficmaster database is able to provide any OD movement through a specific link. It is however do not provide any trip purpose information. The data has been used in conjunction with RSI data in order to supplement purpose information. The benefit of using traffic master link based OD data is that it can fill up any gaps that left by RSI data. We have identified two cordons, inner and outer, in order to develop the matrix.

Traffic Master Link OD data has been obtained for the 25 sites shown in Figure 3-3. The data obtained was a select link origin destination data for the year 2012/2013. Weekends, school holidays and bank holidays were removed. This provided an annual matrix based on 180 days at Lower Super Output Area (**LSOA**) level (Census 2011).

All illogical trips were removed from the data set. Trips captured at multiple links were assigned either to the major link within the set of links or to the first link at which the trip is captured based on the significance of the links included.

Figure 3-3 Traffic Master Link OD Locations-Used for matrix development



3.4. 2011 Journey to Work National Census Data

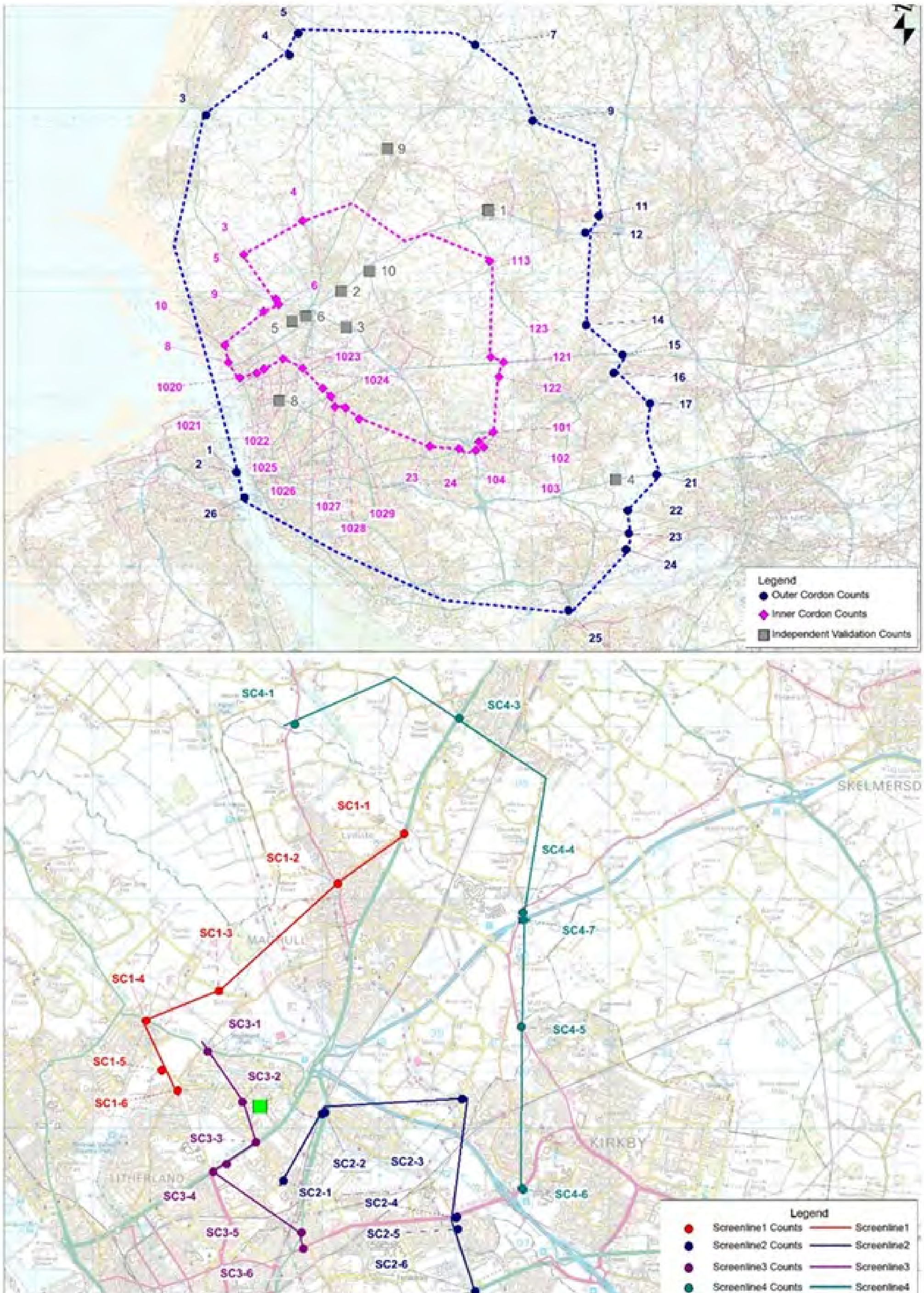
An origin/destination matrix based on the 2011 JTW census data was obtained to assist the infilling of the internal traffic movements that are not captured by other data sources. A database of the JTW trips between all output areas within the study area has been obtained. For this study, car driver and car passenger trips were taken from the available modes in this database and converted to vehicle trips based on RSI occupancy factors.

2011 Census Journey to Work (Home Based Work) is available for home to place of work trip direction only. As this data does not include the return trips, these are calculated by applying 'DIADEM initial tour proportions' to the transposed journey to work matrices.

3.5. Traffic Count Data

Traffic count data has been obtained from previous studies carried out in the area including LCRTM and from long term traffic monitoring sites i.e. TRADS sites. ATC and MCC count data have been obtained for each of the 27 RSI sites and ATC counts at all links along the screenlines and cordons. The traffic count data used for this study in addition to the RSI ATC/MCC data is shown in Figure 3-4.

Figure 3-4 Traffic Count Locations and cordons/Screenlines



There are a total of 154 counts (i.e. 77 locations observed in both directions) which together form the outer cordon, inner cordon and four screenlines. Table 3-2 lists the traffic count data used for calibration and validation.

Table 3-2 Traffic Count Data used for Calibration and Validation

Site ID	Road Name/Location	Year	Type	Use
Screenline 1				
SC1-1	A59-Northway	2012	ATC	Calibration
SC1-2	A5147 Liverpool Road	2012	ATC	
SC1-3	Lunt Lane	2008	ATC	
SC1-4	A5207 Lydiate Lane	2008	ATC	
SC1-5	Edge Lane	2008	ATC	
SC1-6	Gorsey Lane	2008	ATC	
Screenline 2				
SC2-1	Park Lane	2008	ATC	Calibration
SC2-2	Ormskirk Road	2013	ATC	
SC2-3	Waddicar Lane	2012	ATC	
SC2-4	Valley Road	2013	ATC	
SC2-5	Stonebridge Lane	2008	ATC	
SC2-6	East Lancashire Road	2013	ATC	
Screenline 3				
SC3-1	Northern Perimeter Road	2012	ATC	Calibration
SC3-2	Glovers Lane	2008	ATC	
SC3-3	Park Lane West	2012	ATC	
SC3-4	A5036 between A5038 and A5207 (TRADS)	2008	ATC	
SC3-5	Warbreck Moor	2013	ATC	
SC3-6	Longmoor Lane	2013	ATC	
Screenline 4				
SC4-1	A5147 Mairscough Lane	2008	ATC	Calibration
SC4-2	B5195 Turnpike Road	2008	ATC	
SC4-3	A565	2012	ATC	
SC4-4	A506 Cunscough Lane	2012	ATC	
SC4-5	Bank Lane	2013	ATC	
SC4-6	Valley Road	2012	ATC	
SC4-7	M58 J1-3	2013	ATC	
Outer Cordon				
1	Kingsway	2012	ATC	Calibration
2	Kingsway	2012	ATC	
3	Liverpool Road	2012	ATC	
4	Birkdale Cop	2010	ATC	
5	Scarisbrick New Road	2012	ATC	
7	Causeway Lane	2008	ATC	
9	Alder Lane	2008	ATC	
11	School Lane	2008	ATC	
12	M58 Between M58 J5 & M58/M6 J26	2012	ATC	
14	Moss Bank Road	2008	ATC	
15	East Lancashire Road	2008	ATC	
16	Blackbrook Road	2012	ATC	

Site ID	Road Name/Location	Year	Type	Use
17	Pennington Lane	2008	ATC	
21	M62 Between J7&J8	2012	ATC	
22	Warrington Road	2008	ATC	
23	South Lane	2008	ATC	
24	Widnes Road	2008	ATC	
25	Queensway	2013	ATC	
26	Queensway (Mersey Tunnel)	2012	ATC	
Inner Cordon				
3	Park Wall Road	2012	ATC	Calibration
4	A5147 Southport Road	2008	ATC	
5	Brickwall Lane	2012	ATC	
6	Northern Perimeter Road	2012	ATC	
8	Seaforth	2013	ATC	
9	Edge Lane	2008	ATC	
10	A565 Crosby Road North	2012	ATC	
1024	A59 Walton Vale	2013	ATC	
1023	A5038 Bailey Drive	2013	ATC	
1022	A5090 Hawthorne Road	2013	ATC	
1021	A567 Stanley Road	2012	ATC	
1020	A565 Primrose Road	2013	ATC	
1027	A580 Townsend Avenue	2012	ATC	
1028	Utting Avenue East	2012	ATC	
1029	Muirhead Avenue East	2012	ATC	
1025	B5167 Stopgate Lane	2012	ATC	
1026	A580 East Lancs Road	2013	ATC	
104	Carr Lane	2013	ATC	
101	A58 Prescot Bypass	2013	ATC	
113	A570 Rainford Rd	2013	ATC	
102	A57 Derby Road	2013	ATC	
103	Manchester Road	2008	ATC	
121	A580 East Lancs Rd	2013	ATC	
122	Gillars Lane	2013	ATC	
123	Blind Foot Rd	2012	ATC	
23	Seth Powell Way	2013	ATC	
24	A57 Liverpool Road	2013	ATC	
Independent Validation Counts				
VC1	M58 J3-4	2012	ATC	Validation
VC3	M57 J6-7	2013	ATC	
VC4	M62 J8-7	2013	ATC	
VC5	Browns Lane	2012	ATC	
VC6	Dunnings Bridge Road	2013	ATC	
VC10	Maghull Lane	2013	ATC	
VC2	M58 1-A5036	2008	ATC	

Site ID	Road Name/Location	Year	Type	Use
VC8	Southport Road	2008	ATC	
VC9	A570 Southport Road	2008	ATC	

3.6. Travel Time Data

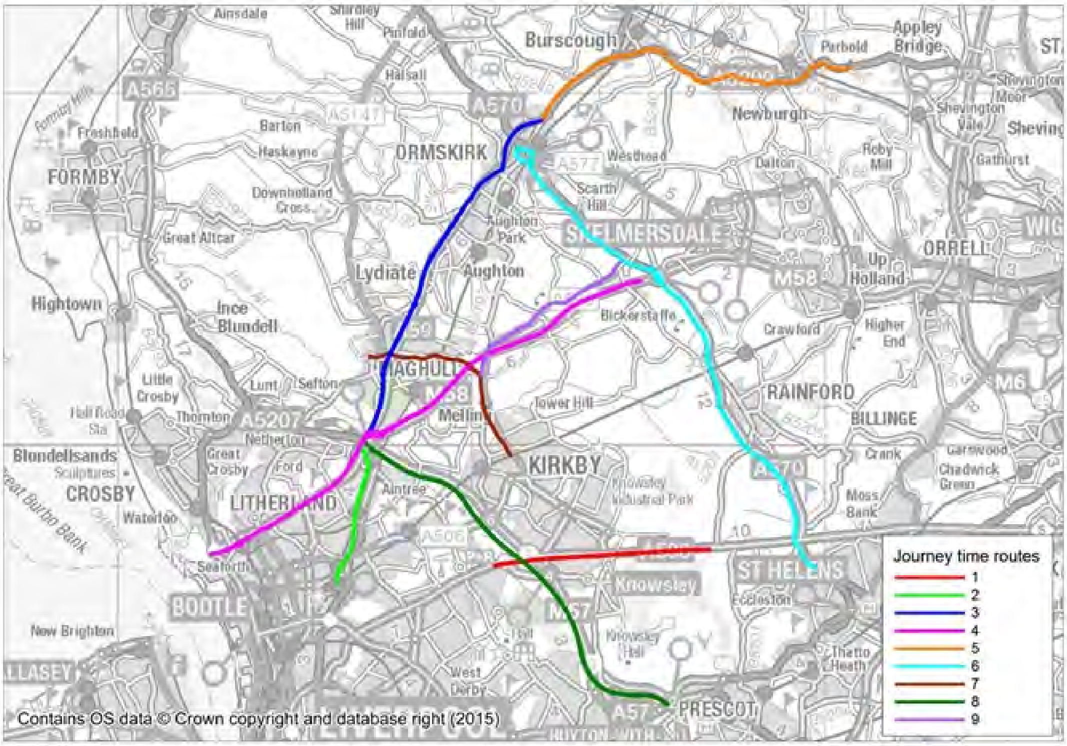
Trafficmaster journey time data uses positional data provided by Satellite Navigation units to produce an average journey time for each link in the Ordnance Survey Integrated Transport Network (ITN).Journey time data for the period September to November in 2011 and 2012, excluding all school holidays and weekends, was obtained from Mott Macdonald, license holder of Trafficmaster data in Merseyside. The data made available to Atkins comprised of average journey times by hour between 07:00 and 19:00. These have been combined into three periods (AM: 07:00-10:00, Inter-peak: 10:00-16:00 and PM peak: 16:00-19:00) by taking a link-wise weighted average of travel times by hourly flow.

Nine routes were identified for journey time validation which were consistent with the traffic model coverage. Observed journey times were extracted for these routes. Timing points were identified along the specified routes to compare section wise performance of modelled journey times against observed journey times. The routes are as follows:

1. A580 East Lancashire Road to A580-B5203 junction
2. A59 Rice Lane/A5098 Hornby Road to Switch Island
3. Switch Island to A59-B5319 junction
4. A5036 Princess Way to M58 J2
5. A59-B5319 junction to Parbold Hill-B5246 junction
6. A570 St Helens to Ormskirk
7. A506 County Road/Boyes Brow to B422 Westway
8. M57 J1 to Switch Island
9. Maghull Lane to A570 Ormskirk Road

The coverage of these journey time routes used for validation of the highway model is presented in Figure 3-5 .

Figure 3-5 Journey Time Routes



Model Development - Network

4. Model Development - Network

4.1. Overview

SATURN has two different levels of detail for network coding,

- Simulation coding – this is a comprehensive level of coding where junctions are represented in detail with information on the links between each junction; and

- Buffer coding – a less detailed level of coding where data is provided only for the links between junctions and not for the junctions themselves.

The Thornton Link Model had a very small simulation area, which was catered for the Thornton Link scheme assessment only. In order to model the wider impact of the M58 Junction 1 scheme, the simulation network has been extended further east and more links have been added to improve the modelling of route choice.

4.2. Network Extension

The network coding in the existing simulation area of the Thornton Link model was reviewed, and a number of improvements were made to characteristics such as distance and vehicle cruise speeds to improve the model accuracy. A small number of local roads were added to improve the loading of traffic from zones on to the network. A review was also undertaken of the geographical coordinates of the nodes in the existing model, which were then updated to reflect their true locations.

The simulation area of the Thornton Link Model was extended as illustrated in Figure 2-1 to cover Maghull, Ormskirk, St Helens, Rainhill, Prescot and Kirkby. The existing skeletal buffer network within this area was recoded using simulation coding, and some additional key links in the area were inserted. These additions included the B5197 from Ormskirk to the A506 at Moss Side, the B5203 from Rainford to Prescot, the A58 from Prescot to St Helens and the A57 from Prescot to Junction 7 of the M62, as well as some local roads to improve the loading of traffic from zones on to the network and to reflect possible alternative routes in the vicinity of M58 Junction 1.

