

NORTH STAFFORDSHIRE LOCAL AIR QUALITY PLAN

UNAPPROVED OUTLINE BUSINESS CASE

APPENDIX 25 - T2 Local Plan Transport Model Validation
Report



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Executive Summary

The North Staffordshire Multi-Modal (NSMM) transport model has been successfully updated with Automatic Number Plate Recognition (ANPR) data to allow the differentiation between compliant and non-compliant cars, LGVs, HGVs and taxis. This has then been successfully validated against traffic count and journey time data.

For most of the validation comparisons the validation is not significantly different to that achieved for the updated 2015 NSMM transport model which confirms that the disaggregation of the demand matrix has only resulted in small changes.

The 2015 base year model validates within acceptable tolerance levels from the previous validation exercise and as a result is suitable to be used for modelling emission strategies across compliant and non-compliant user classes to support the reduction of nitrogen dioxide (NO₂) emissions. Analysis of traffic count data has shown that traffic levels between 2015 and 2018 have not shown any net growth, with the model also validating well against 2018 traffic count data. This therefore removes any need to create an updated 2018 transport model.

This has been confirmed through three validation checks:

- Validation of the 2015 base model following disaggregation of the demand matrices against a conurbation wide dataset to ensure the disaggregation process has not unduly changed the level of validation
- Validation against the 2018 A500 screenline traffic count data
- Validation of the model against the 2019 ANPR data regarding the compliance splits

1 Introduction

1.1 Purpose of the Local Model Validation Report

The Local Model Validation Report (LMVR) describes the current model, the model development undertaken to improve its forecasting capabilities, and the resulting model validation.

The main body of this report is broken down into two sections:

1. **Travel Demand Calibration and Sensitivity Test Section (T2a) (Chapter 3)** that explains in detail the travel demand model calibration and the outcomes of the realism and sensitivity tests in line with TAG Unit M2 requirements
2. **Traffic Assignment Model Validation Section (T2b) (Chapter 4)** that explains in detail how the base year model validates and how it was modified using Automatic Number Plate Recognition (ANPR) data and is validated against real-world data.

This report is part of a suite of documents which must be viewed in collaboration with:

- T1 tracker table - a live document that demonstrates all the transport modelling requirements are being met
- T3 Local Plan Transport Modelling Methodology Report – which outlines the methodology for the transport modelling work to be undertaken

The purpose of the update to the NSMM transport model is to provide an analytical tool that will aid Newcastle-under-Lyme Borough Council (NuLBC), Stoke-on-Trent City Council (SoTCC) and Staffordshire County Council (SCC) in the development and implementation of Air Quality Local Plans. The work undertaken to enhance the model is designed specifically to give the user more granularity regarding classes of road vehicles and users which will enable greater certainty in forecasting the effectiveness of implementing a charging Clean Air Zone (CAZ). This additional detail will allow the users to focus on reducing NO₂ exceedances in North Staffordshire as required by the Ministerial Direction for third wave local authorities.

1.2 Development background

The need to develop this additional capability comes as a direct result from a High Court ruling, where ministers were required to set out any additional steps that could be taken by the councils to speed up compliance with the NO₂ limits, which have been exceeded since 2010. The Government said it will work with the authorities through its Joint Air Quality Unit (JAQU) to support and develop plans to help reduce NO₂ emissions.

1.3 Report structure

This LMVR is divided into the following sections:

Chapter 2 – provides background information on the NSMM transport model including the scope and specification of the modelled network and traffic zones as well as vehicle disaggregation

Chapter 3 – Travel Demand Calibration and Sensitivity Tests (T2a)

Chapter 4 – Traffic Assignment Model Validation Section (T2b)

Chapter 5 – Summary of the validation of the updated NSMM transport model and whether it is fit for purpose

2 Model description and specification

The NSMM transport model covers the whole of the urban areas of Stoke-on-Trent and Newcastle-under-Lyme and extends into the surrounding and wider areas. The full model extent is shown in Figure 2-1 with the detailed and peripheral model extents shown in Figure 2-2 and Figure 2-3. Both road and rail links are modelled. Within the detailed model area junctions are modelled as shown in Figure 2-4.

2.1 Structure of the NSMM transport model

The structure of the NSMM transport model consists of three main modules:

- Highway Assignment Model
- Public Transport Assignment Model
- Demand Model

The highway model is both link and junction based.

2.2 Transport modelling software

The NSMM transport model has been refined and updated using CUBE Voyager Version 6.4 transport modelling software.

2.3 Modelled time periods

The modelled time periods are as follows:

- AM peak hour (08:00 - 09:00hrs)
- Inter-Peak (IP) hour (14:00 - 15:00hrs)
- PM peak hour (17:00 - 18:00hrs)

2.4 NSMM transport model zones and sectors

The NSMM transport model has 288 zones which are split as follows:

- Internal zones 1 – 207 and 275 – 288 zones (see Figure 2-5, Figure 2-6 and Figure 2-7)
- Peripheral zones 208 – 233 (see Figure 2-8)
- Regional zones 234 – 255 (see Figure 2-9)
- National zones 256 – 274 (see Figure 2-10)

The internal zones and modelled transport network represent the greatest level of detail to capture local routing and travel demand responses. The peripheral zones form a ring of buffer zones just outside the detailed modelled area, with a dimension a little larger than the internal zones to provide realistic travel demand to and from these areas.

Regional and national zones are far coarser, for example Scotland is represented by a single zone, this permits representation of destination choice and travel opportunities between external zones and between internal and external zones. Capturing external to external demand is

important in the NSMM transport model area, as it includes roads carrying significant through traffic such as the M6, A500 and A50 Trunk Roads.

As part of the NSMM model update for the Etruria Valley Link Road (EVLR) Project, an additional 14 zones (zones 275 to 288) were added in the Etruria Valley, Festival Park and Middleport areas and are shown in Figure 2-11.