To accommodate the extension of the simulation area, the buffer network was also extended to include further strategic roads in Burscough, Skelmersdale, Wigan, Billinge, east St Helens, Warrington, Runcorn, Widnes and Speke. A number of additional nodes were also added to the existing buffer network in northern Sefton and West Lancashire to improve the geometry of the model links.

4.3. Flow-delay curves

The principal form of capacity restraint in the M58 model is at the junctions. This is appropriate in urban areas with relatively short links, where junction capacities have the greatest impact on link flows and travel times. In the case of longer network links such as on motorways, trunk roads and rural roads, junction capacity has significantly less of an impact on travel times. Consequently, flow-delay curves are required to accurately represent delay, particularly during times of high traffic flow. Most areas of the Thornton Link model simulation network also included flow-delay curves on short distance links. For continued consistency, flow-delay curves based on these have been applied across the extended simulation network. Capacity restraint in the buffer network is also based on flow-delay curves, as is standard practice. As in the Thornton Link model, the curves used are based on COBA 11 speed-flow curves converted into the SATURN flow-delay curve format.

User specified flow-delay curves in SATURN have the following form, calculating t, the link travel time (in seconds), for a given V, the link flow (in passenger car units per hour):

$$t = AV^n + t_0 \qquad V \le C$$

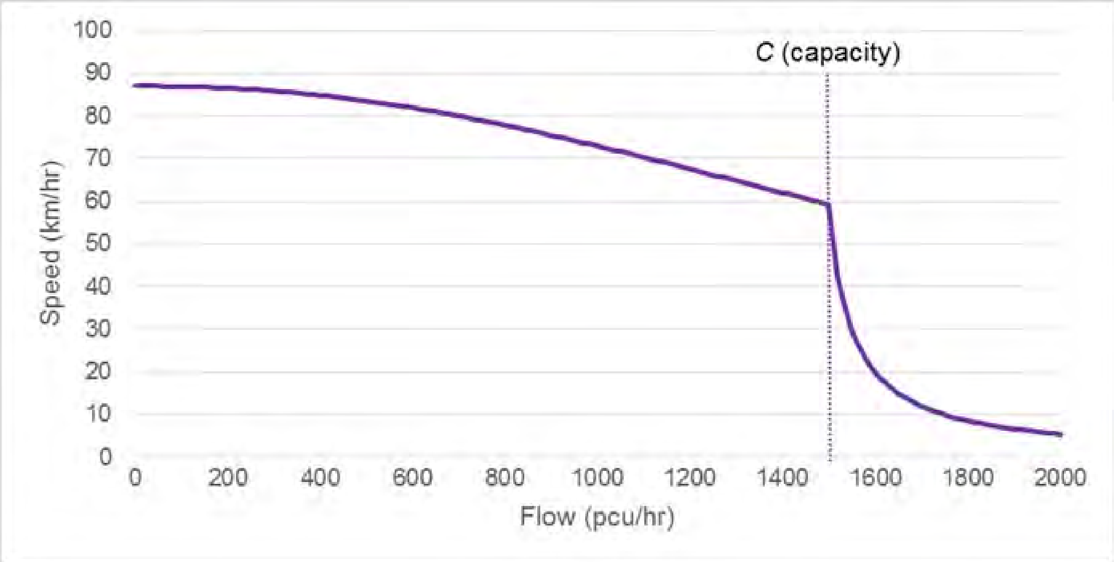
$$t = AC^n + t_0 + \frac{B(V - C)}{C} \qquad V \ge C$$

where

t_0 is the free-flow travel time (in seconds),
C is the link capacity (in passenger car units per hour),
B is half the length of the modelled time period (in seconds),
n is a power given by the user, and
A is calculated by the program to ensure the curve passes through the user-defined travel time at capacity when $V = C$.

Such curves are often presented in the form of a speed-flow curve, obtained from a flow-delay curve by converting travel time over a given link length to average speed. A typical example of a speed-flow curve using the above form with hypothetical parameters is given in Figure 4-1 below.

Figure 4-1 A typical speed-flow curve



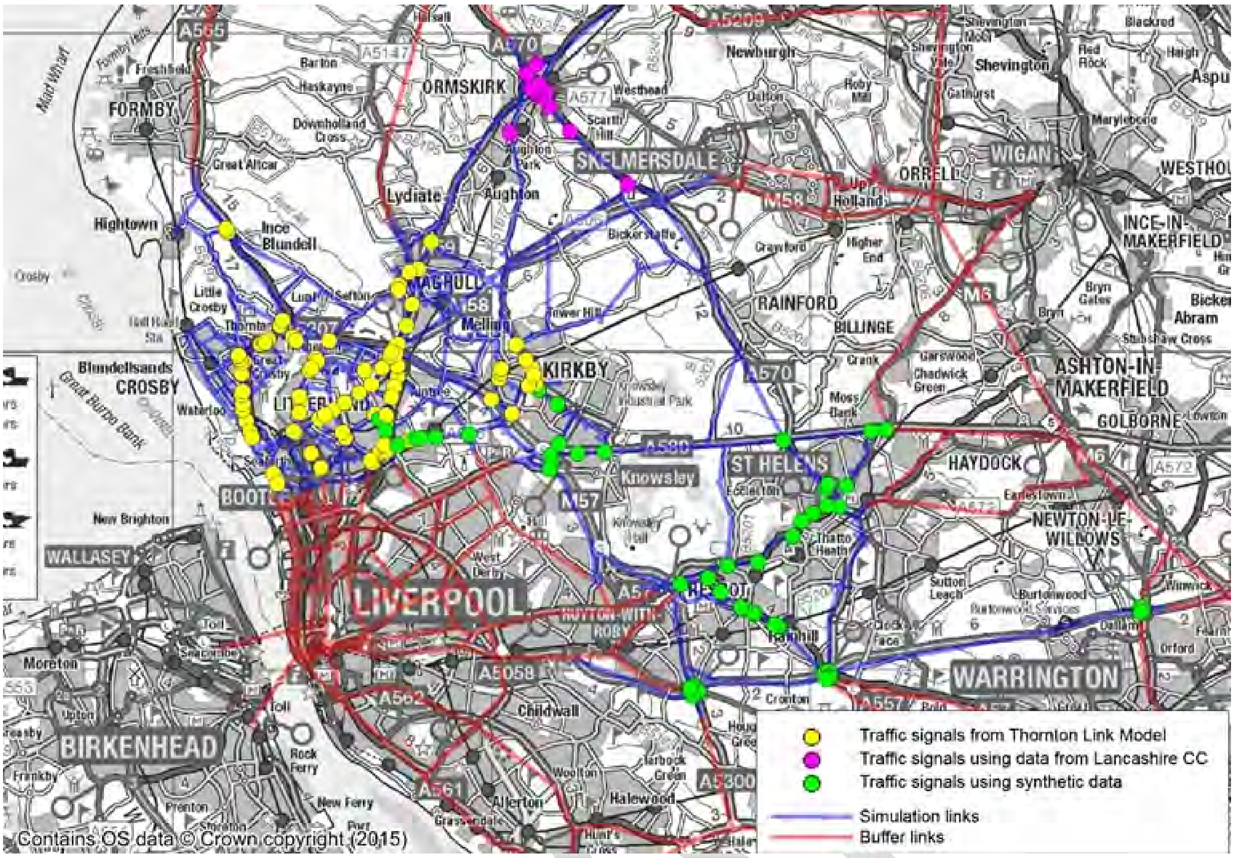
4.4. Centroid Connectors

In the simulation area of the Thornton Link Model, a number of centroid connectors in the core study area were connected using a hypothetical extra arm at a junction. Where applicable, centroid connectors in the latest model were modified to a 'stick' centroid connector type loading at points on links rather than as hypothetical extra arms at junctions. This approach is more conducive to the accurate assessment of junction delay, and was also used for all centroid connectors in the extension of the simulation area.

4.5. Traffic Signals

Major traffic signals have been included in the model covering the simulation network. A majority of the signal timings were available from the Thornton Link Model. We requested signal time information from Knowsley Council and Lancashire County Council, for signals which weren't part of the Thornton Link model simulation area. Any data received from those councils were incorporated in the model. These data typically gave the maximum stage lengths for signals controlled by vehicle actuation or MOVA, so their use in the model is only an approximation of the true signal behaviour. The missing data were supplemented by synthetic data, which were later optimised during the assignment stage to match the average link speed. The locations of traffic signals from each of these sources is shown in **Figure 4-2**.

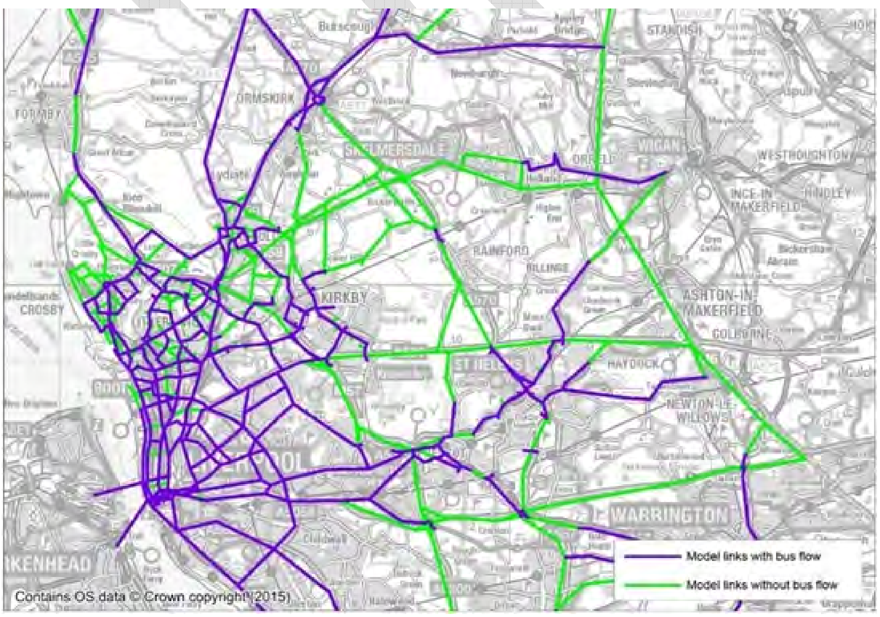
Figure 4-2 Locations of modelled traffic signals



4.6. Public Transport Coding

All bus services were added to the model following predefined routes as bus pre-loads. Bus services and frequencies were reviewed and coded into the network based upon current timetables. This information was obtained from the websites of Merseytravel and Lancashire County Council. The bus routes in the simulation area of the model are shown in Figure 4-3.

Figure 4-3 Bus routes around the simulation area of the model (AM peak)



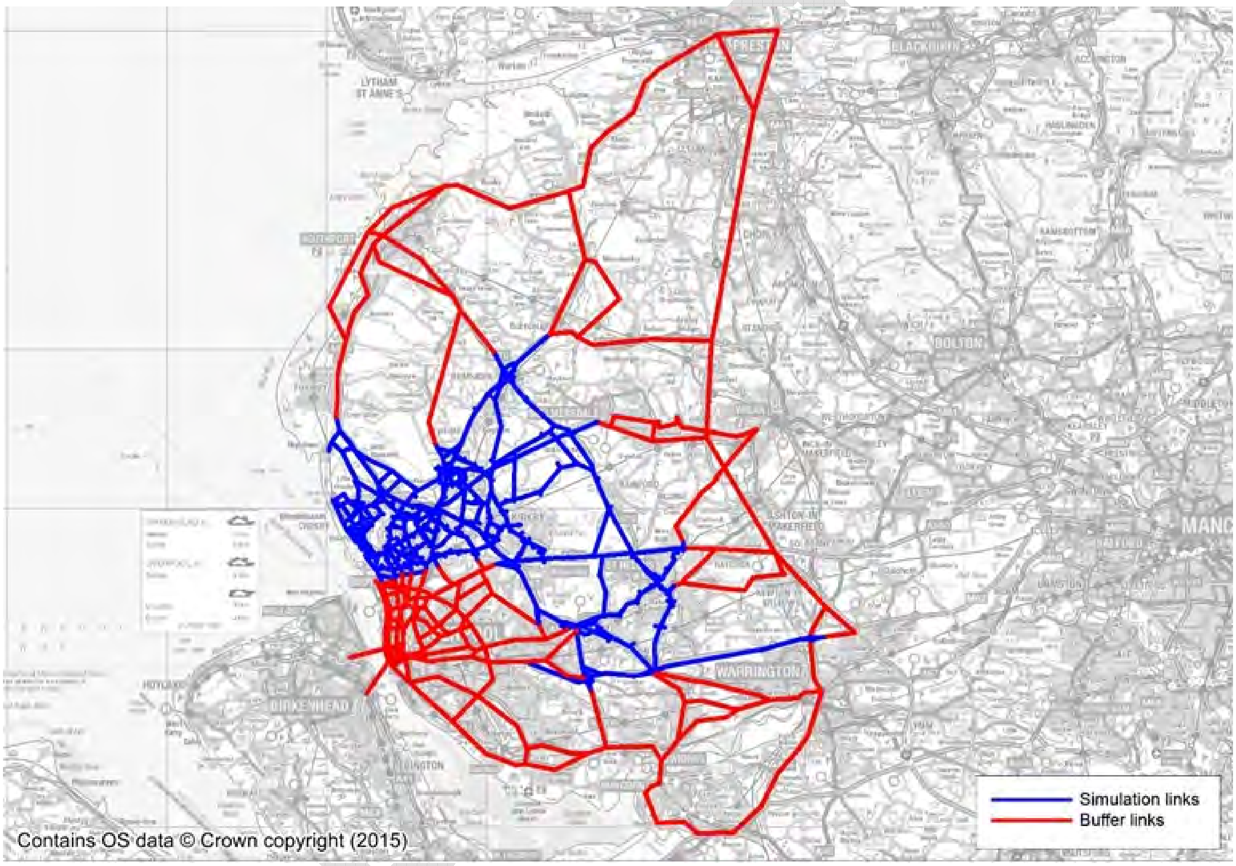
4.7. Network Summary

The table below presents a summary of the updated network for the M58 Junction 1 model. Figure 4-4 presents spatial coverage of the network, distinguishing between simulation area and buffer.

Table 4-1 The M58 Network Statistics

Item	Simulation	Buffer
Links	2069	689
Nodes	936	392
Traffic Signals	147	0
Bus Lines	301	

Figure 4-4 The M58 J1 Model Network



Model Development – Assignment

5. Model Development – Assignment

5.1. Overview

This section describes the assignment process used by the M58 model, including assignment parameters, generalised cost coefficients and convergence criteria.

5.2. Assignment Process

Assignment of trips to the highway network has been 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.'***

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 during each iteration and then compared to 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.

5.3. Generalised Cost Coefficients

The cost of travel is expressed in terms of generalised cost minutes, which can be related back to values of time and out-of-pocket costs in accordance with the TAG Unit A1.3.

The coefficients for the individual components of generalised costs were calculated using TAG Unit A1.3.

The model base year is 2013 with all monetary values calculated and based at 2010 prices.

5.3.1. Values of Time

Perceived values of times are used to calculate costs in this model. Cars, LGV's and HGVs travelling in work time have the same perceived and resource values times. The calculation of values of time is summarised below:

1. Equivalent values are calculated by applying the specified growth in working and non-working values of time (Annual Parameters in TAG Unit A1.3);
2. HGV value has been updated by updating OGV1 and OGV2 proportion; and
3. Values are converted from pounds per hour to pence per minute.

5.3.2. Vehicle Operating Costs

Vehicle Operating Costs are calculated using TAG A1.3 (November 2014) and defined separately for fuel and non-fuel elements before being combined for use in the SATURN assignment. Non-fuel costs are only applied to business travellers.

5.3.2.1. Fuel Costs

The consumption of fuel (in litres per km), adjusted by the fuel efficiency factors, has been multiplied by the cost per litre to provide the cost per km in the model base year (2013). For trips made on employers business i.e. work trips, fuel duty has been included in the calculations as a perceived cost as businesses are not able to reclaim the duty. However, VAT has been excluded as this is reclaimable by businesses. For non-work purposes, the perceived cost of the fuel Vehicle Operating Cost is the market price. LGV fuel costs were derived using the work/non-work proportions obtained from the RSI surveys and used in the calculation of average Value of Time.

5.3.2.2. Non-Fuel Costs

The non-fuel cost element is derived using the formulae set out in TAG A1.3 Table A1.3.14 and is a function of average network speed. No further adjustments are required as the non-fuel costs are assumed to remain constant in real terms, over time. As noted above, the non-fuel cost element is only included for business travellers. All the parameters were sourced from WebTAG (November 2014)

The resulting cost coefficients of pence per minute (PPM) and pence per kilometre (PPK) are presented in Table 5-1 below.

Table 5-1 Assignment Values of PPM and PPK (2010 Prices)

UC	Definition	PPM			PPK
		AM	IP	PM	All Day
1	Car - Business	45.44	44.39	43.69	13.69
2	Car-Work	13.41	13.31	13.11	7.02
3	Car-Others	17.13	17.82	18.32	7.02
4	Light Goods Vehicles	20.45	20.45	20.45	15.67
5	Heavy Goods Vehicles	20.71	20.71	20.71	42.86

5.4. Assignment Convergence

Advice on model convergence is set out in TAG Unit M3.1 (Table 4) and is reproduced in Table 5-2.

The convergence of the assignment is measured with respect to two criteria.

- **Convergence Stability**, which is the condition 'P>98%', where the percentage flow difference is the proportion of modelled links showing a change in flows of less than 1% for four successive iterations; and

- **Convergence Proximity**, which requires the value of the delta parameter to be less than 1%. The delta parameter measures the total cost of excess travel for all origin-destination pairs in the model. The smaller the value of delta, the closer is the model to choosing the minimum cost route and thereby achieving Wardrop user equilibrium in the assignment.

Table 5-2 Summary of Convergence Criteria

Convergence Measures	Type	Base Model Acceptable Values
Delta & %GAP	Proximity	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P) < 1%	Stability	Four consecutive iterations greater than 98%

Source: TAG Unit M3.1 Table 4

6. Model Development – Matrix

6.1. Overview

The prior matrix provides the initial data input into the model development process. This section describes the full process of developing demand matrices for the base year M58 highway model.

6.2. Prior Matrix Development

Demand data has been obtained from the following data sources:

- Re-zoned Thornton Link base matrix.
- Road Side Interview Data- for the inner cordon(27 sites);
- Traffic Master Area OD data – from Merseyside, Halton and West Lancashire;
- Traffic Master Link OD data- for the outer cordon (25 sites);
- Census Journey to work data;

The process of matrix development from all these data sources is described below and the final merging of all data sources to form the prior matrix for the M58 model.

6.3. Thornton Link Matrix Re-zoning

The base demand matrices from Thornton Link Model has been rezoned to suit the zoning system of M58 model. The Thornton Link Model had 183 zones and it has been refined to 343 zones to suit the M58 model.

6.3.1. Rezone Methodology

- Rezoning has been done based on population and employment data from census 2011 extracted from NOMIS at LSOA level.

- New zones have been split based on the boundaries of the old zone system.

- As the LSOA zone boundaries didn't match with split zone boundaries, area overlap has been used initially to arrive at split zone population/employment. Then these overlap proportions have been individually inspected looking at satellite imagery for type of land use or any vacant spaces.

- After arriving at each split zone's population/jobs, new zone matrix proportions were worked out for each zone. Zonal proportions were calculated as: **Row factor * Column factor**

- As the (combination of) new zone boundaries doesn't match old zone boundaries we cannot evidently arrive at zonal proportion matrix. Saturn module MXM5 is used to arrive at new zone matrix. Intra zonal trips are not treated separately as its magnitude in the existing model is minimum.

- To understand whether outbound trips or return trips are dominant for each peak and purpose, tour proportions from table C1, C2 and C3 of Diadem manual were considered. Combinations of planning parameters used are summarised in Table 6-1 to arrive at zonal proportions.

Table 6-1 Planning Parameter Combinations

Purpose	AM		IP		PM	
	Row Factor	Column Factor	Row Factor	Column Factor	Row Factor	Column Factor
HBW	Population	Employment	Population + Employment	Population + Employment	Employment	Population
HBEB	Population	Employment	Population + Employment	Population + Employment	Employment	Population
HBO	Population	Employment	Population + Employment	Population + Employment	Population + Employment	Population + Employment

LGV	Employment	Employment	Employment	Employment	Employment	Employment
HGV	Employment	Employment	Employment	Employment	Employment	Employment
HBW- Home Based Work, HBEB – Home Based Employer Business, HBO – Home Based Others, LGV – Light Goods Vehicle, HGV – Heavy Goods Vehicles						

6.4. Road Side Interview

Partially Observed demand matrices have been built using the RSI data. As discussed previously in this report, the RSI survey data provides origin/destination information for the strategic movements within the study area. The exact process used to generate the observed matrices from this data is summarised below.

Data from 27 RSI sites that have been collected for various studies in the region between 2008 and 2013 have been used for building partial matrices. The location of these sites is shown in Figure 3-1.

These RSI sites were combined to form a cordon and each site in the cordon has been separately analysed based on local knowledge for factors like whether the sites are independent of each other or competing with each other, duplication of trips, major or minor road, strategic route, access to industrial estate, etc. Based on this judgement, sites were grouped into two categories, to be added (sites which are independent and major roads where loss of trips is to be avoided) or merged together (Sites that are likely to have duplicate trips which when included in the matrix will results in over estimation of demand pattern which is to be avoided).

To avoid double counting during the merging process, the variance weighting method has been adopted. The variance weighting average merges all sets of source data based on their statistical accuracy measured by sampling and site-specific errors at each RSI survey station. For this study we have adopted the Index of Dispersion weighting method for matrix merging.

Before the merging process, a number of tasks have been undertaken in processing the raw RSI data, as follows:

- Incomplete and void RSI data records are removed;
- Illogical trips are removed by logical checking;
- Extracting the coordinates for post codes and establishing the study zone correspondence;
- Calculating expansion factors for each RSI site by interview direction, vehicle type and time period;
- Matrix transposition for non-interview direction for each RSI site by interview direction, vehicle type and time period, if appropriate; and
- Produce RSI matrices in vehicles for each site by time period and direction.

6.4.1. Vehicle Type, Trip Purpose and Time Period

The modes to be modelled are car, LGV and HGV. Trip purpose is categorised into work, business and others. Time periods considered are AM (07:00-10:00), IP (10:00-16:00) and PM (16:00-19:00). RSI site wise matrices are developed at period level which will be converted to a peak hour matrix after merging.

6.4.2. Matrix Transposition

All 27 RSI data, collected from different sources, were captured by survey on one direction. We have transposed the interviewed direction trips to produce the non-interviewed direction matrices.

Table 6-2 Matrix Transpose

AM-Interview Direction	Transposed to PM non interview direction
IP-Interview Direction	Transposed to IP non interview direction

PM-Interview Direction	Transposed to AM non interview direction

6.4.3. MCC Mode Split to ATC data

The ATC data has been averaged from Tuesday to Thursday as most of the RSI surveys were undertaken during this period. To derive the mode split for ATC count for each RSI site, firstly the hourly MCC counts (collected on the same day as interview surveys) were computed by mode (car, LGV, HGV and others). This MCC mode split is applied to corresponding ATC counts (all vehicles) by hour and direction.

6.4.4. Growth Factors

As the ATC counts were collected during different years from 2008 to 2013 and the matrix base year being 2013, the counts were factored to bring all counts to 2013. The factoring was based on TEMPRO (v6.2) by time period and as follows:

Table 6-3 Growth Factors

Year	AM	IP	PM
2008	1.020	1.032	1.018
2010	1.018	1.022	1.016
2012	1.009	1.008	1.007

6.4.5. Expansion Factors

Expansion factors were worked out using the RSI sample and the count data for each time period (AM, IP and PM), each purpose (Work, business and others) and vehicle type (car, LGV and HGV). Counts factored to 2013 level were used to calculate the expansion factors.

The RSI samples were expanded to the factored ATC counts for each site (long term ATC counts, usually 2-3 weeks weekday data).

Expansion factors were obtained from the two steps shown below:

Step 1: Expansion factors were calculated using period count and the period sample (AM: 7:00-10:00, PM: 16:00–19:00 IP: 10:00-16:00).

$$Expansion\ Factor_2 = \frac{Period\ \ Counts}{Period\ Sample}$$

Step 2: If the calculated expansion factor in step 1 is greater than 20 or equal to 0 for car and is greater than 15 or equal to 0 for LGV and HGV due to observed zero records for that period, then the all 12 hour counts and surveyed records have been used for computing the expansion factors for that period.

If these factors are still equal to zero, however, no other actions have been undertaken and the resultant RSI matrices for that time period is assumed as zero.

$$Expansion\ Factor_3 = \frac{Period\ Counts}{12\ hour\ Sample}$$

Note that due to these adjustments some calculated expansion factors are less than 1 which is true as under certain circumstances there are more sample period records than counts especially in the non-interview direction and these were considered as 1.

6.4.6. Variance Matrices

Variance Matrices are worked out at 2 levels:

- Site Variance
- Sample Variance

6.4.6.1. Site Variance

Site variance is computed as per DfT's MATVAL formula:

Site Constant (K) = (a+b+c+d+e+f) – based on site-related constants as per table below:

Site specific variance	Conditions
+2.5	if interviews have been factored to a manual classified count (MCC)
or +0.5	if factored to an automatic traffic count (ATC)
+1.0	if total site flow is based on a 1-day count
or +0.5	if based on a 1-week count
or +0.0	if based on 2 weeks or more of data
+1.5	if the survey day-of-week to average weekday factor (which may be equal to 1.0) is based on national or regional data
or +0.0	if based on local data
+2.5	if a regional or national factor (which may be equal to 1.0) has been applied to convert to a different month
or +0.0	if the data was collected in the correct month or a local conversion factor is available
+6.0	for every year between data collection and model base, if a regional or national growth factor (which may be equal to 1.0) has been applied
or +0.0	if a local growth factor is available
+10.0	if reversibility has been assumed
or +5.0	if interviews are factored to a reverse direction count
or +0.0	for the interviewed direction

6.4.6.2. Sample Variance

Sample Variance calculated from DfT's MATVAL Formula:

- Var=f(f-1); where f = expansion factor
- Calculated by mode, time period, direction

Total Variance is calculated as:

$$Var(Q_a) = f(f-1)q_a + fKFq_a$$

Where:

f is the expansion factors calculated as Q/q

q_a is the directly observed records;

K is the site-related constant based on the characteristics of the interviewing at the RSI site, which can be referred to the following table xx;

F is a flow-related factor representing the flow level that a given degree of uncertainty applied to, which is defined as Q/1000.

A maximum of 9999 is assumed as the value of total variance for RSI sites with zero samples or low samples.

6.4.7. Matrix Merging Methodology

The observed 27 individual RSI sites form the inner cordon for the study area. The merging of matrix cells from different sites is applied in a pair-wise and consecutive procedure. For any two trip matrices, the merged trip matrix is combined cell by cell base by using the following mathematical formula, which is also adopted in the DfT's MATVAL programme, as follows:

$$f_m = \frac{f_1 I_2 + f_2 I_1}{I_1 + I_2}$$

Where:

f_m the merged flow estimates from two matrices;

f_1: the cell trip value for matrix 1

f_2: the cell trip value for matrix 2

I_1: the index of dispersion for matrix 1

I_2: the index of dispersion for matrix 2

The Index of Dispersion (ID) is a "normalised" measure of uncertainty defined as the variance divided by the estimate.

Meanwhile, the merged index of dispersion is calculated as:

$$I_m = \frac{I_1 I_2}{I_1 + I_2}$$

Where:

I_1 and I_2 are the index of dispersion (ID) for matrix 1 and 2 respectively and I_m is the merged Index of Dispersion.

6.4.7.1. Four cases occurring during merging process

When merging from individual RSI screenline/cordon, there are four possible conditions which may exist for any individual matrix cell, as follows:

1. Case 1

For a cell with positively observed trips in both matrix 1 and matrix 2, the merged flow and Index of dispersion are calculated by the following formula:

- Merged Trip Matrix

$$f_m = \frac{f_1 I_2 + f_2 I_1}{I_1 + I_2}$$

- Merged index of dispersion

$$I_m = \frac{I_1 I_2}{I_1 + I_2}$$

All parameters are the same as defined above.

2. Case 2

If trips are observed in matrix 1 but not in matrix 2 then:

- Merged cell trip value of f_m equals to f_1;
- Merged cell index of dispersion equals to I_1;

3. Case 3

If trips are observed in matrix 2 but not in matrix 1 then:

- Merged cell trip value of f_m equals to f_2;
- Merged cell index of dispersion I_m equals to I_2;

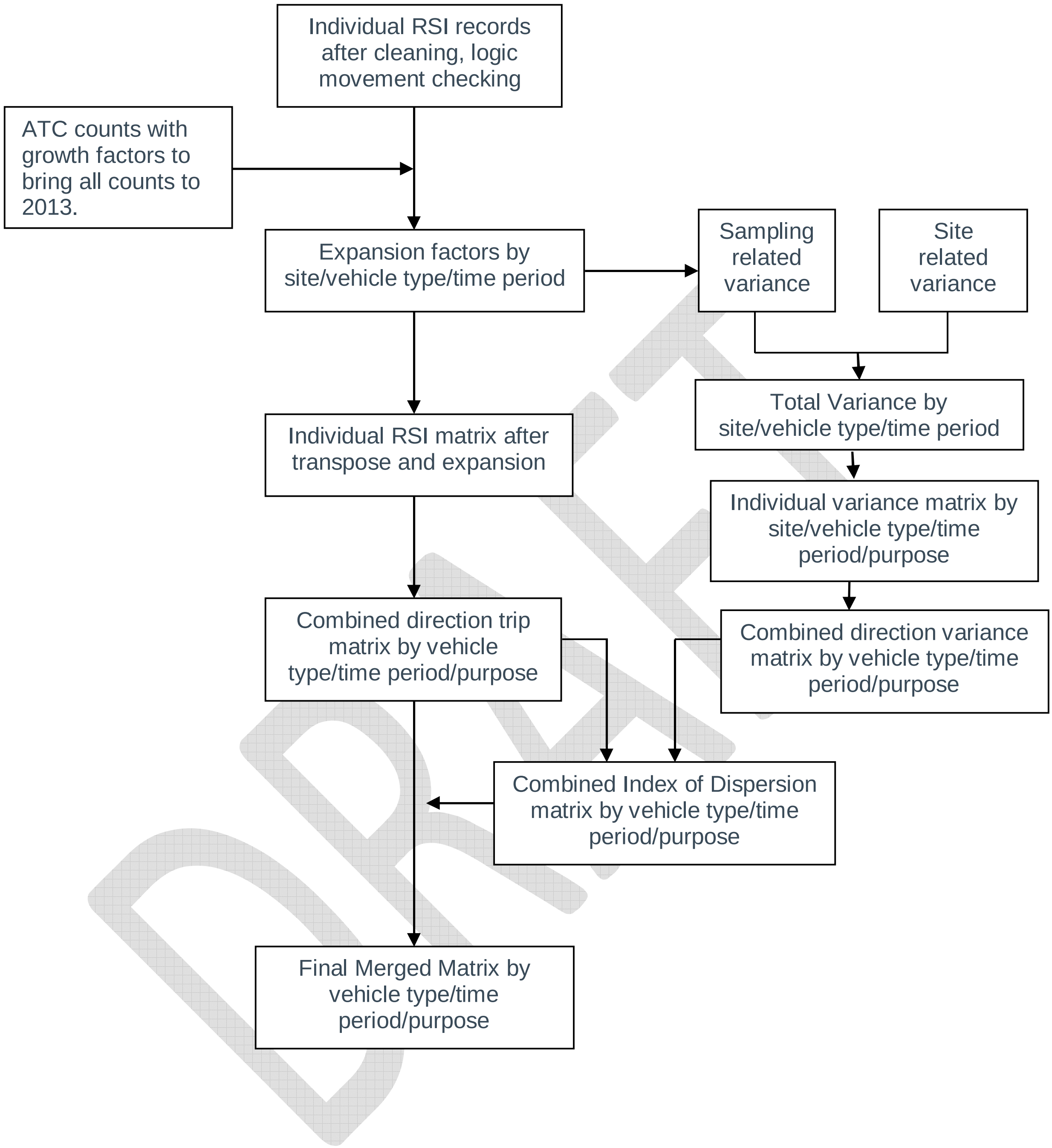
4. Case 4

If trips are not observed in either matrix 1 or matrix 2 then:

- Merged cell trip value of f_m equals to 0;
- Merged cell index of dispersion I_m equals to 0;

The overall merging process is presented in Figure 6-1.