Figure 2-1: Extent of modelled road and rail network

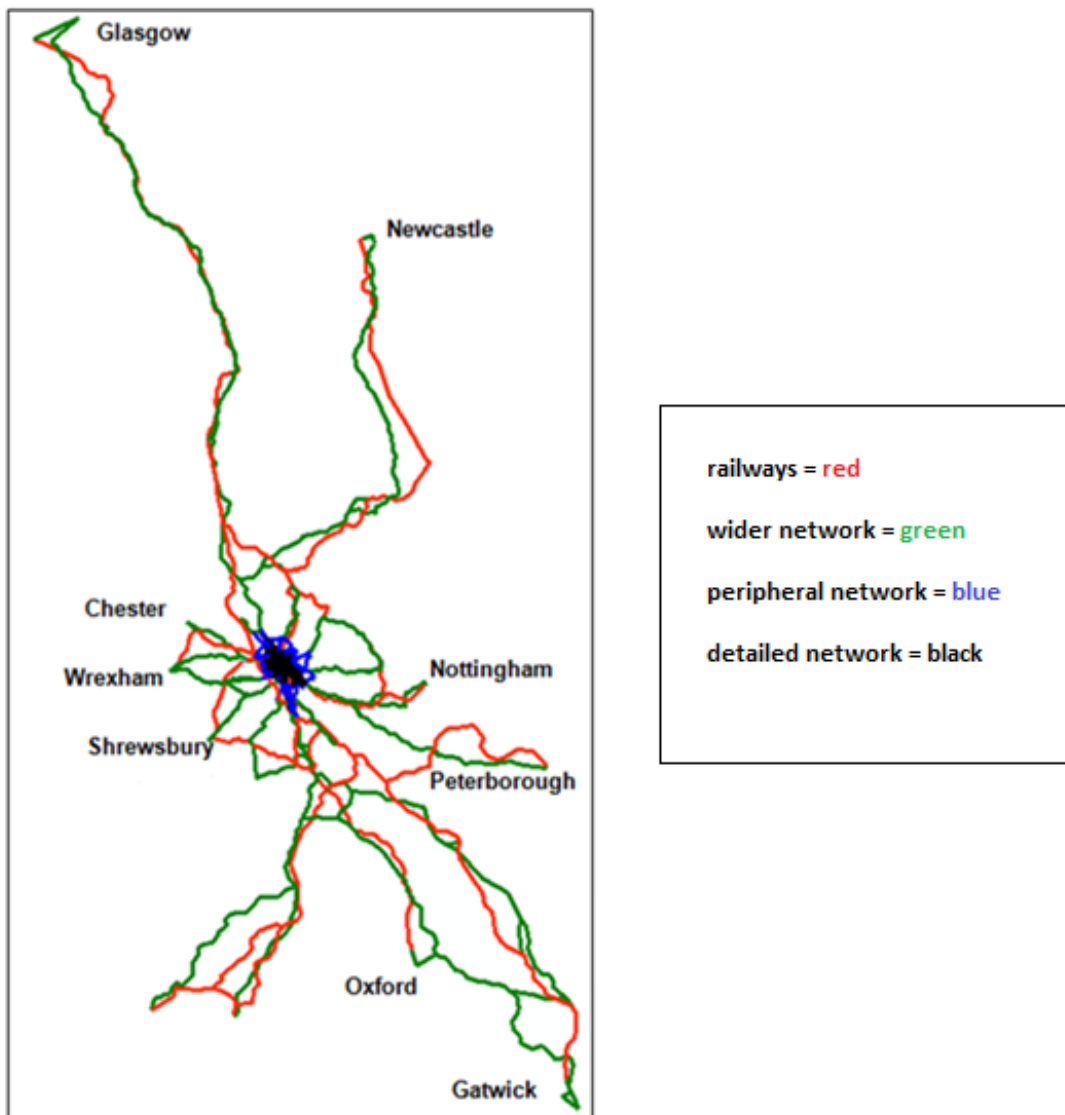


Figure 2-2: Extent of modelled peripheral and internal road and rail networks

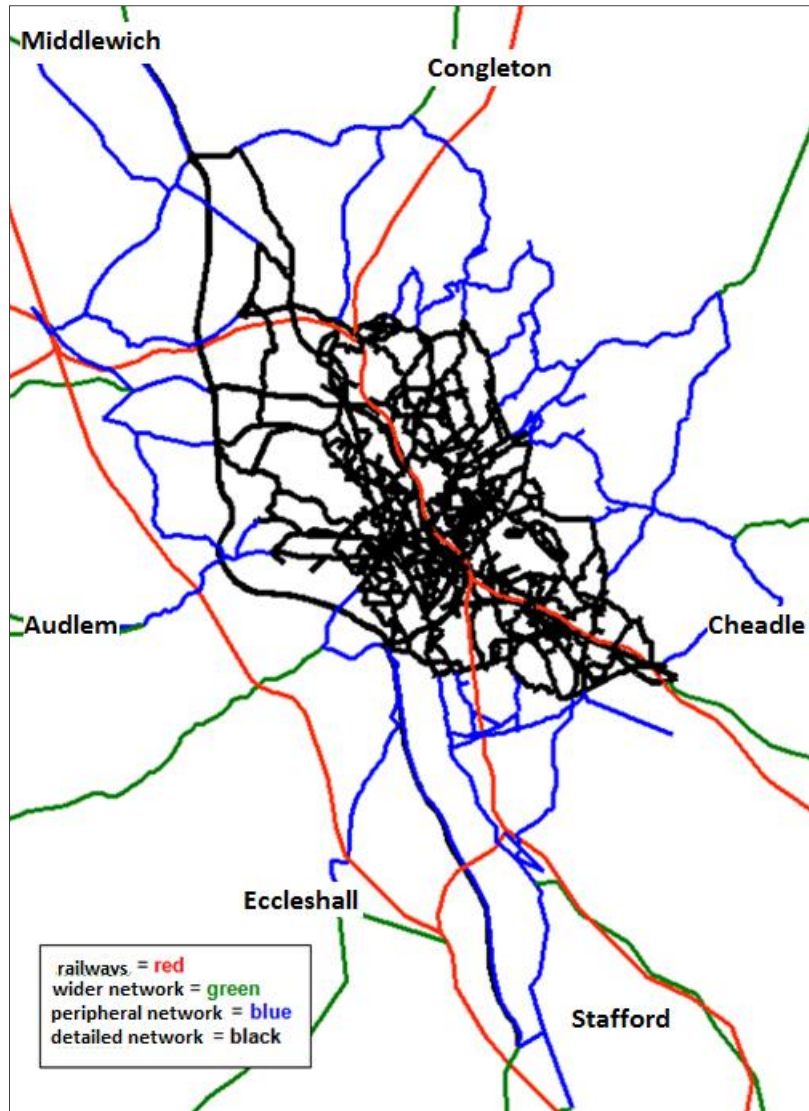


Figure 2-3: Modelled internal road network

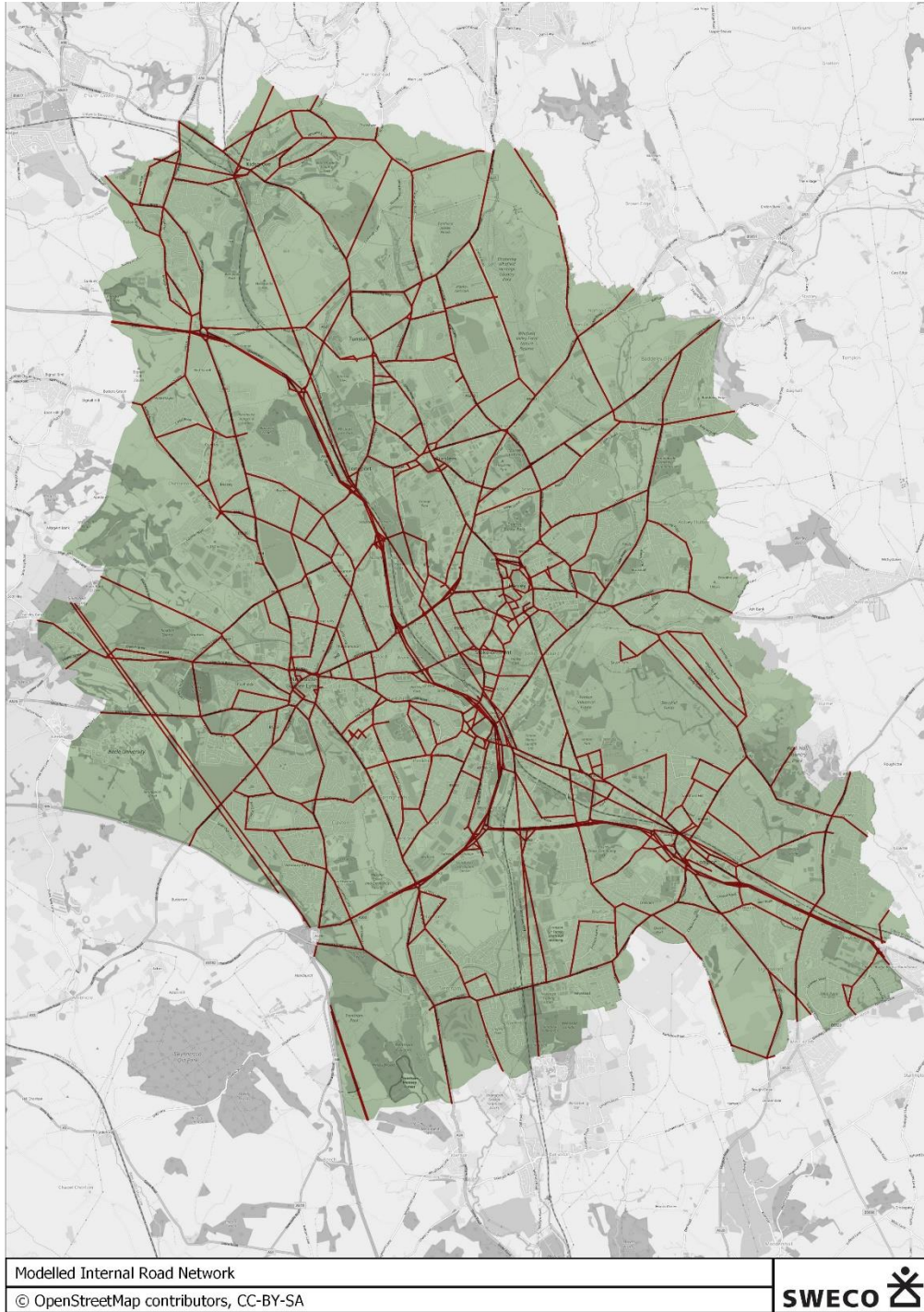


Figure 2-4: Modelled junction

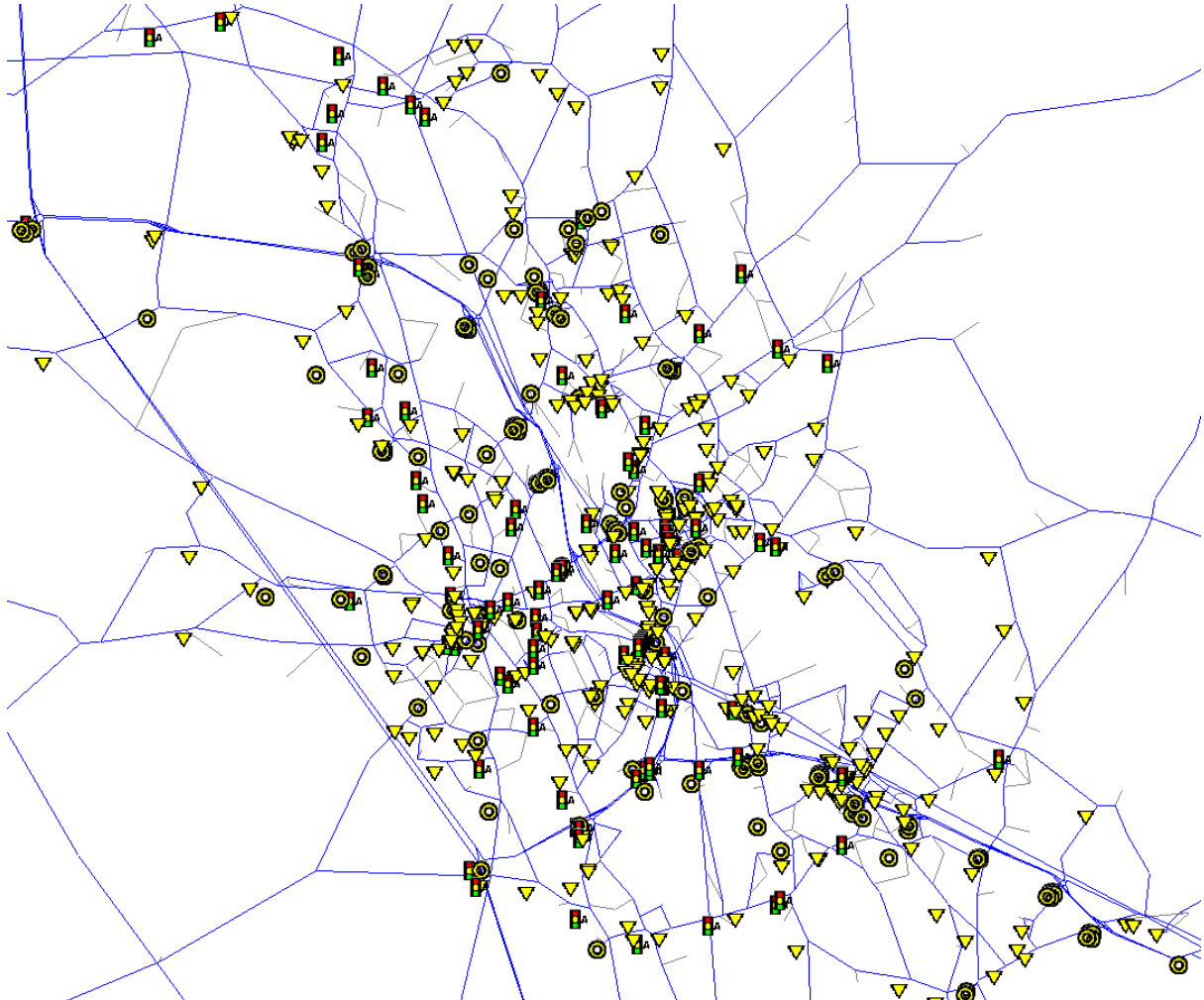


Figure 2-5: Internal transport model zones (north)