Figure 6-1 RSI Matrix Merging Process



6.5. Traffic Master Area OD data

The Traffic Master Area OD data has been obtained from Merseyside, Halton and West Lancashire. Figure 3-2 shows the Traffic Master OD area region.

6.5.1. Merseyside and Halton

The data from Merseyside and Halton covers all movements to/from/within Merseyside and Halton for a period between September to November 2012 (excluding weekends and bank holidays) for car, LGV and HGV and not segmented by purpose. This was divided by the number of weekdays to obtain a typical weekday sample matrix at LSOA level. The LSOA peak period matrices were converted to the traffic model zoning system based on the population and employment data from 2011 census data.

6.5.1.1. Matrix Expansion

Base year trip ends for the traffic model zones for this region is extracted from TEMPRO v6.2. The peak period matrices were factored to these trip ends to obtain the Traffic Master expanded matrices for Merseyside and Halton.

It should be noted that the expansion to TEMPRO trip ends is done only for car and LGV and HGV matrices are unexpanded.

6.5.2. West Lancashire

The data from West Lancashire covers all movements within West Lancashire for a period between September to November 2012 (excluding weekends and bank holidays) for car, LGV and HGV and not segmented by purpose. This has been divided by the number of weekdays to obtain a typical weekday sample matrix at LSOA level. The LSOA peak period matrices have been converted to M58 zoning system based on the population and employment data from 2011 census data.

6.5.2.1. Matrix Expansion

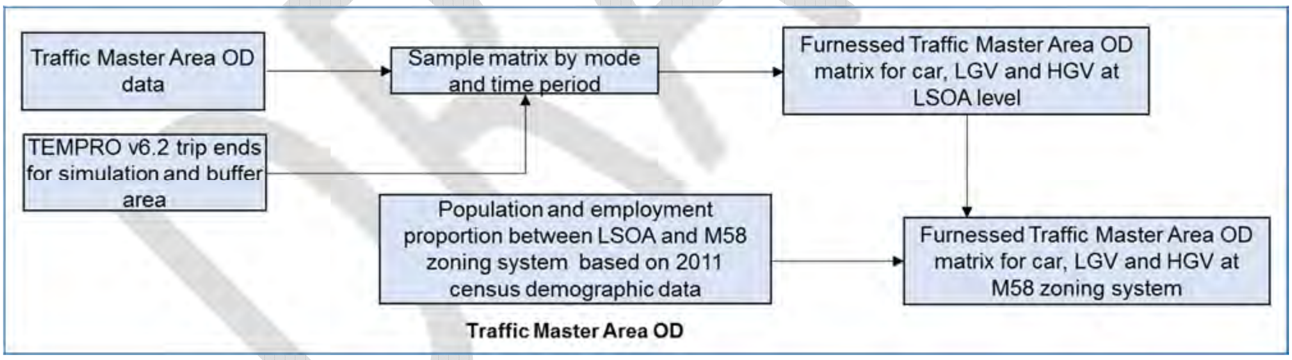
Base year trip ends for the traffic model zones for this region is extracted from TEMPRO v6.2. Since the sample matrix is only for movements within West Lancashire, the trip ends were factored to obtain the total production for the internal movements based on RSI merged matrix by mode. The peak period matrices were factored to these trip ends to obtain the Traffic Master expanded matrices for Merseyside and Halton.

It should be noted that the expansion to TEMPRO trip ends is done only for car and LGV and HGV matrices are unexpanded.

6.5.3. Traffic Master Area OD merged matrix

The matrix from both the above data sources were added together to obtain the final Traffic Master Area OD matrix. The car matrix was divided into three purpose group (work, business and others) based on the RSI purpose split. The flow chart showing the Traffic Master Area OD processing is shown in Figure 6-2.

Figure 6-2 Traffic Master Area OD data processing



6.6. Traffic Master Link OD data

Traffic Master Link OD data has been obtained for the all sites shown in Figure 3-3.

6.6.1.1. Matrix Expansion

Traffic count availability corresponding to each link OD site was established and the data was processed by time period. The MCC proportion at inner cordon RSI sites were applied to this ATC data to obtain car, LGV and HGV peak period counts. All data prior to 2013 was factored using TEMPRO growth rate to bring all counts to 2013 levels.

Even though the data was obtained for 180 days, average one day sample was very low per link and hence the 180 days sample matrix was expanded to match the corresponding link count for the remaining sites for car, LGV and HGV.

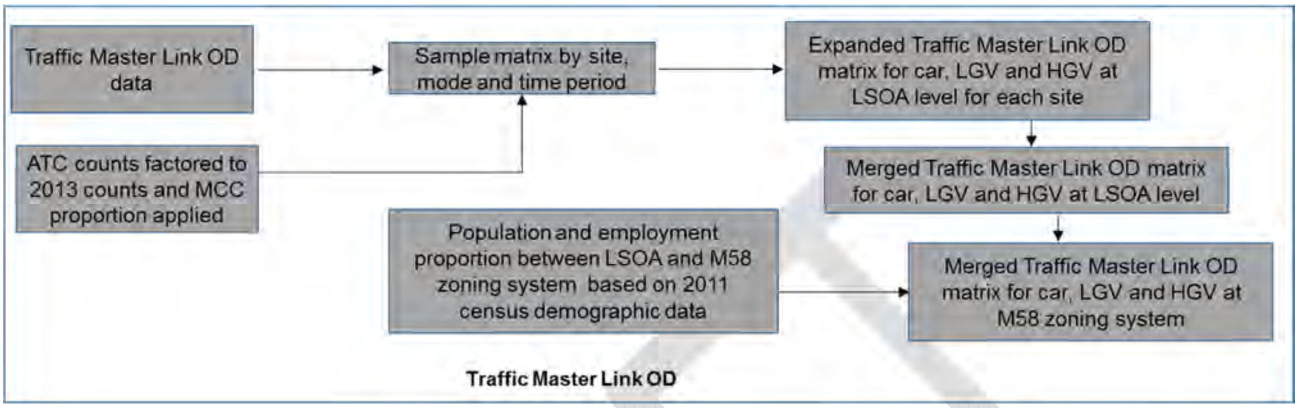
It was noted that for some sites HGV sample was zero even though link count is available and hence the matrix is not available for these sites.

The LSOA peak period matrices were converted to the traffic model zoning system based on the population and employment data from 2011 census data.

Car matrix was divided into three purposes- work, business and others based on merged RSI proportions.

The flow chart showing the Traffic Master Link OD processing is shown in Figure 6-3.

Figure 6-3 Traffic Master Link OD data processing



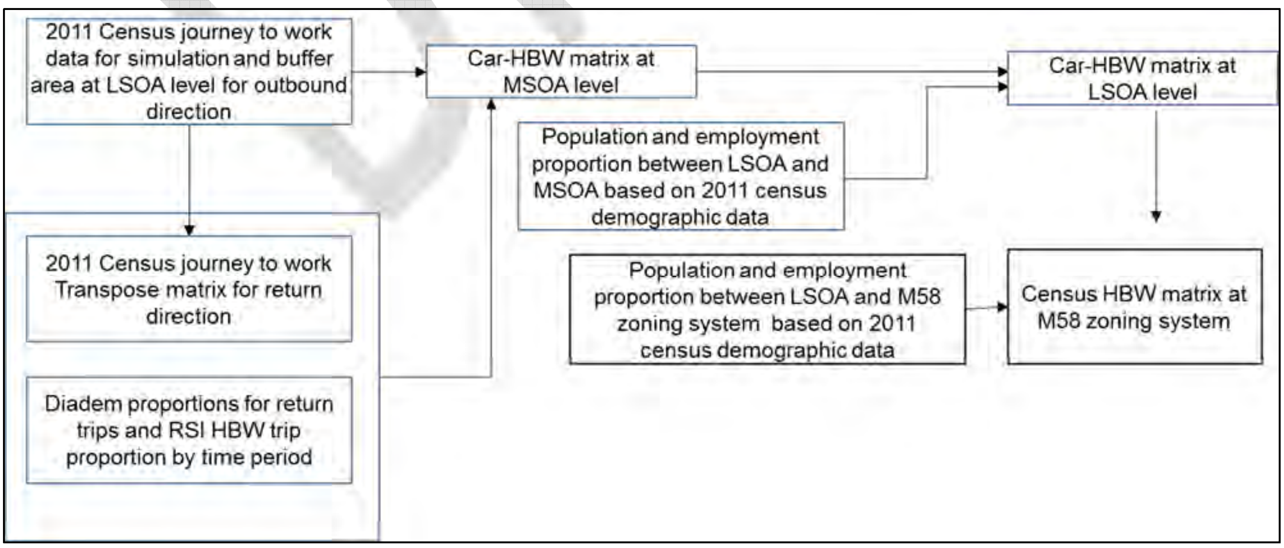
6.7. Census 2011 Journey to Work data

The Census Journey to work data is primarily home based work (HBW) purpose only and also for one direction data i.e from home to work. The matrices are available at Middle Super Output Area (MSOA) level. The MSOA level matrices were converted to LSOA level by applying the population and employment proportion between LSOA and MSOA based on 2011 census demographic data. The matrices were obtained for simulation and buffer area.

The return trips were calculated based on the DIADEM Initial tour proportions for home based work. Return trips are calculated based on DIADEM proportions and added to the home to work direction trips to obtain the HBW matrix for three time periods. The LSOA peak period matrices were converted to M58 zoning system based on the population and employment data from 2011 census data.

The flow chart showing the Traffic Master Link OD processing is shown in Figure 6-4.

Figure 6-4 Census Journey to Work data processing



6.8. Compiling the Full Prior matrices

The section above describes the steps that were taken to generate the observed matrices for each user class and time period from various sources. As has been noted, these matrices have only the observed movements for some OD pairs and unobserved movements for other OD pairs due to the nature of their location. Therefore these individual matrices were compiled together to produce the full final prior matrices. This was done by two methods- Method1 and Method2. The prior matrix developed from these two methods were initially assigned to the network and their performance compared against observed traffic flow at cordons and screenlines and journey time. Based on the initial results method 2 matrix was comparing well with the observed information and hence this prior matrix was considered for further model development. Method1 matrix development process is provided in Appendix A. Method2 matrix development process is as described below:

- Assign the rezoned PLTM base matrix onto the highway network. Extract SLA (Select Link Analysis) of matrix at outer cordon.
- Replace the SLA matrix (step 1) with the Traffic Master Link OD matrix.
- Assign the matrix from step2 onto the highway network and extract the SLA of inner cordon.
- Replace the SLA matrix (step 3) with the merged RSI matrix.
- Infill the I-I movements in step4 matrix with Traffic Master Area OD matrix for car – business, others.
- Add the I-I movements in step4 matrix with Traffic Master area OD matrix for LGV and HGV, since the Traffic Master Area OD sample size for LGV and HGV is low .
- Infill the I-I movements in step4 matrix with Census Journey to Work for car – HBW matrix.
- Combine Step 5, step6 and step7 to obtain the initial prior matrix.

6.9. Matrix Estimation

The development of the prior matrix has been described in the previous section and the modelled flows have been compared to the observed counts for the calibration screenlines to determine whether further matrix calibration was required using matrix estimation.

The comparison of the observed and modelled flows across the screenlines is summarised in Table 6-4 to Table 6-6 for the prior trip matrices (including external to external movements) for all time periods.

Table 6-4 Summary of Cordon and Screenline Calibration (Prior Matrix) – AM Peak hour

Cordon/Screenline	Direction	Flow Difference (%)
Outer Cordon	Inbound	11%
	Outbound	13%
Inner Cordon	Inbound	-9%
	Outbound	-10%
Screenline1	Northbound	-27%
	Southbound	-6%
Screenline2	Northbound	24%
	Southbound	7%
Screenline3	Eastbound	-23%
	Westbound	3%
Screenline4	Northbound	-20%
	Southbound	11%

Table 6-5 Summary of Cordon and Screenline Calibration (Prior Matrix) – Inter Peak hour

Cordon/Screenline	Direction	Flow Difference (%)
Outer Cordon	Inbound	10%
	Outbound	8%
Inner Cordon	Inbound	-9%
	Outbound	-12%
Screenline1	Northbound	-10%
	Southbound	-5%
Screenline2	Northbound	13%
	Southbound	13%
Screenline3	Eastbound	-14%
	Westbound	-9%
Screenline4	Northbound	-9%
	Southbound	5%

Table 6-6 Summary of Cordon and Screenline Calibration (Prior Matrix) – PM Peak hour

Cordon/Screenline	Direction	Flow Difference (%)
Outer Cordon	Inbound	6%
	Outbound	5%
Inner Cordon	Inbound	-8%
	Outbound	-12%
Screenline1	Northbound	11%
	Southbound	-17%
Screenline2	Northbound	6%
	Southbound	15%
Screenline3	Eastbound	5%
	Westbound	-23%
Screenline4	Northbound	1%
	Southbound	6%

TAG Unit M3.1 advises that the primary purpose of matrix estimation is to refine estimates of trips that are not intercepted in surveys. Although Traffic Master Data is used in addition to the RSI surveys and rezoned to Thornton Link model matrix, it is recognised that matrix estimation is still required to calibrate the matrices.

Matrix estimation was applied to the prior trip matrix to improve the matrix calibration using the SATURN SATME2 process and the following principles were adopted:

- Counts used as constraints in matrix estimation were derived from ATCs;
- Constraints were applied at the Car, LGV and HGV level; and
- Screenline constraint (Combined Constraints) were applied.

6.10. The SATME2 Process

The SATURN modules SATME2 and SATPIJA are used for matrix estimation and in combination attempt to match assigned link flows in the model with observed traffic counts. The matrix estimation process forms part of the calibration process and is designed to modify the origin-destination volumes by reference to the observed traffic counts. Trips are adjusted in the prior matrix to produce the estimated matrix, which is most likely to be consistent with the traffic counts. The equation used may be written as:

$$T_{ij} = tij \prod_a X_a^{Pija}$$

where:

- T_{ij} is the output estimated matrix of OD pairs ij;
- tij is the prior matrix of OD pairs ij;
- $\prod_a$ is the product over all counted links a;
- X_a is the balancing factor associated with counted link;
- Pija is the fraction of trips from I to j using link a.

This process is dependent on several factors, and therefore it has been monitored closely to ensure that:

- The trip matrix is converging to a stable solution;
- Travel patterns at a sector level are reasonable;
- Changes should not be significant; and
- Trip length distributions are reasonable.

6.11. Matrix Estimation Constraints

All counts that had not been designated as validation counts were used within the matrix estimation process to calibrate the model. This includes outer cordon, inner cordon, screenline 1, screenline 2, screenline 3 and screenline 4.

Using the SATPIJA control file, checks are made to ensure that the overall trip distribution of the original prior trip matrix is maintained by limiting the change to cell values for Cars, LGV and HGV.

The matrix estimation process is applied to adjust the car matrix followed by light vehicle matrix and then followed by heavy vehicle matrix. In total six matrix estimation iterations are implemented. As described previously, the link counts used in the matrix estimation process are formed as a series of calibration screen-lines for Car, LGV and HGV matrices. In addition, diligence is exercised to ensure that the quality and consistency of the input count data is high.

6.12. Matrix Summary

Table 6-7 shows the matrix totals for the prior matrices for the three time periods.

Table 6-7 Prior Matrix Totals

Time Period	Car	LGV	HGV	Total
AM	85967	10062	9076	105105
IP	62568	8352	8128	79048
PM	89499	7723	5253	102475

7. Model Calibration

7.1. Overview

This section details the results of the model calibration after the application of matrix estimation and the model performance against WebTAG guidelines. In order to make the best use of the available data, all counts at screenlines and cordons have been used within the matrix estimation process. However, these were applied within matrix estimation as short screenline constraints rather than individual counts as constraints.

7.2. Calibration Criteria

The guidelines as outlined in DMRB are shown in Table 7-1. The observed flow and screenline flow criteria in the table relate to total link flows and link flows by vehicle type.

It is stressed that these values are guidelines only. DMRB Volume 12 Part 1 emphasises that:

"A model that does not meet these guidelines may still be acceptable for appraisal of a given scheme if the discrepancies are within survey accuracies and the larger discrepancies are concentrated away from the area of greatest importance to that scheme."

Table 7-1 DMRB calibration Guidelines

Criteria and Measures	Guidelines	
DMRB Flow Criteria		
Observed flow < 700vph	Modelled flow within ± 100vph	>85% of links
Observed flow 700 to 2700vph	Modelled flow within ± 15%	
Observed flow > 2700vph	Modelled flow within ± 400vph	
DMRB GEH Criteria		
Total screen line flows (normally > 5 links) to be within ± 5%	All (or nearly all) screen lines	
GEH statistic for individual links <5	> 85% of links	
GEH statistic for screen line totals <4	All (or nearly all) screen lines	

The GEH statistic is a generally accepted value used as an indicator of 'goodness of fit', i.e. the extent to which the modelled flows match the corresponding observed flows. This is recommended in the calibration guidelines contained in the Design Manual for Roads and Bridges (DMRB) Volume 12 and is defined as:

$$GEH = \sqrt{\frac{(M-C)^2}{0.5 \times (M + C)}}$$

Where: M = modelled flow;

C = observed flow (or count).

The guidance in DMRB also considers desired levels for the statistical regression of observed and modelled traffic flows. The desired levels for the two main regression statistics to measure the goodness of fit are an R-squared value of greater than 0.95, and a regression curve gradient in the range 0.9 to 1.1.

7.3. Network Calibration

The calibration procedure involved a number of steps to ensure that the model reproduces observed traffic flows in the model network. These included:

- Adjustments of link and junction operating parameters to represent the existing situation;
- Checks to ensure that link speeds on the network were realistic;
- Checks of centroid connectors to accurately represent the loading points to/from the zone;
- Checks to ensure that delay calculations at junctions were realistically represented; and
- Use of matrix estimation (ME2) procedure to fine tune the prior trip matrices to obtain the best 'fit' with the observed link flows within the model network.

The prior matrix was assigned to the network and the model performance compared against the observed counts and journey time. Based on this initial assignment results the following changes were carried out as part of network calibration to improve the overall performance of the model:

- Counts in excess of capacity – where an observed count was noticeably higher than the coded network capacity the capacities where checked and amended if necessary;
- Excessive junction delays – the largest overall delays, and the largest differences between the link travel times and the observed data were checked and subsequently junction coding were checked;
- Low flows – where the modelled flow was substantially below than counted; this revealed locations where traffic was either restricted at an upstream junction or where a competing route was more attractive; and
- Poor reproduction of observed travel times - detailed comparisons of modelled travel times against the observed journey time routes revealed locations where additional modifications to signal settings were necessary in order to replicate the observed levels of delay.

The results of the matrix estimation process were closely monitored to ensure stability and that realistic trip matrices were created and there were no major deviation from the prior matrix.

7.4. Impact of Matrix Estimation

TAG unit M3.1 states that the changes brought by matrix estimation should not be significant. The criteria by which the significance of changes is measured is presented in Table 7–2.

Table 7–2 Significance of Matrix Estimation Changes

Measure	Significance Criteria
Matrix zonal cell values	Slope within 0.98 and 1.02 Intercept near zero R^2 in excess of 0.95
Matrix zonal trip ends	Slope within 0.99 and 1.01 Intercept near zero R^2 in excess of 0.98
Trip length distributions	Means within 5% Standard deviations within 5%
Sector to sector level matrices	Differences within 5%

Source: TAG Unit M3.1 Table 5

7.4.1. Matrix Totals

There is no current guidance set out in TAG unit M 3.1 on the acceptability of the amount of change brought about by matrix estimation to the matrix totals. A comparison of the matrix totals before and after the application of matrix estimation to show the impact of matrix estimation is shown in Table 7–3.

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Table 7–3 Comparison of Matrix Totals (PCUs) - Prior vs Post ME2

User Class	AM			IP			PM		
	Prior	PostME	% Diff	Prior	PostME	% Diff	Prior	PostME	% Diff
Car	85967	85942	0%	62568	61943	1%	89499	91311	-2%
LGV	10062	9587	5%	8352	8728	-5%	7723	7587	2%
HGV	9076	8358	8%	8128	8951	-10%	5253	4605	12%
Total	**105105**	**103887**	**1%**	**79048**	**79622**	**-1%**	**102475**	**103503**	**-1%**

The table above (**Table 7–3**) shows that at a matrix total level across all user classes, the number of trips in the matrix changes by about +/-1% which is not significant. Considering the effects by user class, the matrix estimation process resulted in 0 to -2% change for car trips across all time periods. The percentage change for LGV is in the range of 2 to 5%. The HGV matrix has changed more by 8 to 12% between prior and PostME. This is due to the lack of internal HGV trips and the sample of HGV demand from surveys is generally lower than car. These gaps in prior matrix means that a greater reliance on matrix estimation to achieve appropriate flows on links.

7.4.2. Matrix Zonal Values

The changes at the matrix zonal level by time period is shown in Table 7–4.

Table 7–4 Matrix Estimation Changes by Time Period

Measure	Significance Criteria	AM	IP	PM
Matrix Zonal Cell Values	Slope within 0.98 and 1.02	0.979	0.984	0.982
	Intercept near zero	0.002	0.003	0.005
	R^2 in excess of 0.95	0.927	0.9682	0.9277
Matrix Zonal Trip Ends (Rows)	Slope within 0.99 and 1.01	0.917	0.922	0.963
	Intercept near zero	4.357	3.924	2.834
	R^2 in excess of 0.98	0.947	0.9724	0.9725
Matrix Zonal Trip Ends (Columns)	Slope within 0.99 and 1.01	0.883	0.907	0.928
	Intercept near zero	32.26	23.195	24.496
	R^2 in excess of 0.98	0.964	0.9742	0.967

The first assessment is to consider the impact of matrix estimation at a cell to cell level. The analysis in Table 7–4 indicates that at a cell to cell level, the impact of matrix estimation across the whole matrix is within the WebTAG criteria with the exception being R^2 for AM and PM peak hour, eventhough they are close to 0.95.

The second criteria is to consider the change in the matrix trip ends from the prior matrices to the matrices resulting from matrix estimation. At a trip end level, the impact of matrix estimation is further from the criteria even though the R^2 value is close to the WebTAG criteria for all time periods. These changes are attributed to the following factors:

- Given the uncertainties in the development of the HGV prior matrices, (resulting from a lower sample rate from RSI surveys, Traffic Master OD data and poor representation in the rezoned prior matrix), it is to be expected that matrix estimation would refine the HGV matrices to a greater extent than other vehicle types.

- Traffic Master Area OD data was used as the source for LGV and HGV internal movements (lower sample rate). However, no appropriate expansion factor was available for these modes and the prior matrix was unexpanded. This has resulted in matrix estimation refining the matrix based on the link count information.

7.5. Trip Length Distribution

The third criteria to assess the impact of matrix estimation on the prior matrices is the changes in trip length distribution before and after matrix estimation.

Table 7–5 % Change (post vs prior) in Mean and Standard Deviation for Trip Length Distribution

Time Period	Car		LGV		HGV	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
AM	-7%	-4%	-10%	-5%	-4%	4%
IP	-7%	-4%	-7%	-3%	-4%	-2%
PM	-6%	-5%	-9%	-4%	0%	5%

The analysis demonstrates that the mean criteria is marginally exceeded for car and LGV for all time periods and this can be attributed to the fact that rezoned base matrix did not have trips for the internal zones and disaggregation of Traffic Master/Census Journey to Work zone system to smaller M58 zoning system.

Figure 7-1 to Figure 7-9 show the change in trip length distribution between the prior and PostME assignments for each time period and vehicle class.

These graphs indicate that the proportion of trips in each distance band remains very stable between the prior and Post ME assignments in all three time periods.

Figure 7-1 Trip Length Distribution for AM Peak Hour (Car)

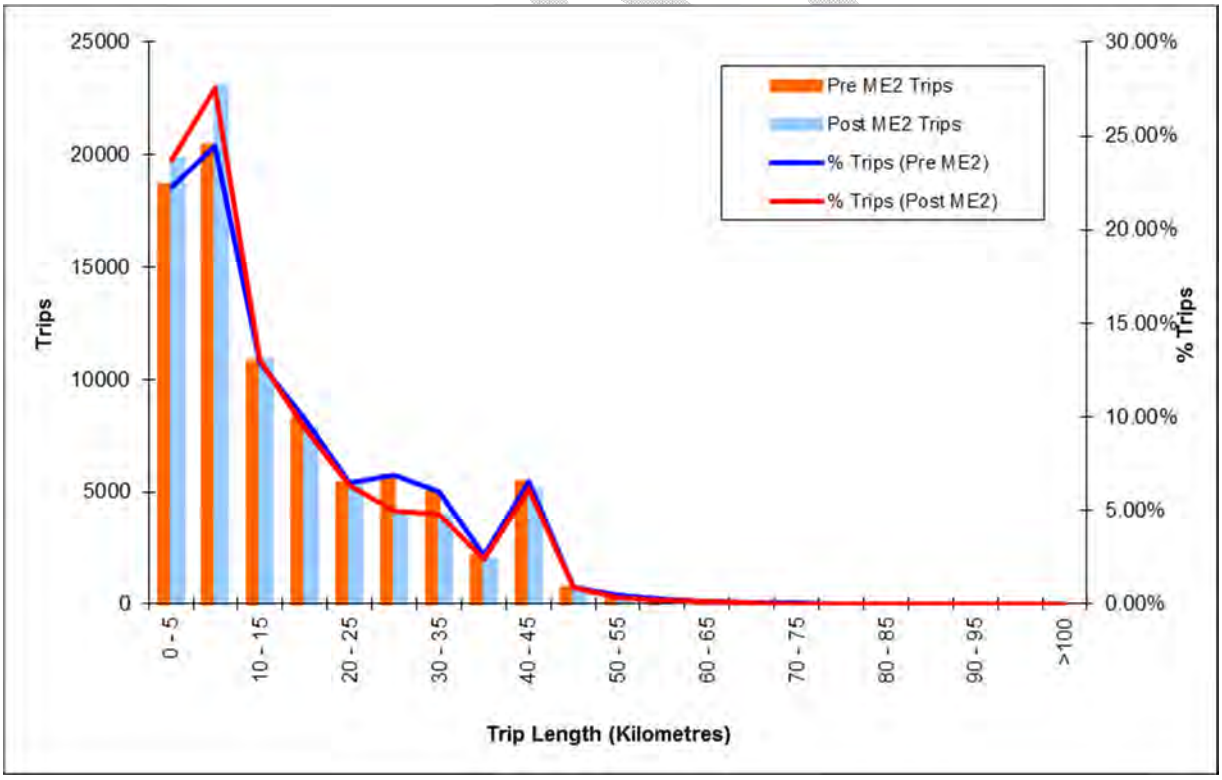


Figure 7-2 Trip Length Distribution for AM Peak Hour (LGV)

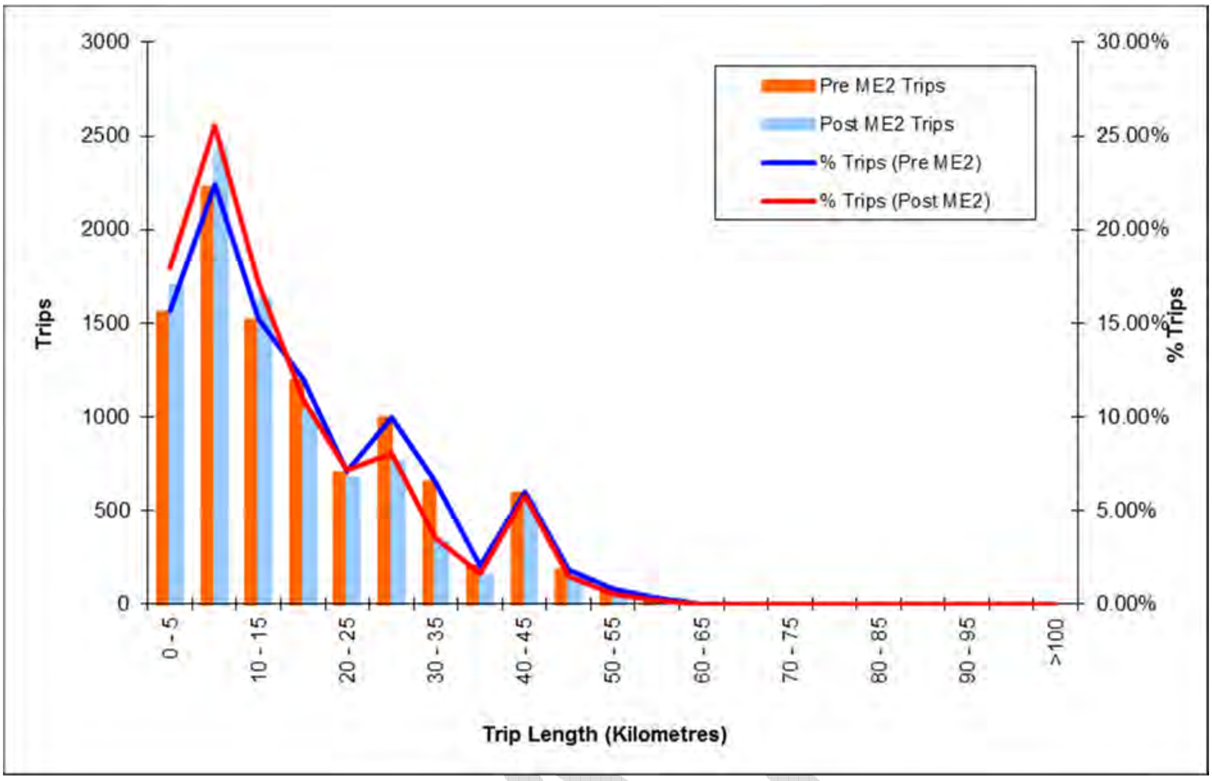


Figure 7-3 Trip Length Distribution for AM Peak Hour (HGV)