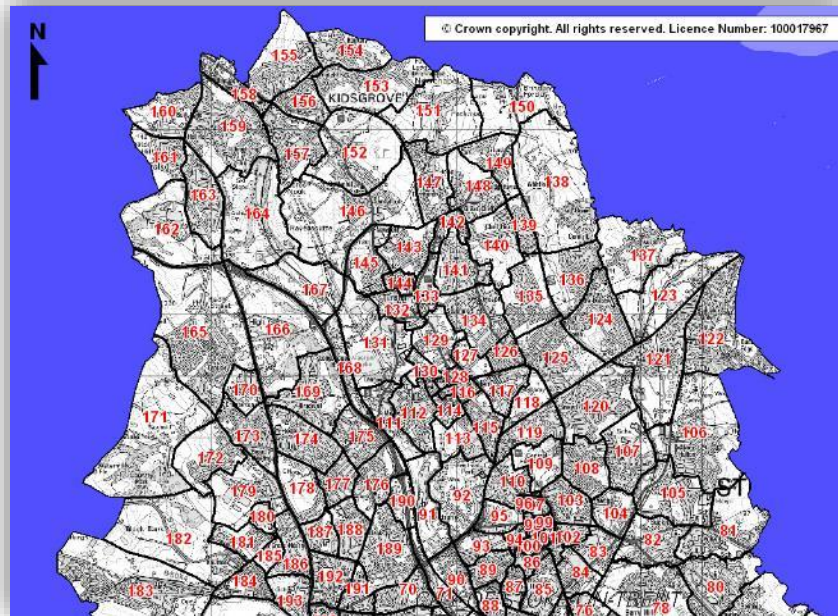


Figure 2-6: Internal transport model zones (south)

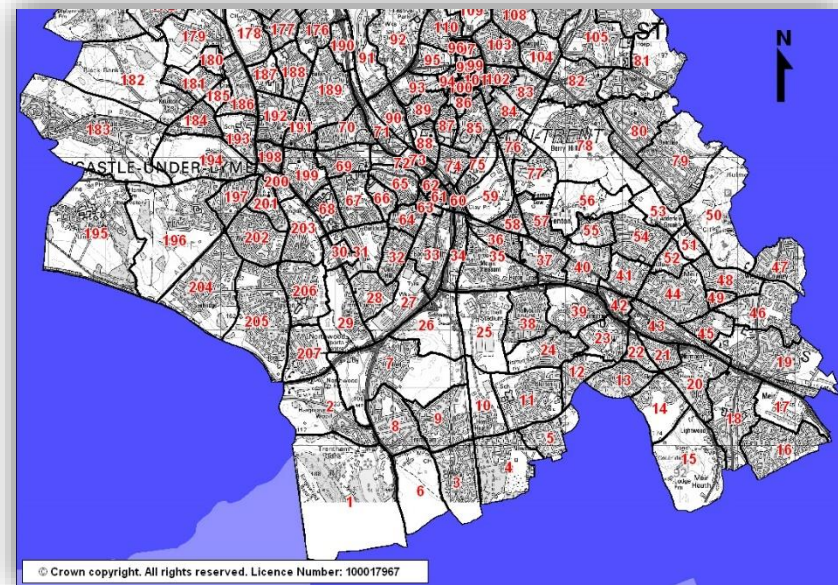


Figure 2-7: Internal transport model zones (central area)