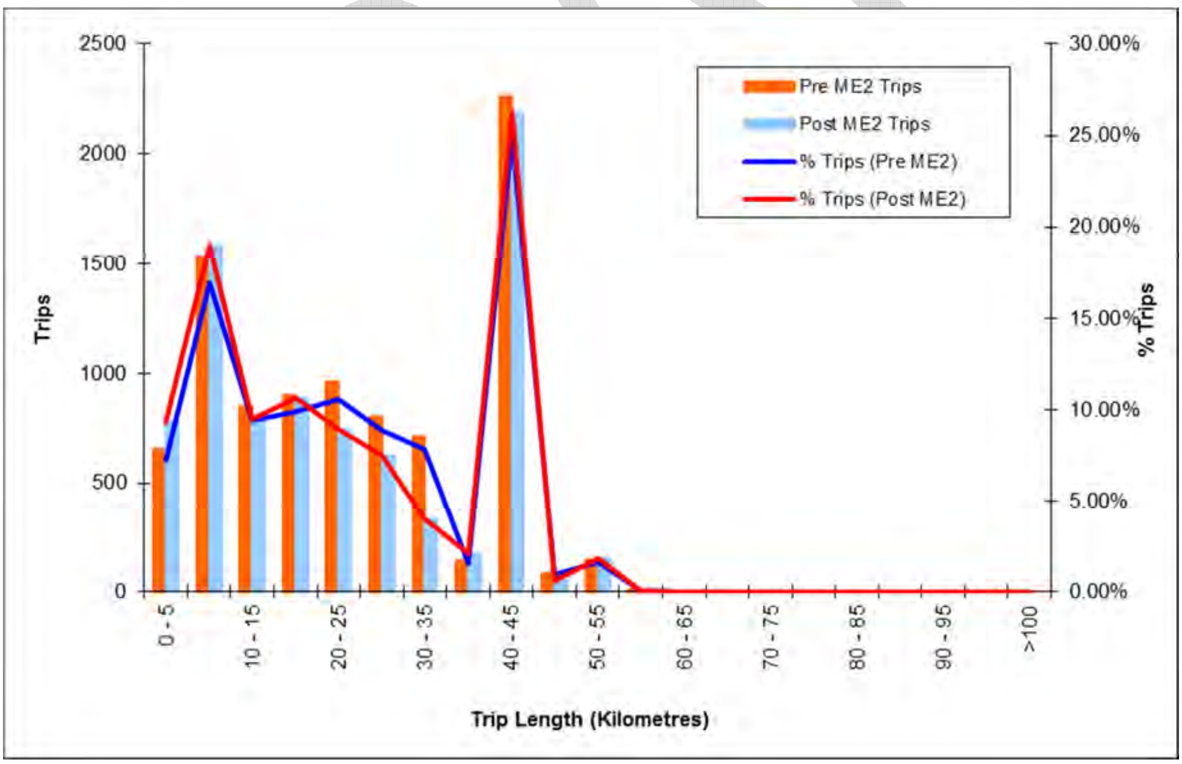


Figure 7-4 Trip Length Distribution for Inter Peak Hour (Car)

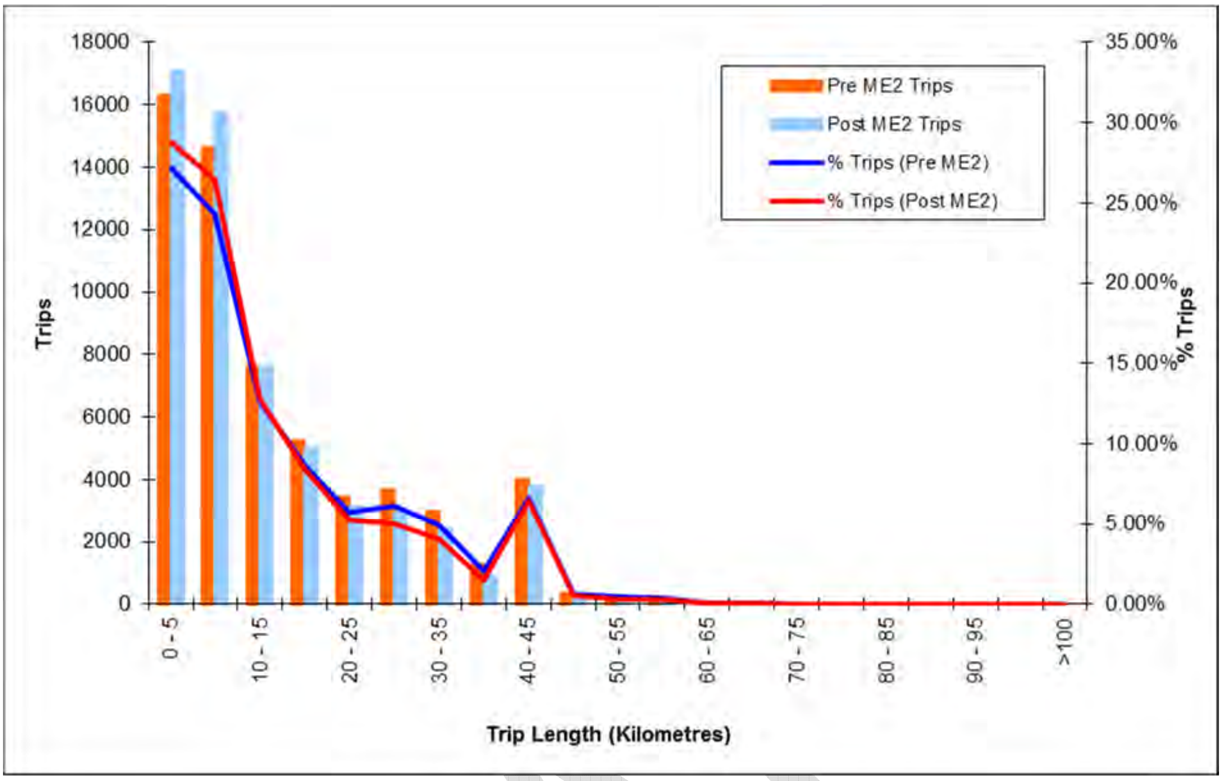


Figure 7-5 Trip Length Distribution for Inter Peak Hour (LGV)

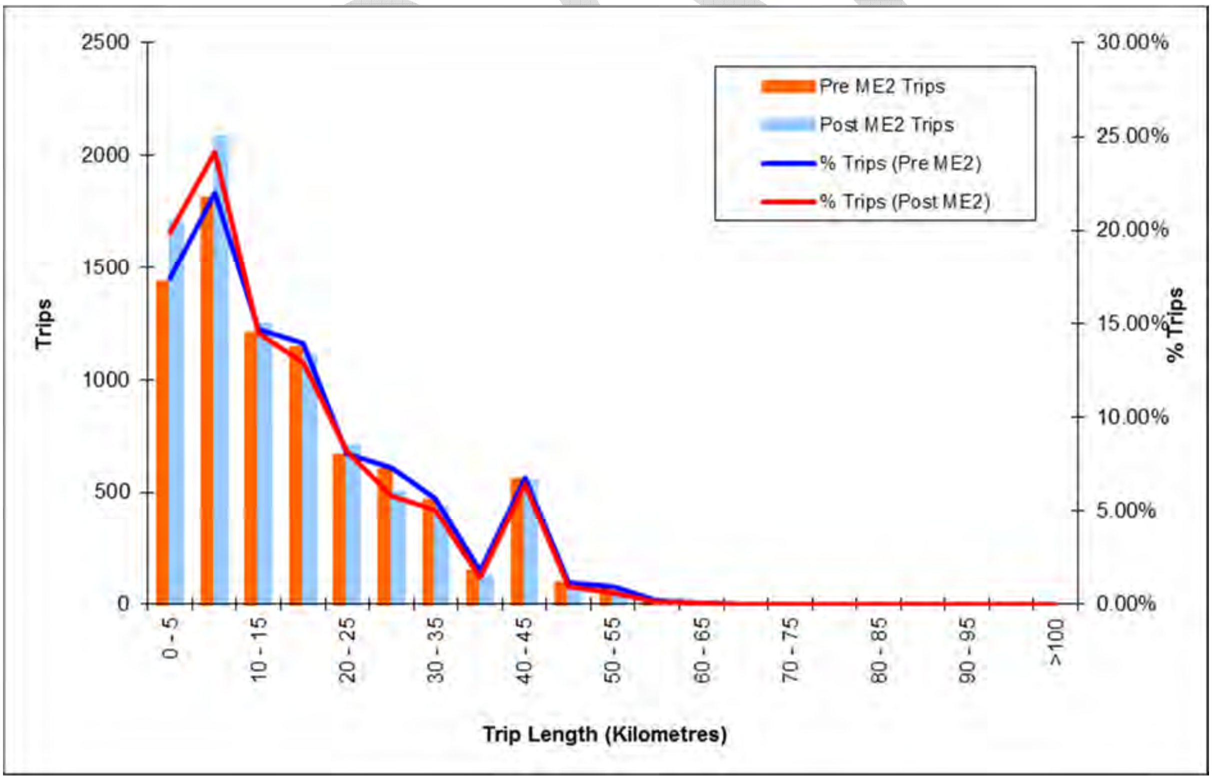


Figure 7-6 Trip Length Distribution for Inter Peak Hour (HGV)

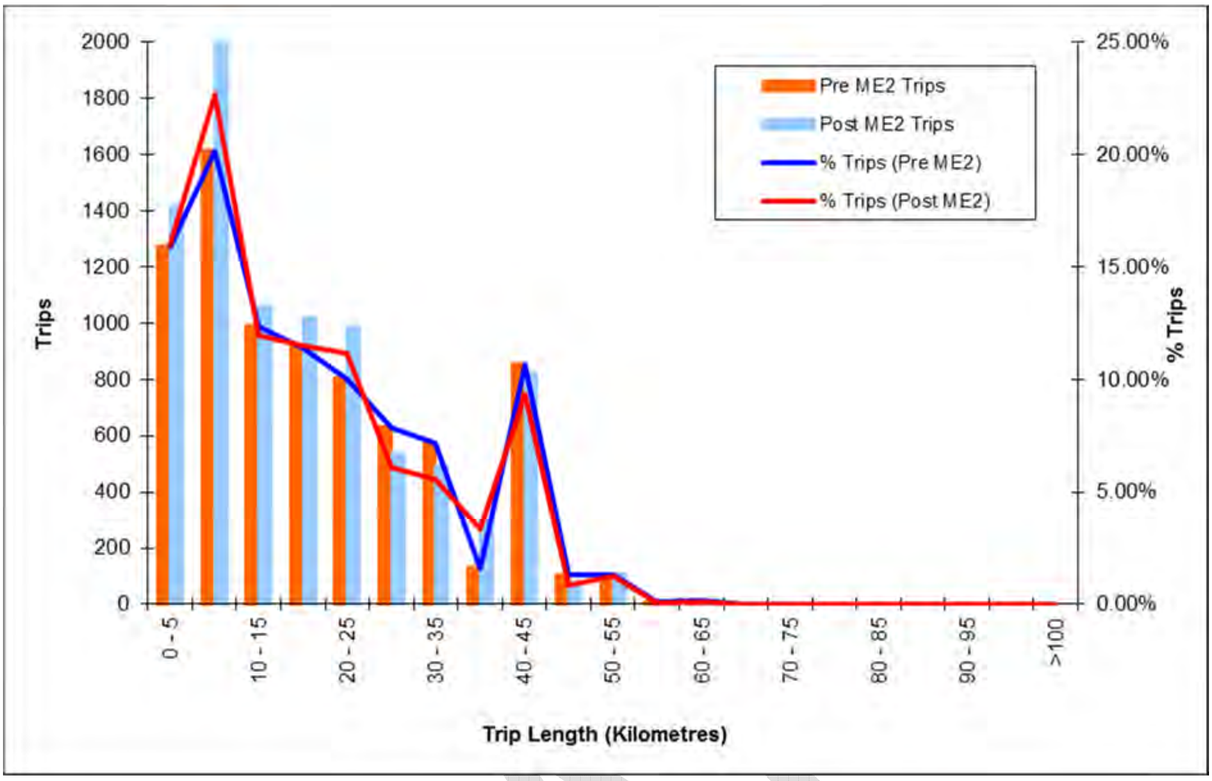


Figure 7-7 Trip Length Distribution for PM Peak Hour (Car)

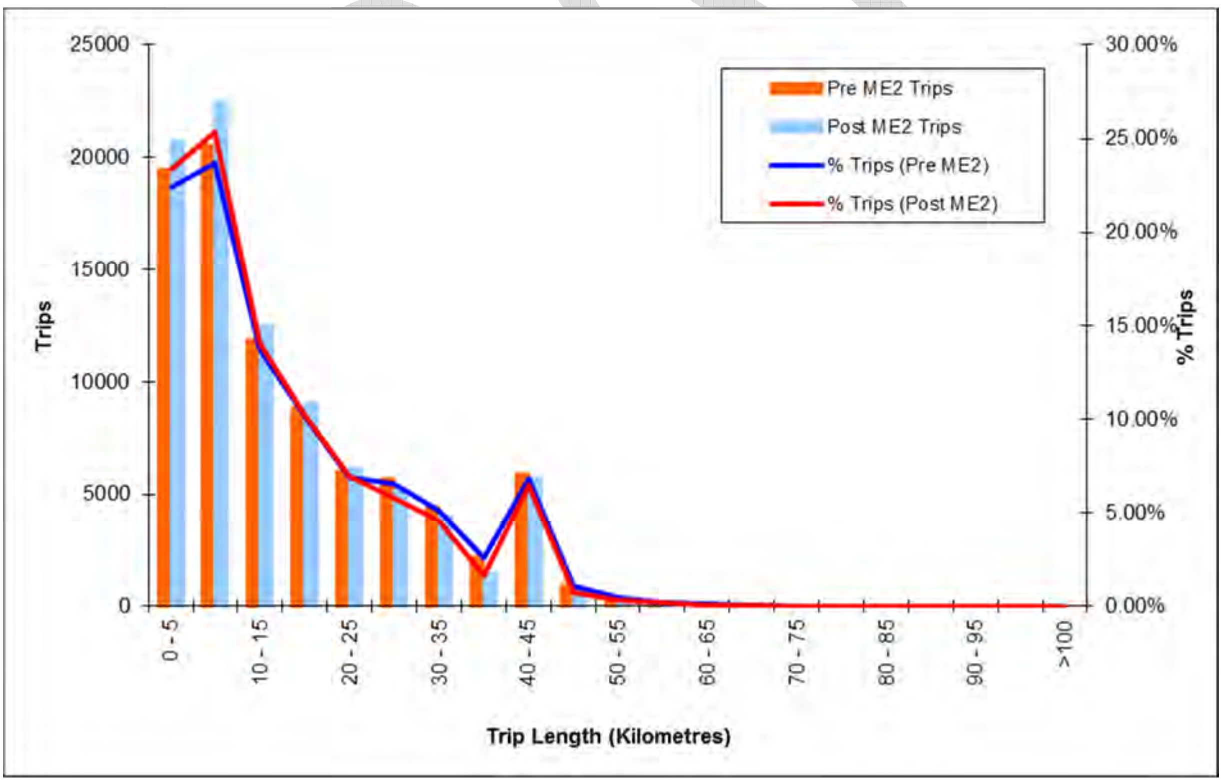


Figure 7-8 Trip Length Distribution for PM Peak Hour (LGV)