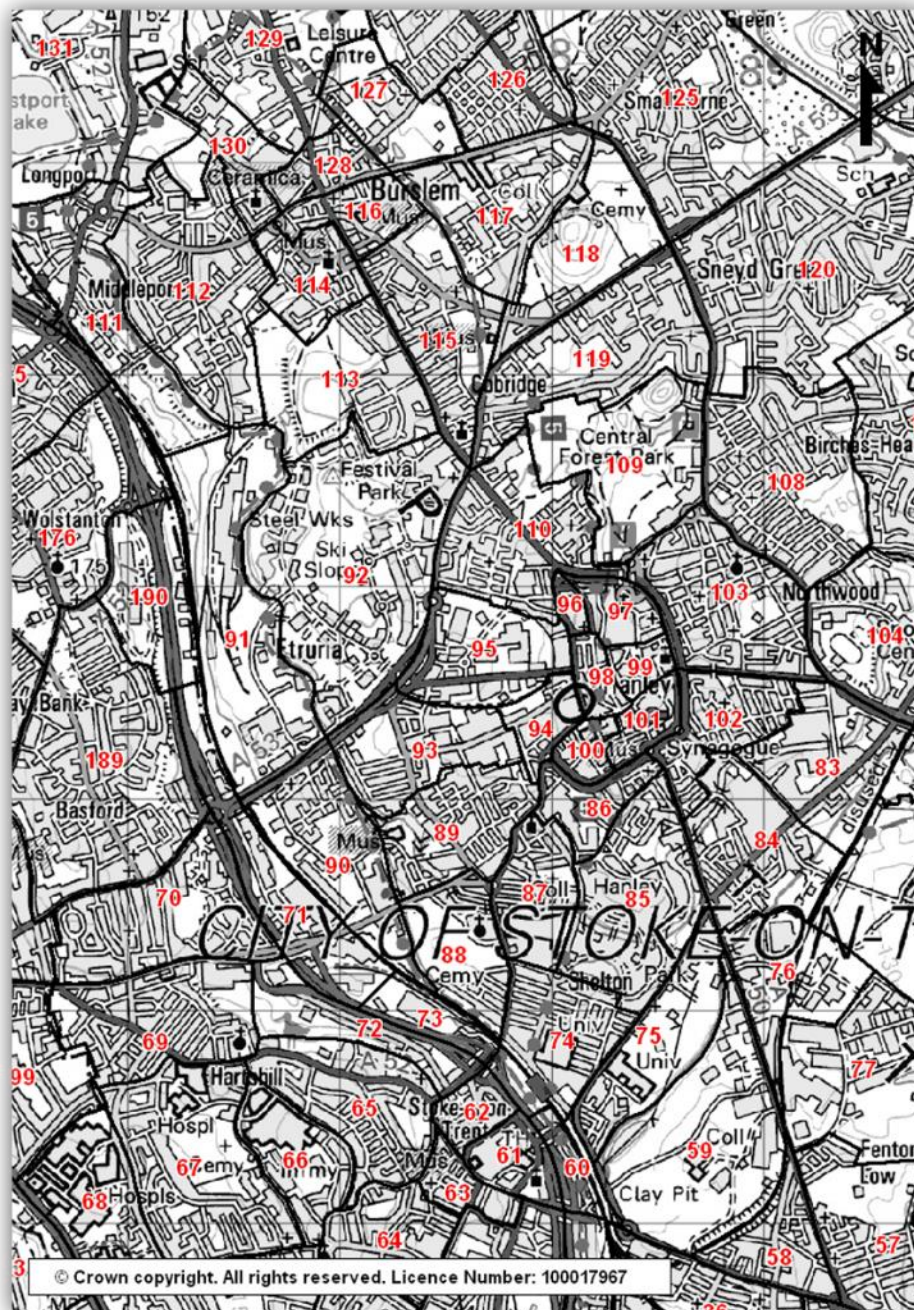


Figure 2-8: Peripheral transport model zones

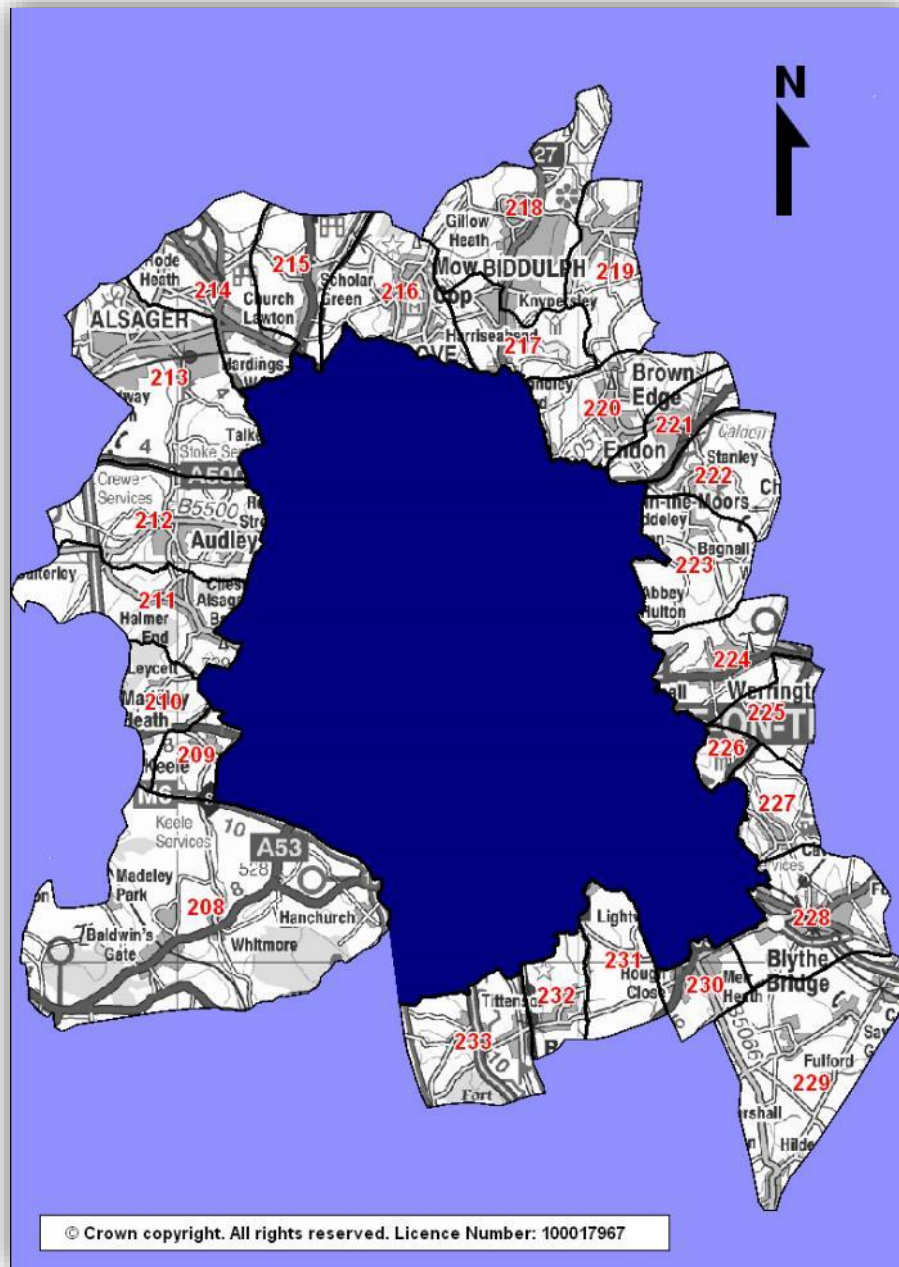


Figure 2-9: Regional transport model zones

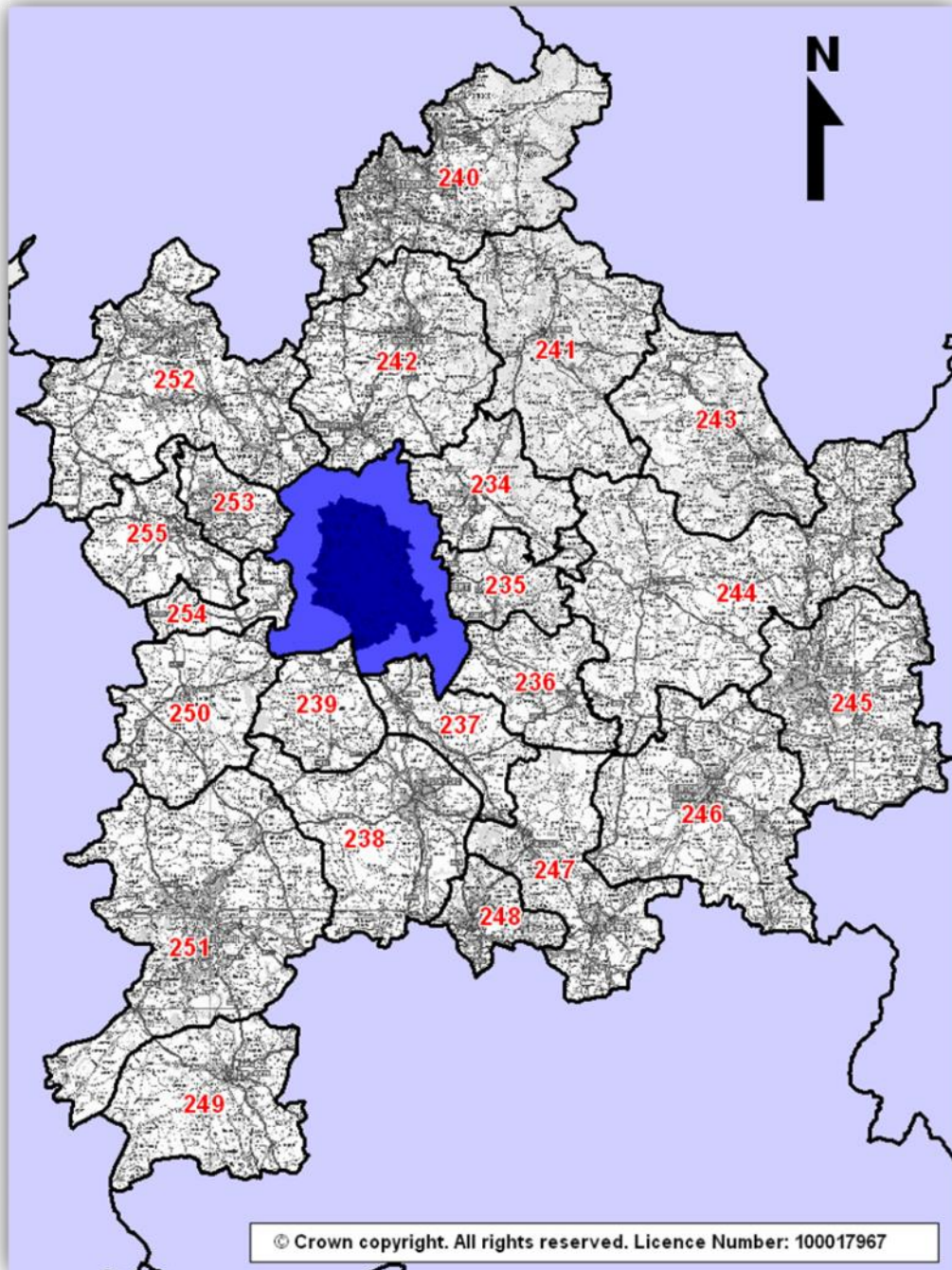


Figure 2-10: National transport model zones

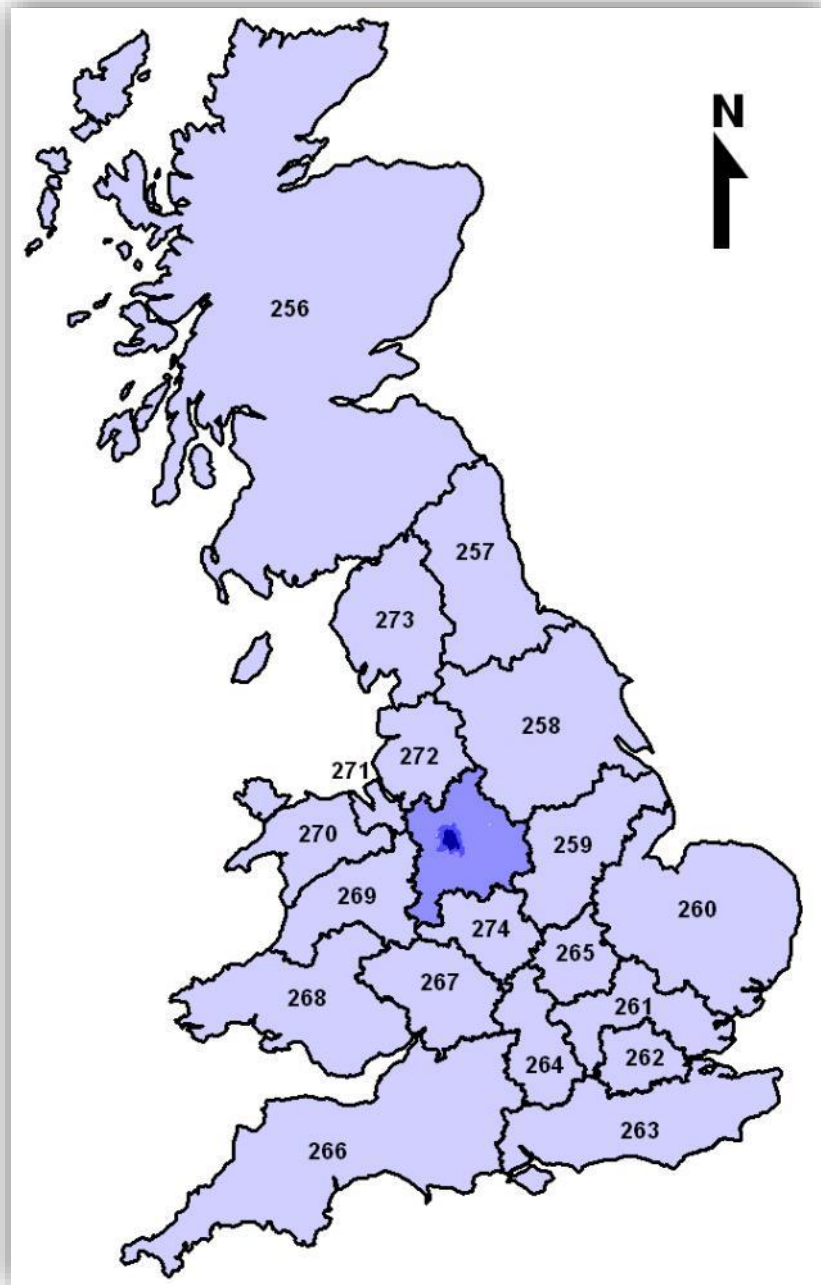
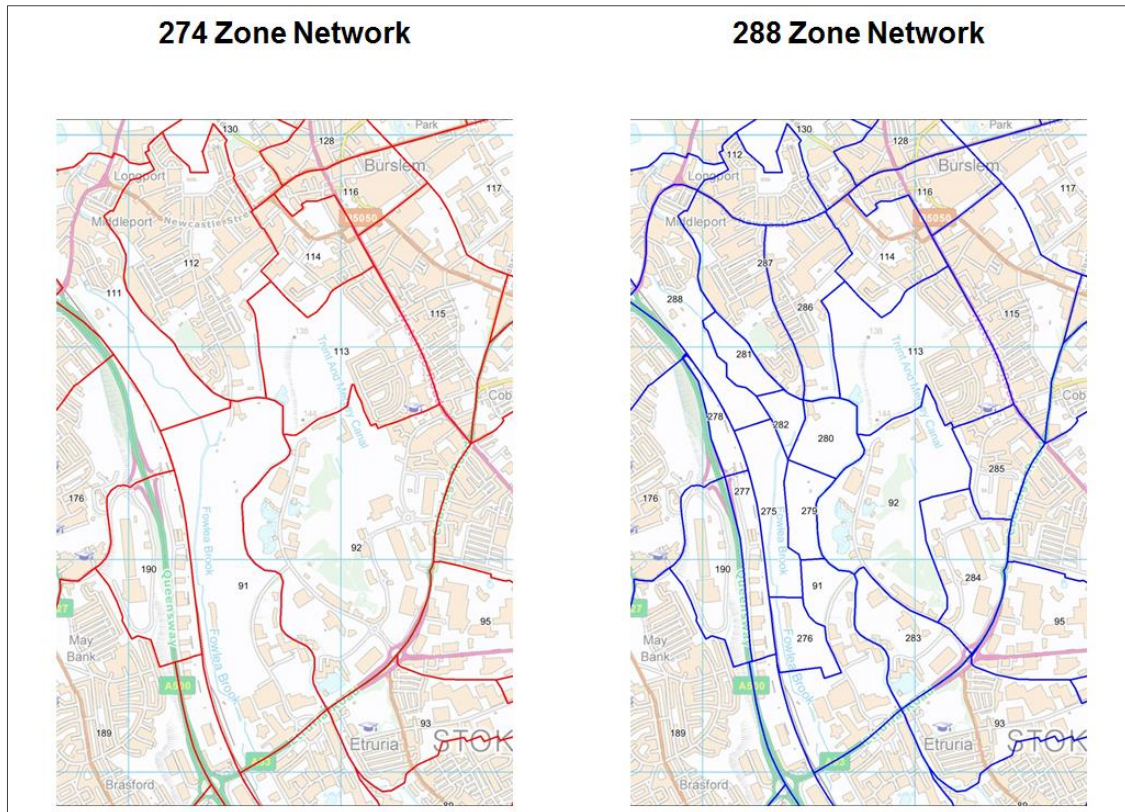


Figure 2-11: Disaggregation of internal transport model zones (central area)



2.5 Model Base Year

The NSMM transport model has a base year of 2015. As part of the refinement and update to the modelled trip matrices a review of the traffic growth between 2015 and 2018 was undertaken to determine if the model needed to be rebased to 2018.

Table 2-1 shows that the traffic growth on a screenline to the east of the A500 between 2015 and 2018 was either negative or marginal. Figure 2-12 shows the location of these counts. Given the lack of traffic growth and the extensive nature of the 2015 base model calibration and validation, as discussed in chapters 3 and 4, it was agreed with JAQU that the model development work would be undertaken on the previously calibrated and validated 2015 model, albeit that model would be disaggregated.

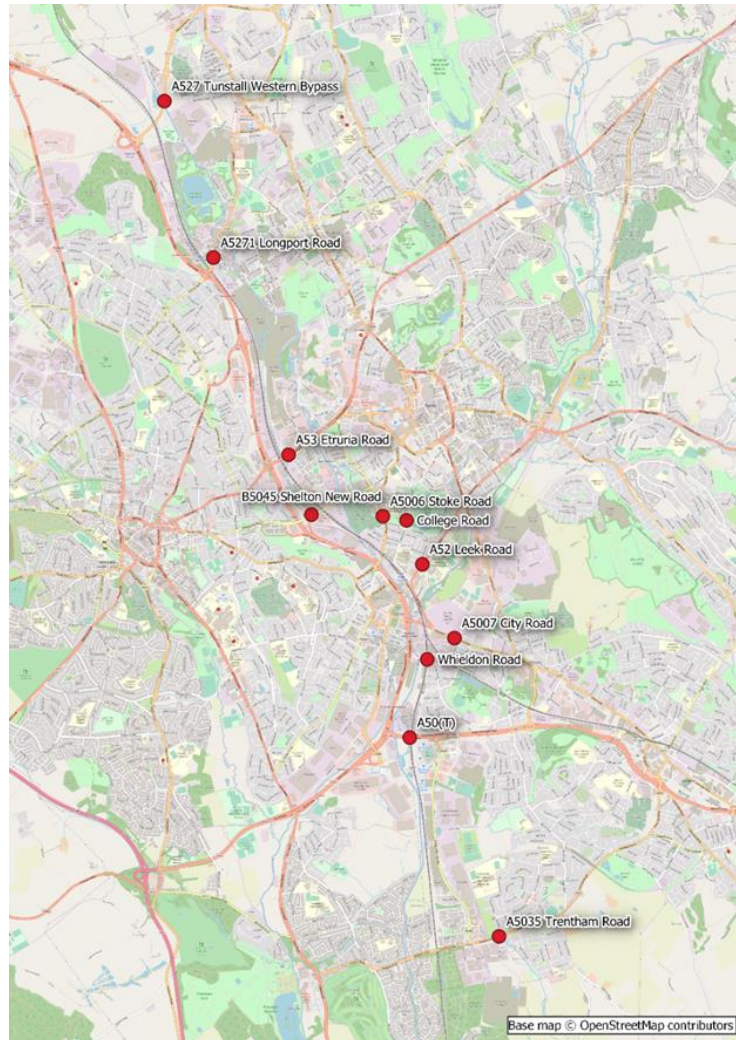
The traffic growth shows that the A50 trunk road has the highest growth in total and for cars, however this is only 4-5% growth between 2015 and 2018 and it is also on the strategic road network which would not form part of the air quality assessment. The A52 Leek Road has the lowest growth between 2015 and 2018 however this is likely to have been affected by roadworks. Leek Road aside, there are no locations that have big changes, total traffic growth between 2015 and 2018 at each location is within +/- 5%.

Table 2-1: Traffic growth between 2015 and 2018

Road	2015 - 2018 Growth				
	Cars	LGVs	HGVs	Buses	Total
A527 Tunstall Western Bypass	1.006	1.078	1.306	1.178	1.027
A5271 Longport Road	0.976	1.071	0.919	0.514	0.983
A53 Etruria Road	1.032	1.064	0.947	0.79	1.032
B5045 Shelton New Road	1.015	0.974	1.093	0.99	1.012
A5006 Stoke Road	0.957	0.897	1.27	1.432	0.956
College Road	1.005	1.141	0.629	0.64	0.981
A52 Leek Road*	0.624	0.557	0.822	0.487	0.617
A5007 City Road	0.947	1.134	0.908	0.769	0.964
Whieldon Road	1.029	0.833	0.583	0.667	0.982
A50(T)	1.046	1.117	0.929	1.204	1.041
A5035 Trentham Road	0.934	1.063	0.823	1	0.946
Total	0.99	1.051	0.953	0.785	0.994

* 2018 observed traffic flows affected by long-term major roadworks

Figure 2-12: Location of 2015 / 2018 traffic counts



3 Travel demand calibration and sensitivity tests (T2a)

This section details the variable demand model and its update to enable the modelling of a charging Clean Air Zone (CAZ). It also covers the segmentation of vehicle type matrices by CAZ compliance status using ANPR survey data.

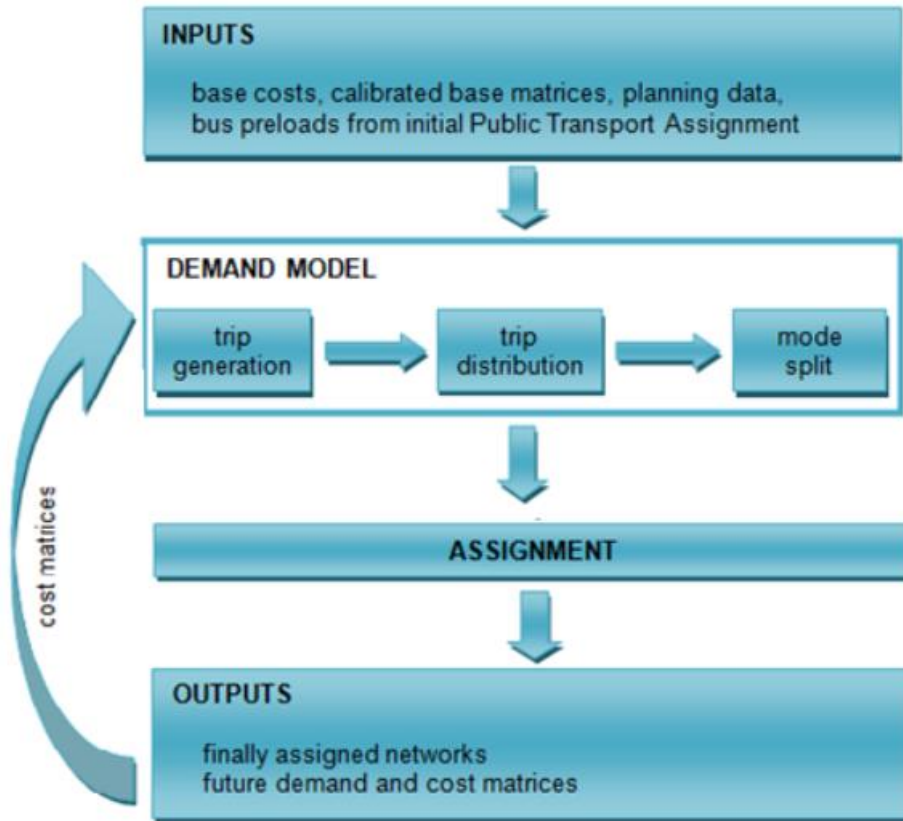
The NSMM demand model was recently calibrated as part of the EVLR Project in line with TAG unit M2 including appropriate realism testing. The demand model forecasts change in trip patterns in terms of trip generation, distribution and mode split due to changes to the highway network, public transport service provision and changes to planning data.

It is acknowledged that given the Stated Preference (SP) surveys were only undertaken in early September 2019, further work will be required to refine the demand model for option testing which will be detailed in due course, the approach is also outlined in the T3 report.

3.1 Form of the NSMM demand model

The demand model has the same spatial, geographic and temporal extent as the assignment model as outlined in sections 2.3 and 2.4 of this report. The basic structure of the NSMM demand model is shown diagrammatically in Figure 3-1. It is an absolute model applied incrementally in that the absolute change between the base and future synthetic trip matrices are added to the calibrated base assignment trip matrices. Any resultant negatives, following the addition of the absolute change to the calibrated base trip matrices are redistributed at sector level. This is as described in section 4.3.6 of TAG unit M2 – Variable Demand Modelling.

Figure 3-1: Demand model structure



3.2 Model segmentation

In order to produce a robust demand model, calculations at each stage are undertaken separately for each of the demand segments. ‘Segmentation’ is the division of travel, traveller and transport attributes into different categories so that all travellers in the same category can be treated in the same way. This segmentation assists the estimation of how much and what type of demand each zone produces or attracts and also reflects the different variation in responsiveness to changes in travel costs and conditions by traveller type.

At the trip generation stage, home based person trips are segmented into:

- Six socio-economic groupings (HH1 to HH6), see Table 3-1.
- Three car ownership categories (0, 1, 2 or more)
- Four trip purposes:
 - Home-based work (HBW)
 - Home-based education (HBE)
 - Home-based shopping (HBS)
 - Home-based other (HBO)

This gives a total of 72 home-based demand segments.

Non-home-based trips are divided into two segments:

- Non-home-based employer’s business (NHBEB)
- Non-home-based other (NHBO)

Goods vehicle trips are divided into two segments:

- LGV trips (all purposes)
- HGV trips (all purposes)

The demand segmentation is largely derived from surveyed demand data. The six socio-economic groupings shown in Table 3-1 are based on the percentage of economic households within each Output Area using 2011 Census data. The information will be used to derive an approximation of household income for each socio-economic grouping which can be used to segment demand for modelling different charging schemes. This will be undertaken once the SP survey work is complete and this report will be appropriately updated.

Table 3-1: NSMM transport model socio-economic groupings

Category	Household Size	No. Employed People
1	1	0
2	>1	0
3	1-2	1
4	3+	1
5	1-3	2+
6	4+	2+

3.3 Trip generation

The trip generation stage determines the number of trips that are being generated by and attracted to each zone in the transport model. This process is undertaken slightly differently for home based and non-home based person trips and for non-home based goods vehicle trips.

3.3.1 Home-Based person trips

Trip rates were derived from 2009 household interview surveys and roadside interviews. They have subsequently been reviewed and benchmarked against home-based trip rates from TRICS, resulting in the application of the home-based production trip rates detailed in Table 3-2 to the forecast changes in the number of households. Note the rates below are just applied to the changes in future households not the total number of future households. The same approach is applied for all future land use change.