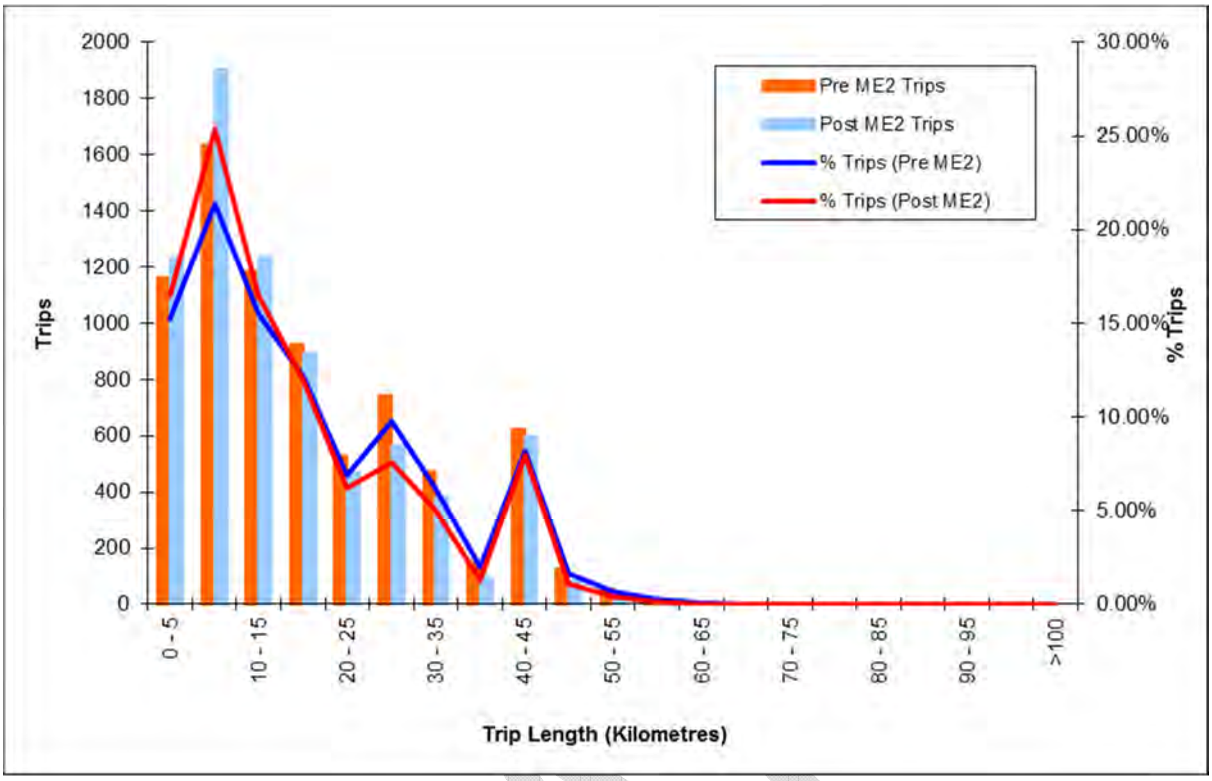
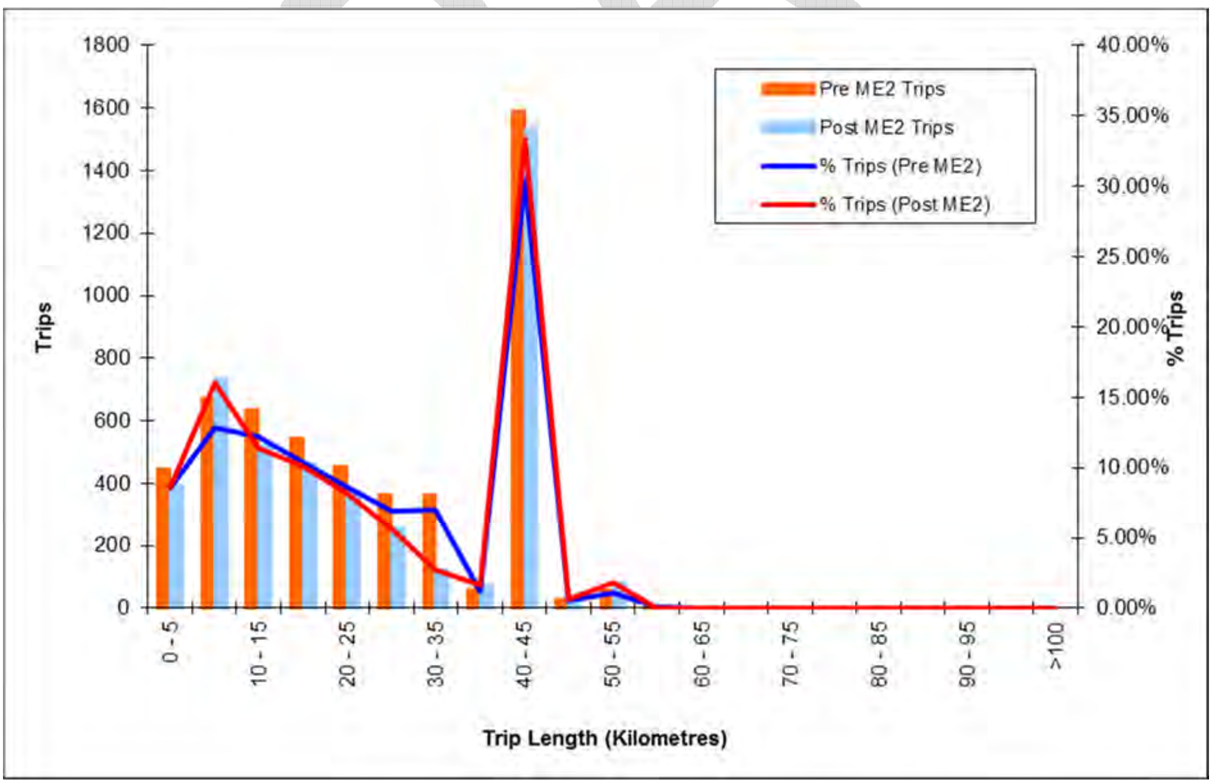


Figure 7-9 Trip Length Distribution for PM Peak Hour (HGV)



7.6. Sector Analysis of Prior and Post Matrix Estimation

The fourth criteria to assess the impact of matrix estimation is to consider the matrix changes at a sector level prior and PostME. For the purpose of this study, a 3 sector system has been defined based on the study area boundary and method of prior matrix development (Sector1- Simulation, Sector2- Buffer and Sector3- External). The sector map is shown in Figure 7-10. The comparison for all vehicle types combined between prior and PostME matrices is shown in Table 7–6 to Table 7–8.

Figure 7-10 Sector Map

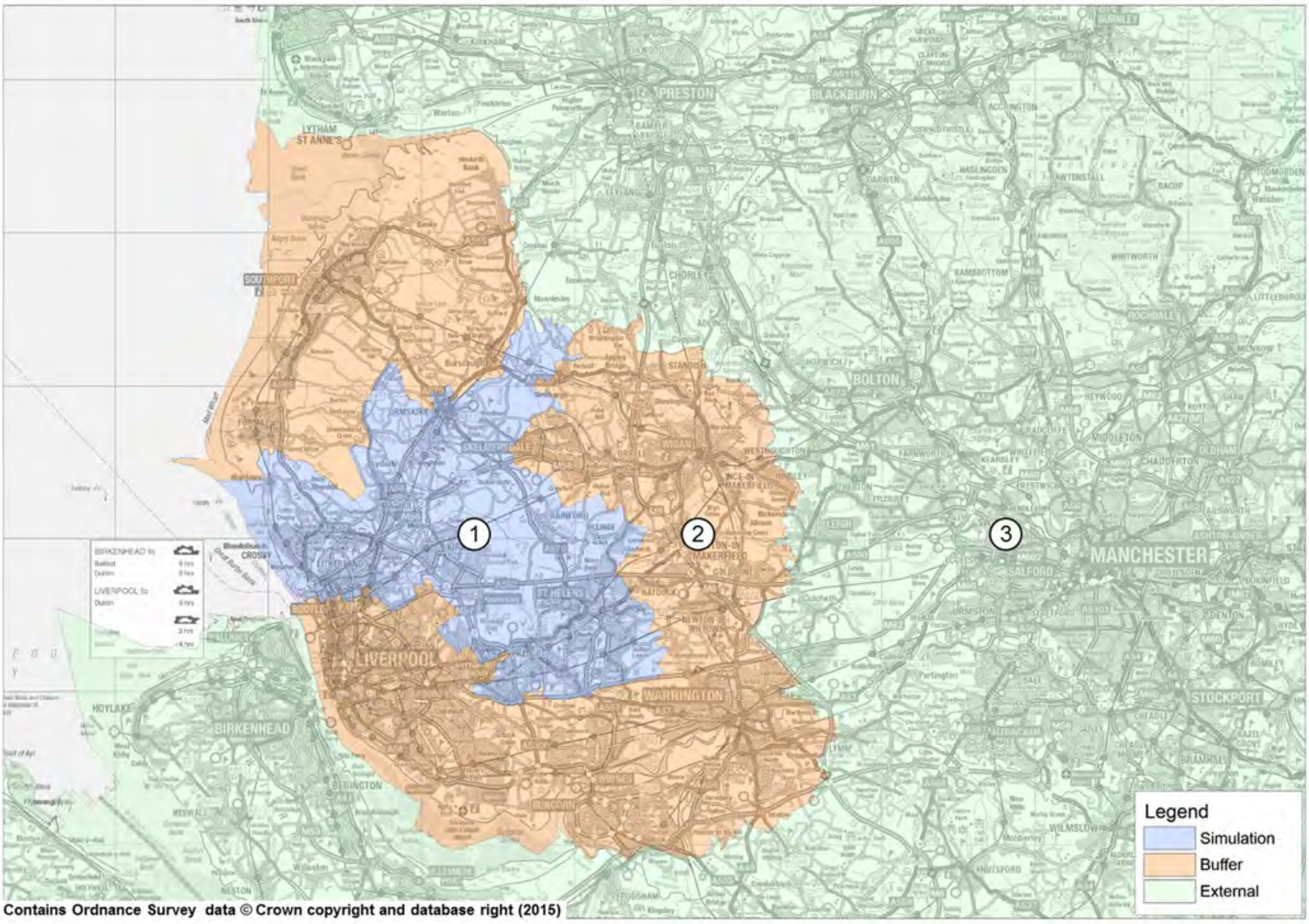


Table 7–6 Impact of Matrix Estimation at a Sector to Sector Level-AM Peak

Sector	1	2	3
1	**10%**	**7%**	**-17%**
2	5%	1%	**-13%**
3	**-16%**	**-17%**	-4%

Table 7–7 Impact of Matrix Estimation at a Sector to Sector Level-Inter Peak

Sector	1	2	3
1	**9%**	5%	-5%
2	4%	**6%**	**-19%**
3	**-16%**	**-12%**	-3%

Table 7–8 Impact of Matrix Estimation at a Sector to Sector Level-PM Peak

Sector	1	2	3
1	**13%**	2%	3%
2	3%	3%	**-17%**
3	**-17%**	1%	-2%

Note: Bold text shows exceeding TAG criteria of 5%.

Overall changes in the matrices are reasonably modest given that the process includes base matrix rezoning from a 183 zoning system to 343 zoning system and with the inclusion of new data. Large changes are generally matched to relatively small sectors (in matrix terms). For Sector1, the internal movements are failing the WebTAG criteria for all time periods. This is attributed to the fact that the LGV and HGV matrix is not comprehensive for the intra movements within this sector and for car the trips were derived from Traffic Master/Census Journey to work and converted from a larger zone to smaller M58 zone system as discussed earlier. The other sector movements which do not meet the WebTAG criteria, do not contribute more than 20% of the total trips.

7.7. Model Convergence

The model convergence by time period is given in Table 7–9 for the last four assignment-simulation loops.

Table 7–9 Summary of Model Convergence

Time Period	Assignment - Simulation Loop	Delta (%) (δ)	%Gap	% Flow Change
AM	15	0.0229	0.025	99.6
	16	0.0183	0.025	99.7
	17	0.0165	0.021	99.7
	18	0.0149	0.025	99.8
IP	10	0.0124	0.014	99.4
	11	0.0107	0.0095	99.2
	12	0.0101	0.0099	99.5
	13	0.0041	0.0064	99.6
PM	18	0.0192	0.017	99.3
	19	0.0142	0.017	99.8
	20	0.0114	0.015	99.8
	21	0.0091	0.018	99.8

Table 7–9 shows that the model has achieved a high level of convergence and the model meets all of the required TAG convergence criteria. They are stable for at least four consecutive assignment-simulation loops and the delta and %gap values comfortably exceed the targets specified in the TAG of 0.1%. Similarly, the percentage flow difference achieved is higher than the 98% required by guidance.

7.8. Flow calibration

The final validated model was compared against observed traffic flows at all sites along the outer cordon, inner cordon and four screenlines as presented in Figure 3-4. The assessment criteria follows those defined in TAG Unit M3.1 Table 1, which states that differences between modelled flows and observed flows should be less than 5% of the counts for all or nearly all screenlines. A summary of traffic flow comparison at overall screenline and cordon level is presented in Table 7–10 to Table 7–12. Full calibration results for individual links is contained in Appendix B.