Table 3-3 shows the target attraction rates which are used to calculate the home-based purpose splits in order to correct the trip attractions. To calculate productions and attractions for home-based trips the demand model uses the following planning data:

- Residential units (split by the 6 socio-economic categories)
- Number of jobs
- Number of school places
- Retail GFA

Table 3-2: Target household production trip rates by time period

Land Use	AM Peak-Hour	Inter-Peak Hour	PM Peak-Hour
Household (per house)	0.72	0.414	0.621

Table 3-3: Target attraction trip rates by time period

Land Use	AM Peak-Hour	Inter-Peak Hour	PM Peak-Hour
Employment (per job)	0.31	0.09	0.28
Primary School (per school place)	0.688	0.053	0.133
Secondary School (per school place)	0.298	0.306	0.034
College / University (per school place)	0.136	0.066	0.08
Food Superstore (GFA)	0.06032	0.13985	0.14824
Shopping Centre – Local Shops (GFA)	0.14888	0.17531	0.20459
Non-food Retail (GFA)	0.0066	0.07734	0.04583
Mixed Shopping Malls (GFA)	0.01428	0.04836	0.01785

The demand model calculates the number of home-based productions in each zone by multiplying the household information by an appropriate trip rate for each of the 72 home-based

demand segments. For the forecast change in households these are then factored to the target household trip rates outlined in Table 3-2.

Target home-based attractions for the forecast change in other land uses are calculated using the trip rates in Table 3-3. The resulting target home-based attractions are then solely used to inform the home-based production split by purpose. This therefore ensures that the total attractions match the total productions.

3.3.2 Non-Home-Based person trips

Non-home-based trips occur between employment, education, shopping and other locations. Roadside interview and public transport interview data have been used to derive origin and destination person trip rates for employment, education, shopping and leisure. Origin and destination person trip ends for non-home based activity are calculated by multiplying the planning data by these rates. 'Employer's business' trips are assumed to occur between employment locations while other trips may occur between any combinations of locations. In each modelled peak-hour the proportion of trips made on employer's business is given by the survey data and this is used to split the work-based trips into 'employer's business' trips and other trips. Both origins and destinations are factored to match their average total.

Non-home-based business trip ends are derived through multiplying the number of jobs by the non-home based business trip rate. The non-home-based other trips are derived by multiplying jobs, school places, retail gross floor area and leisure site gross floor area by the equivalent non-home-based trip rate and adding these together.

3.3.3 Non-Home-Based goods vehicle trips

All good vehicle trips are calculated using origin and destination rates calculated from roadside interview data. The origin and destination trip end values calculated are factored to match the average total.

3.4 **Trip distribution**

The trip distribution process takes the factored trip ends produced by the trip generation process and decides how to distribute movements to and from each zone across all of the zones. This is done automatically using CUBE Voyager's gravity model functionality. The inputs to this process are the trip ends, cost matrices and friction and K-factors.

3.4.1 Derivation of composite costs

For person trips by private transport the initial composite cost matrix is produced as follows:

1. Private transport cost skims (in minutes) are taken from the appropriate calibrated model run
2. For home-based trips these matrices are partially transposed
3. Parking charges are converted to costs in minutes
4. Three separate values of time based on the TAG Databook are calculated for the following trip purposes:
 - Home-based work trips
 - Home-based education, shopping and other and non-home based other
 - Non-home-based employer's business
1. Production (or origin for non-home based) end walk times are added on as are attraction (or destination) end search and walk times and parking costs in minutes. To

be comparable with public transport fares the parking costs used are half of the anticipated actual parking costs

2. Intra-zonal costs are set to the lowest inter-zonal cost multiplied by 0.5

After the first run through of the demand model the input cost matrices used are those calculated from the integral assignment.

For person trips by public transport the initial composite cost matrix is produced in a similar fashion as follows:

1. Public transport total trip time (walk time + ride time), wait time and fare cost skims are taken from the appropriate model run
2. All time-based costs are summed to a single total
3. For home-based trips time and cost matrices are partially transposed
4. Fares are converted to costs in minutes
5. As previously, three separate values of time are used:
 - o Home-based work trips
 - o Home-based education, shopping and other and non-home based other
 - o Non-home-based – employer’s business
1. Fares (in minutes) are added to the time-based costs to give a total time-based cost
2. Intra-zonal costs are set to the lowest inter-zonal cost multiplied by 0.5

Again, after the first run through of the demand model the input cost matrices used are those calculated from the integral assignment.

For goods vehicles the process is simpler as they are assumed not to experience complications caused by a requirement to park at a distance from their destination and there is no mode choice and therefore no requirement for calculation of the composite cost. Separate productions and attractions are derived for LGVs and HGVs and they are distributed separately through the distribution model to produce separate LGV and HGV trip matrices. The goods vehicle cost matrices are calculated as follows:

1. Goods vehicle cost skims (in minutes) are taken from the appropriate model run
2. The mean values of the LGV and HGV cost skims are taken separately
3. Intra-zonal costs are set to the lowest inter-zonal cost multiplied by 0.5

It should be noted that the demand model excludes any cost damping.

Home-based shopping and home-based other are singly constrained gravity models at the production end, whilst home-based work, education, non-home-based, and goods vehicle trips are doubly constrained at both the production and attraction ends.

3.4.2 Friction factors

Friction factors are used to indicate how popular low-cost trips are in comparison to high cost trips. In this case a logit model has been used such that, at the most basic level, the friction factor is given by the exponential function $\exp(-\beta c_{ij})$. However, in practice even the most

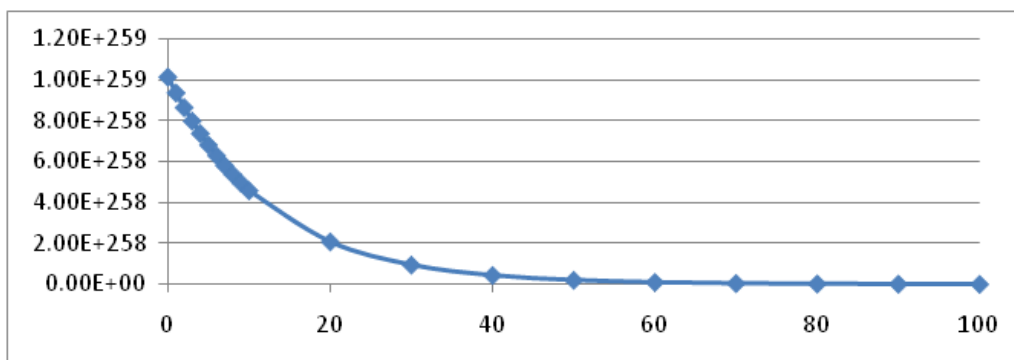
homogenous trip purposes include a range of behaviour types. An illustration of this is that while most trips to work will follow a standard distribution curve some people have journeys to work which are governed by the home location requirements of their families and so travel much further than is typical. This means that values of β which give a good result for the shorter sections of the trip length distribution are unable to match the longer sections. For this reason, the precise form of the friction factor equation used is:

$$\text{Friction Factor} = Ae^{-\beta_{AC}} + Be^{-\beta_{BC}} + Ce^{-\beta_{CC}}$$

The overall friction factor values are not important: it is only the relative values at different costs which are significant and so the values of A, B and C are chosen such that the widest possible range of costs have finite friction factor values. For this reason A is always equal to 1×10^{259} , this being the largest factor which can be accommodated by the software. The values of B and C are always at least an order of magnitude lower and so the greatest part of the friction factor curve comes from the first term.

The general form of a typical friction factor curve is shown in Figure 3-2.

Figure 3-2: Typical friction factor curve



3.4.3 K-Factors

The use of K-factors is generally advised against and in this case, they are all set to 1.

3.4.4 Calibration

The trip distribution model is calibrated by adjusting the β values and constants used in the friction factor equation to calculate the friction factor curves.

In order to produce an overall total number of trips which is correct following distribution then blanking global correction factors are also applied. In most cases these are close to 1. The β values and constants found to give the best match to the observed trip length distributions in each modelled peak hour are given in Table 3-4 to Table 3-6.

Table 3-4: AM peak-hour β values and constants

Demand Segment	A	β_A	B	β_B	C	β_C	Global Factor
HBW	$1x10^{259}$	0.08	$1x10^{257}$	0.03	$3x10^{255}$	0.010	1.49
HBE	$1x10^{259}$	0.06	$5x10^{255}$	0.02	$5x10^{255}$	0.010	1.40
HBS	$1x10^{259}$	0.80	$1x10^{256}$	0.08	$4x10^{253}$	0.020	0.81
HBO	$1x10^{259}$	0.30	$3x10^{257}$	0.06	$1x10^{255}$	0.020	0.90
NHB	$1x10^{259}$	0.60	$1x10^{257}$	0.08	$7x10^{254}$	0.020	0.73
LGV	$1x10^{259}$	0.30	$5x10^{257}$	0.06	$1x10^{257}$	0.030	1.06
HGV	$1x10^{259}$	0.30	$6x10^{257}$	0.05	$2x10^{255}$	0.010	1.10

Table 3-5: Inter-Peak hour β values and constants

Demand Segment	A	β_A	B	β_B	C	β_C	Global Factor
HBW	$1x10^{259}$	0.10	$1x10^{258}$	0.06	$1x10^{256}$	0.015	2.26
HBE	$1x10^{259}$	0.20	0	0.02	0	0.010	3.17
HBS	$1x10^{259}$	0.70	$1x10^{256}$	0.06	$4x10^{253}$	0.015	0.99
HBO	$1x10^{259}$	0.50	$2x10^{256}$	0.06	$4x10^{253}$	0.015	0.88
NHB	$1x10^{259}$	0.10	$2x10^{257}$	0.06	$4x10^{256}$	0.020	1.05
LGV	$1x10^{259}$	0.30	$1x10^{258}$	0.06	$1x10^{256}$	0.019	1.05
HGV	$1x10^{259}$	0.30	$1x10^{258}$	0.06	$1x10^{256}$	0.013	1.14

Table 3-6: PM Peak-hour β values and constants

Demand Segment	A	β_A	B	β_B	C	β_C	Global Factor
HBW	$1x10^{259}$	0.10	$5x10^{258}$	0.06	$2x10^{256}$	0.014	1.43
HBE	$1x10^{259}$	0.20	$3x10^{257}$	0.06	$1x10^{254}$	0.010	2.30
HBS	$1x10^{259}$	0.60	$5x10^{256}$	0.08	$2x10^{254}$	0.020	0.82
HBO	$1x10^{259}$	0.50	$1x10^{257}$	0.08	$2x10^{254}$	0.020	0.90
NHB	$1x10^{259}$	0.60	$5x10^{256}$	0.08	$3x10^{254}$	0.020	0.91
LGV	$1x10^{259}$	0.20	$2x10^{258}$	0.06	$5x10^{256}$	0.020	0.99
HGV	$1x10^{259}$	0.30	$5x10^{257}$	0.06	$7x10^{255}$	0.012	1.13

The trip distribution model for 2009 has been recalibrated as part of the update of the 2015 demand model to improve the level of validation of the car and goods vehicle trip distribution model against 2009 observed data. For this re-calibration of the distribution modelling, the β , A, B and C values have not been altered. Instead the friction factors have been reviewed and adjusted for the 38 generalised cost bands for which they are applied, in order to get a better fit between the output trip length distribution and the observed data.

3.5 Mode choice

The mode choice model splits the person trip matrix into car and public transport trip matrices on the basis of the respective costs of the use of each mode and lambda (or mode split) constants.

The zero car ownership demand segments (HBW0, HBE0, HBS0 and HBO0) are considered captive to public transport and are not included in the mode split model. For the one and two-plus car ownership demand segments CUBE Voyager's XCHOICE logit choice module is used to carry out mode choice on the basis of the input costs and lambda values.

The output car trip matrix is divided by a car occupancy factor to give a vehicle (rather than a person) trip matrix. Trips less than one kilometre by public transport are multiplied by 1/3 and those between one and two kilometres by 2/3 as it is assumed that a high proportion of these trips will actually be made on foot.

The mode choice model is calibrated by adjusting the lambda values used by XCHOICE and the mode constants used in the calculation of the cost matrices. The values found to give the best match to the observed mode splits in each modelled time period are given in Table 3-7.

Table 3-7 Mode split lambda values and constants

Demand Segment	AM Peak Hour		Inter-Peak Hour		PM Peak Hour	
	Lambda	Mode Constant	Lambda	Mode Constant	Lambda	Mode Constant
HBW	0.096	20 (one car) 20 (two+ cars)	0.2	20 (one car) 20 (two+ cars)	0.21	20 (one car) 20 (two+ cars)
HBE	0.096	20 (one car) 20 (two+ cars)	0.12	20 (one car) 20 (two+ cars)	0.42	20 (one car) 20 (two+ cars)
HBS	0.96	30 (one car) 40 (two+ cars)	0.91	26 (one car) 32 (two+ cars)	0.9	26 (one car) 32 (two+ cars)
HBO	0.48	30 (one car) 40 (two+ cars)	0.75	35 (one car) 50 (two+ cars)	0.85	30 (one car) 40 (two+ cars)
NHB	0.96	24	0.2	30	0.9	24

3.6 Demand response to a CAZ

For modelling a charging CAZ, the NSMM transport model will be adapted to ensure it can model all the possible demand responses to trips entering, travelling within or routing through a CAZ. This will include undertaking some sensitivity testing to sense check the reduction in highway demand following the introduction of a charging CAZ is logical as well as checking demand changes when applying different CAZ charges. The demand responses and the methodology for modelling them are outlined in Table 3-8. It should be noted that Table 3-8 does not provide a hierarchy of response but just outlines the different demand responses that will be captured in the updated NSMM transport model. This report will be updated following the SP surveys carried out in early September and the resultant completion of the demand model update.

Table 3-8: CAZ demand responses

Response	Demand Response to CAZ	Methodology
1	Replacing or upgrading vehicle	Choice modelling will be applied using stated preference data to ascertain the likelihood of non-compliant car, taxis, LGV and HGV users that travel through, within or to and from the CAZ to upgrade their vehicle to a compliant one. This choice modelling for non-compliant cars will be undertaken using income segmentation making use of the socio-economic categories which will permit a calculation of the proportion of households in different income categories based on the number of people in employment.
2	Cancelling trip	A multinomial choice model will derive the percentage of non-compliant car demand by income category that cancel their trip for cars, this will also be undertaken for taxis, LGVs and HGVs that travel through, within or to and from the CAZ. These trips will be removed from the final assigned matrices.
3	Change of destination	A multinomial choice model will derive the percentage of non-compliant car demand by income category with a destination in the CAZ (but an origin outside). These trips will then be redistributed to non-CAZ destinations. Goods vehicles will be excluded from this demand response as they don't have a choice to change their destination as their delivery destinations would be fixed irrespective of a CAZ charge.
4	Modal shift	A multinomial choice model will derive the percentage of demand by income category that change mode from the car, for non-compliant car trips that travel through, within or to and from the CAZ. The NSMM transport model does not explicitly model walking and cycling trips, so a percentage reduction in car trips will be needed for related policies.

5	Change route to avoid CAZ	<p>A multiple select link analysis will be undertaken on the 2022 Reference Case at the inbound cordon locations to the CAZ. Non-compliant cars, LGVs and HGVs select link matrices will be filtered to identify through trips only, external to the CAZ.</p> <p>A multinomial choice model for non-compliant cars, LGVs and HGVs will derive the percentage of these through trips that would re-route to avoid the CAZ.</p> <p>The NSMM assignment model will allow for a single cordon CAZ charge affecting trips currently routing through the CAZ and therefore reassigning some through demand onto more attractive (non -charged) routes. This will be represented on the network by having a CAZ charge on a cordon of links forming the charging zone in both directions which will be picked up by the model and allowed for in the generalised cost for the routing assignment. The charge on each charging link will be modally consistent however will be permitted to differ for cars, LGVs and HGVs as appropriate. Sense checks will be undertaken on the level of reassignment. Additional scripting will be required using demand matrices for specific OD movements to capture charges for internal movements only (i.e. within the CAZ charge area), in addition further scripting will be required to avoid anyone being charged more than once.</p>
6	Pay the CAZ charge	<p>Following the above demand responses, the remaining car, taxi, LGV and HGV trips that start or end their journey in the CAZ or go through it will continue to do so (but pay a daily charge). Modelling responsiveness and payment of CAZ charging will use income segmentation derived from the socio-economic groupings.</p>

3.7 Demand model calibration

The NSMM demand model will be further updated and calibrated using regression analysis on the SP survey to update the choice modelling to reflect responses to a charging CAZ. This will be reported in an updated version of this report.

This section therefore centres on the calibration of the existing demand model matrices against observed data. Checks of the 2015 synthetic demand trip matrices have been carried out by comparing the trip length distributions of these matrices with 2009 observed trip matrices derived from roadside interviews. The comparisons have been carried out using the 2009 matrices as these are based on observed data and will therefore accurately reflect actual travel patterns.

Table 3-9 shows the distance class banding used in the comparisons of the trip length distributions for the 2009 observed and 2015 synthetic trip matrices. The match between the observed and synthetic trip length distributions are shown in Figure 3-3 to Figure 3-5 for car and public transport trips for the AM peak hour, IP hour and PM peak hour time periods, respectively. The equivalent information for the LGV trip matrices are shown in Figure 3-6 to Figure 3-8 and for the HGV trip matrices in Figure 3-9 to Figure 3-11.

As can be seen from Figure 3-3 to Figure 3-11, the 2015 synthetic trip length distributions show a very close match with the equivalent observed information for all modes of travel and time periods confirming that the demand matrices have been calibrated to a very good level of accuracy.

Table 3-9: Distance class banding for trip length distribution

Distance Class	Range (km)
1	< 1
2	1 – 2
3	2 – 3
4	3 – 5
5	5 – 10
6	10 – 15
7	15 – 25
8	25 – 35
9	35 – 50
10	50 – 100
11	100 – 200
12	> 200

Figure 3-3: AM peak hour car and public transport trip length distribution comparisons

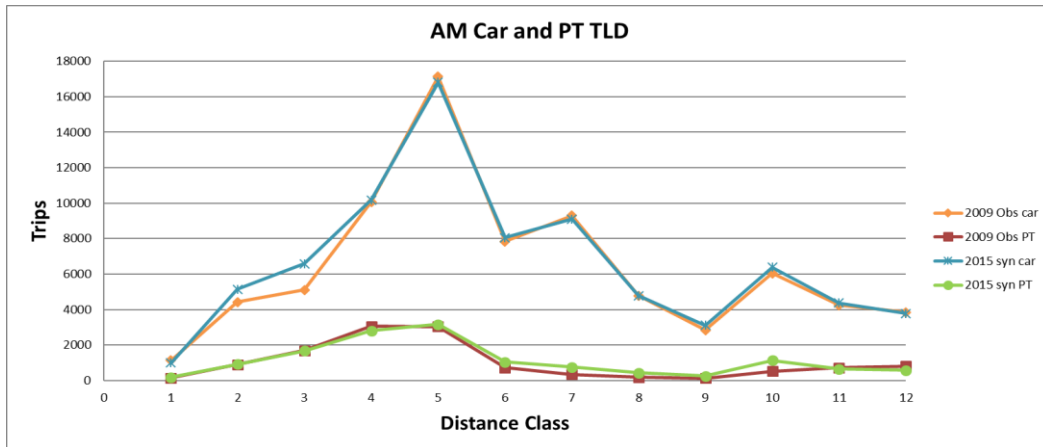


Figure 3-4: IP hour car and public transport trip length distribution comparisons

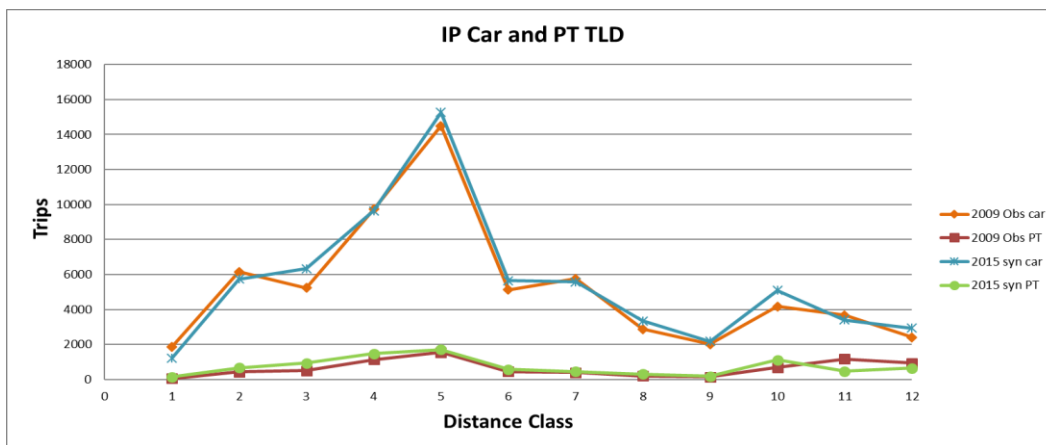


Figure 3-5: PM peak hour car and public transport trip length distribution comparisons