Table 7–10 Flow Calibration- AM Peak

Screenline	Direction	Observed flow	Modelled flow	Difference	% Difference	WebTAG	
						Flow	GEH
Outer Cordon	Inbound	24512	23976	-535	-2%	✓	
	Outbound	20603	20477	-126	-1%	✓	
Inner Cordon	Inbound	17715	16897	-818	-5%	✓	
	Outbound	19976	19292	-685	-3%	✓	
Screenline 1	Northbound	3520	3417	-103	-3%	✓	
	Southbound	5166	5012	-154	-3%	✓	
Screenline 2	Northbound	3765	3796	30	1%	✓	
	Southbound	5563	5499	-64	-1%	✓	
Screenline 3	Eastbound	5906	5612	-294	-5%	✓	
	Westbound	4797	5032	235	5%	✓	
Screenline 4	Northbound	4908	4833	-75	-2%	✓	
	Southbound	5066	5052	-14	0%	✓	
Number of screenlines complying with WebTAG						**12/12**	
Percentage of screenlines complying with WebTAG						**100%**	
Percentage of individual links complying with WebTAG						**92%**	**93%**

Table 7–11 Flow Calibration- Inter Peak

Screenline	Direction	Observed flow	Modelled flow	Difference	% Difference	WebTAG	
						Flow	GEH
Outer Cordon	Inbound	16177	16138	-39	0%	✓	
	Outbound	16211	16105	-106	-1%	✓	
Inner Cordon	Inbound	13875	13459	-415	-3%	✓	
	Outbound	13910	13343	-567	-4%	✓	
Screenline 1	Northbound	2858	2890	32	1%	✓	
	Southbound	2787	2793	6	0%	✓	
Screenline 2	Northbound	3448	3518	70	2%	✓	
	Southbound	3764	3764	0	0%	✓	
Screenline 3	Eastbound	4184	4112	-72	-2%	✓	
	Westbound	4243	4284	41	1%	✓	
Screenline 4	Northbound	3230	3229	-1	0%	✓	
	Southbound	3216	3210	-6	0%	✓	
Number of screenlines complying with WebTAG						**12/12**	
Percentage of screenlines complying with WebTAG						**100%**	
Percentage of individual links complying with WebTAG						**97%**	**98%**

Table 7–12 Flow Calibration- PM Peak

Screenline	Direction	Observed flow	Modelled flow	Difference	% Difference	WebTAG	
						Flow	GEH
Outer Cordon	Inbound	22285	22133	-152	-1%	✓	
	Outbound	23097	22692	-405	-2%	✓	
Inner Cordon	Inbound	18638	18256	-382	-2%	✓	
	Outbound	17915	17183	-732	-4%	✓	
Screenline 1	Northbound	4843	4708	-134	-3%	✓	
	Southbound	3166	3113	-53	-2%	✓	
Screenline 2	Northbound	4838	4735	-103	-2%	✓	

	Southbound	4820	4693	-126	-3%	✓	
Screenline 3	Eastbound	4523	4588	65	1%	✓	
	Westbound	5683	5379	-305	-5%	✗	
Screenline 4	Northbound	5155	5144	-11	0%	✓	
	Southbound	4864	4888	24	0%	✓	
Number of screenlines complying with WebTAG						**11/12**	
Percentage of screenlines complying with WebTAG						**92%**	
Percentage of individual links complying with WebTAG						**94%**	**93%**

The above results shows that the model is calibrated well to the observed counts. A summary of the results is presented below:

AM Peak hour:

- All screenlines pass the WebTAG criteria for flow; and
- 92% and 93% of individual links pass the WebTAG flow and GEH criteria respectively.

Inter Peak Hour:

- All screenlines satisfy the WebTAG flow criteria; and
- 97% and 98% of individual links pass the WebTAG flow and GEH criteria respectively.

PM Peak Hour:

- All screenlines satisfy the WebTAG flow criteria except screenline3 Westbound only marginally higher than the WebTAG criteria; and
- 93% of counts have a GEH of less than 5 and 94% of counts pass the WebTAG flow criteria.

8. Model Validation

8.1. Overview

Model validation is a comparison of model output data with observed data to assess the accuracy of the calibrated model and establish its suitability as a basis from which to prepare forecasts. There are guidelines set by TAG Unit M3.1 specifying the criteria that determine whether the calibrated model is considered to be a valid representation of reality or not. The fundamental point of validation is that the observed counts to be used for validation need to be independent of the calibration. In line with the guidelines, independent data sets, in the form of link counts, have been used for validation of the models.

Validation of the M58 model encompassed the following aspects:

- Network validation, in terms of routeing;
- Flow validation; and
- Journey time validation

8.2. Network Validation

A check on the validity of route choice in the model was undertaken by examining a number of key modelled routes. The plots in Appendix C illustrate that the model multi-routes traffic according to a combination of the shortest distance and time. This can give rise to a number of different routes between most Origin-Destination (O-D) pairs onto which the model assigns varying proportions of traffic. The level of multi-routing reflects the levels of congestion by time of day and the relative density of the network used in the model.

The routes selected for analysis were considered to be important at a local and strategic level in terms of the assessment of the M58 Junction 1 scheme, and most are likely to be affected by the alteration of the junction. The routes considered are between the various combinations of Kirkby, Maghull, Ormskirk, Liverpool city centre, and Manchester. The routes, shown in Appendix C, compare favourably with routes indicated by online journey planners, and so are considered to be logical.

8.3. Flow Validation

A summary of the flow validation results is presented in Table 8-1, with a detailed link by link assessment shown in Appendix D. The locations of the validation counts are listed in Table 3-2 and shown in

Figure 3-4. A total of 18 counts, at 9 sites, were used in the validation process. These counts were independent of those used in the model calibration process. The criteria used for evaluation are the flow and GEH criteria for individual links.

Table 8-1 Link flow validation summary

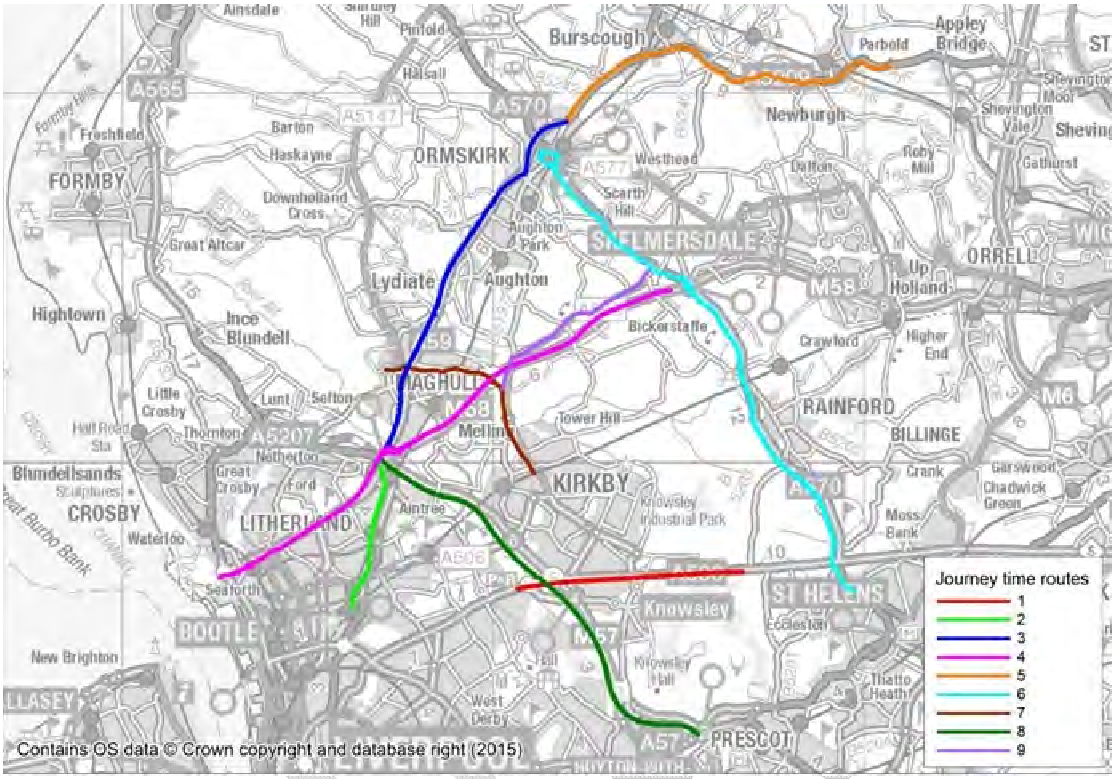
Time Period	Number of counts	Flow criteria number and % pass		GEH number and % pass	
AM	18	13	72%	13	72%
IP	18	13	72%	14	78%
PM	18	17	94%	16	89%

The PM peak meets the TAG acceptability guideline for flow validation, with over 85% of validation links meeting the flow and GEH criteria. While the AM peak and inter-peak do not meet this guideline, the tables in Appendix D indicate that both periods contain several validation links that are close to meeting the TAG criteria.

8.4. Journey Time Validation

Journey time validation was undertaken to ensure that travel times and delays along links and at junctions across the study area are accurately represented in the model. The validation was based on a comparison of modelled and observed journey times along nine survey routes, illustrated in Figure 8-1.

Figure 8-1 Journey time validation routes



As described in Chapter 3, TrafficMaster travel time data was obtained for the length of these routes. The data used for validation covered all weekdays in the neutral months of September, October and November 2012, excluding school holidays, with the exception of Route 8 Southbound where data was only available for the equivalent period in 2011. For each journey time route segment, there were on average 604 observed timings in the dataset for the AM peak, 1102 observed timings in the inter-peak, and 538 in the PM peak.

TrafficMaster travel time data consists of an average of travel times of all vehicles travelling along each link segment. To ensure a robust comparison, the modelled journey time was extracted to include the average delay for vehicles on each link, rather than the delay specific to the turn being made on the route.

The TAG validation criterion requires that modelled times along routes should be within 15% of observed times, or within one minute if higher. The acceptability guideline is for the criterion to be satisfied on over 85% of routes. The journey time validation results for this model are summarised in Table 8-2 to Table 8-4.

Table 8-2 Summary of journey time validation - AM peak

Route	Description	Direction	Observed (s)	Modelled (s)	Diff (s)	% Diff	Within TAG
1	A580 East Lancashire Road to A580-B5203 junction	EB	356	340	-15	-4%	Yes
		WB	347	316	-31	-9%	Yes
2	A59 Rice Lane/A5098 Hornby Road to Switch Island	NB	503	589	86	17%	No
		SB	579	635	56	10%	Yes
3	Switch Island to A59-B5319 junction	NB	822	762	-60	-7%	Yes
		SB	886	908	22	3%	Yes
4	A5036 Princess Way to M58 J2	EB	931	1048	118	13%	Yes
		WB	1023	933	-90	-9%	Yes

5	A59-B5319 junction to Parbold Hill-B5246 junction	EB	839	892	53	6%	Yes
		WB	929	968	39	4%	Yes
6	A570 St Helens to Ormskirk	NB	1152	1019	-133	-12%	Yes
		SB	1122	1163	40	4%	Yes
7	A506 County Road/Boyes Brow to B422 Westway	NB	606	624	18	3%	Yes
		SB	622	689	67	11%	Yes
8	M57 J1 to Switch Island	NB	400	432	33	8%	Yes
		SB	407	440	33	8%	Yes
9	Maghull Lane to A570 Ormskirk Road	EB	363	379	15	4%	Yes
		WB	318	337	19	6%	Yes
% within TAG							94%

Table 8-3 Summary of journey time validation – Inter-peak

Route	Description	Direction	Observed (s)	Modelled (s)	Diff (s)	% Diff	Within TAG
1	A580 East Lancashire Road to A580-B5203 junction	EB	353	319	-34	-10%	Yes
		WB	344	396	52	15%	Yes
2	A59 Rice Lane/A5098 Hornby Road to Switch Island	NB	583	598	15	3%	Yes
		SB	650	598	-52	-8%	Yes
3	Switch Island to A59-B5319 junction	NB	815	735	-80	-10%	Yes
		SB	832	718	-114	-14%	Yes
4	A5036 Princess Way to M58 J2	EB	899	852	-46	-5%	Yes
		WB	921	869	-52	-6%	Yes
5	A59-B5319 junction to Parbold Hill – B5246 junction	EB	837	759	-78	-9%	Yes
		WB	842	758	-83	-10%	Yes
6	A570 St Helens to Ormskirk	NB	1094	1027	-67	-6%	Yes
		SB	1082	1105	23	2%	Yes
7	A506 County Road/Boyes Brow to B422 Westway	NB	550	596	46	8%	Yes
		SB	579	597	18	3%	Yes
8	M57 J1 to Switch Island	NB	387	389	2	1%	Yes
		SB	405	387	-18	-4%	Yes
9	Maghull Lane to A570 Ormskirk Road	EB	344	363	19	6%	Yes
		WB	319	331	11	4%	Yes
% within TAG							100%

Table 8-4 Summary of journey time validation - PM peak

Route	Description	Direction	Observed (s)	Modelled (s)	Diff (s)	% Diff	Within TAG
1	A580 East Lancashire Road to A580-B5203 junction	EB	356	329	-26	-7%	Yes
		WB	345	347	2	1%	Yes
2	A59 Rice Lane/A5098 Hornby Road to Switch Island	NB	691	610	-82	-12%	Yes
		SB	776	679	-96	-12%	Yes
3	Switch Island to A59-B5319 junction	NB	882	901	19	2%	Yes
		SB	876	808	-68	-8%	Yes
4	A5036 Princess Way to M58 J2	EB	1030	903	-128	-12%	Yes
		WB	1003	993	-10	-1%	Yes
5	A59-B5319 junction to Parbold Hill – B5246 junction	EB	879	887	8	1%	Yes
		WB	860	921	61	7%	Yes
6	A570 St Helens to Ormskirk	NB	1122	1286	164	15%	Yes

		SB	1182	1093	-89	-8%	Yes
7	A506 County Road/Boyes Brow to B422 Westway	NB	613	676	63	10%	Yes
		SB	646	628	-19	-3%	Yes
8	M57 J1 to Switch Island	NB	430	484	54	13%	Yes
		SB	406	420	14	3%	Yes
9	Maghull Lane to A570 Ormskirk Road	EB	351	383	32	9%	Yes
		WB	329	333	4	1%	Yes
% within TAG							100%

These results indicate an excellent level of journey time validation. All ten routes achieve the TAG criterion in each time period, with the exception of Route 2 northbound in the AM peak, which is 11 seconds from achieving the criterion. In each period, the results are thus well within the acceptability guideline. Graphs of the journey time results are presented in Appendix E.

8.5. Summary

This assessment of the validation process shows that the level of journey time validation for this model is excellent when compared with TAG acceptability criteria. Although the level of link flow validation does not meet the TAG acceptability guideline in the AM peak and inter-peak, the individual link data indicate that the guideline is close to being achieved. The choice of routes between key model locations is also considered to be logical. On the balance of this evidence, along with the analysis of model development steps in previous chapters, it is considered that the model is suitable for the assessment of the M58 Junction 1 improvement.

Conclusion

9. Conclusion

This report has provided an overview of the development of the 2013 base year model developed to support the development of Business Case for the M58 Junction1 improvement scheme. Three models have been developed to represent the AM peak hour (0800-0900), an average inter-peak hour (1000-1600) and PM peak hour (1700-1800) traffic conditions.

The indicators of model performance set out within the report demonstrate that the models robustly represent base year 2013 AM peak, inter-peak and PM peak hour traffic levels and patterns in Sefton, Kirkby and surrounding areas. Matrix estimation was employed to adjust the prior trip matrices to observed traffic counts within the study area. This process was closely monitored to ensure that realistic trip matrices were created. The output matrices were analysed for changes in trip totals and the results suggest a very close match with the guidance. Trip length was analysed, which demonstrated that the matrix estimation process had a small but insignificant impact on trip length in the model matrices. The model convergence achieves all of the required DMRB criteria.

The model achieves an excellent level of flow calibration across all three time periods. At screenline and cordon level all three peak periods achieved 100% of the flow criteria except for PM peak. This is considered to be a good calibration result compared to the DMRB criteria. The DMRB guidance requires nearly all screenlines to match the observed flow.

The validity of route choice in the models was checked through an examination of a selection of routes in the study area. In all cases, route choice was found to be both logical and consistent with expectation.

Flow validation was undertaken using count data independent of the data used in our calibration process. The PM peak results meet the required criteria whereas the AM (72%) and IP (78%) results are very close to the acceptance guidance. Despite narrowly failing to achieve the DMRB acceptability thresholds, the results are considered to demonstrate a good level of flow validation given the number and the location of counts used in the validation process.

An excellent level of journey time validation was also achieved throughout all peak periods. The majority of modelled journey times were also within 10% of the observed times.

It is the conclusion of this report that the base year models yield a very good representation of current traffic patterns within the study area, and form a robust basis upon which future year forecasts can be developed and can subsequently be used to assess the M58 Junction 1 scheme assessment.