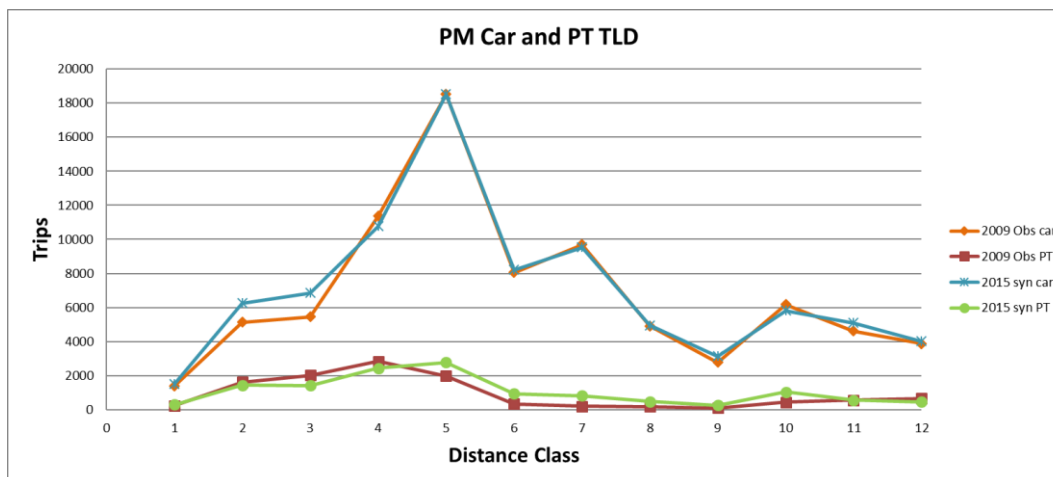


Figure 3-6: AM peak hour LGV trip length distribution comparisons



Figure 3-7: IP hour LGV trip length distribution comparisons

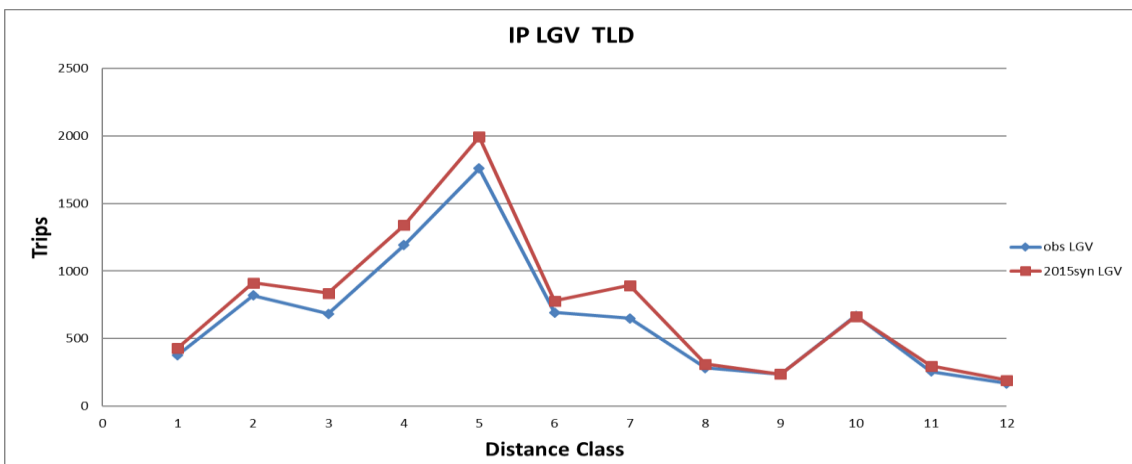


Figure 3-8: PM peak hour LGV trip length distribution comparisons

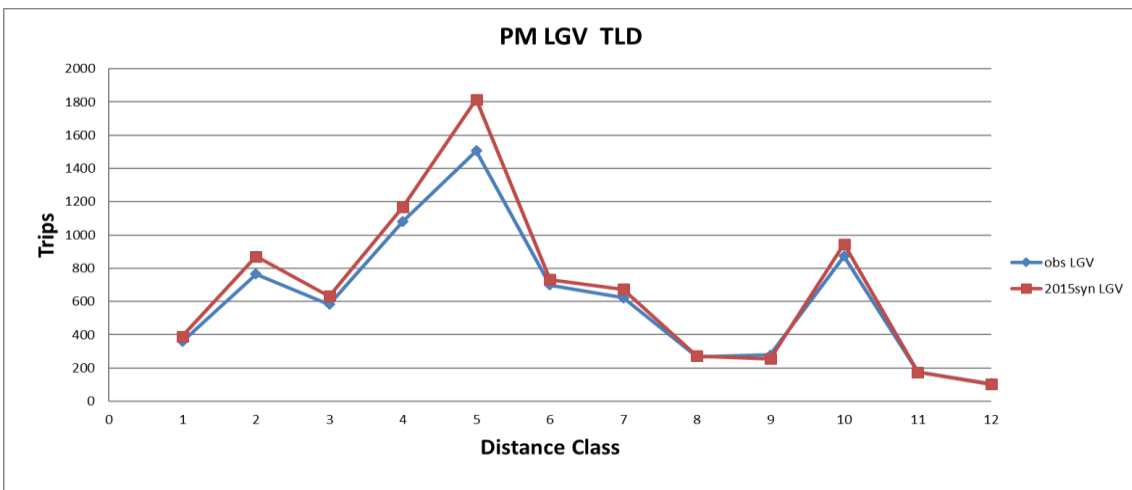


Figure 3-9: AM peak hour HGV trip length distribution comparisons

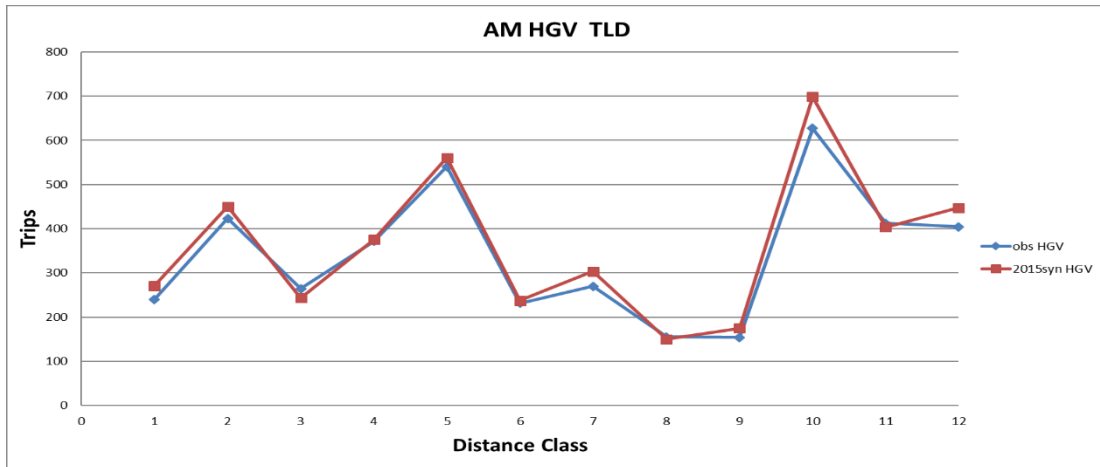


Figure 3-10: IP peak hour HGV trip length distribution comparisons

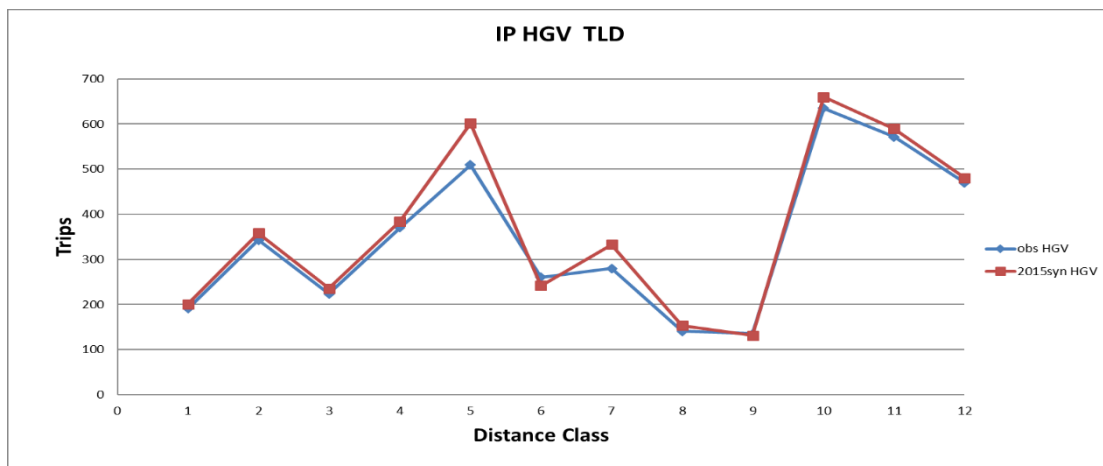
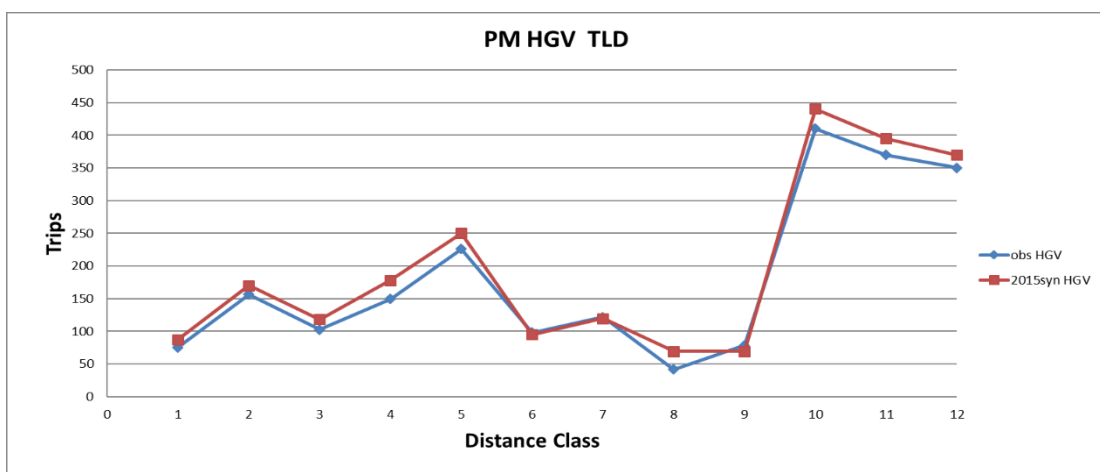


Figure 3-11: PM peak hour HGV trip length distribution comparisons



3.8 Realism testing

It is essential to ensure that a variable demand model behaves ‘realistically’ by changing the various components of travel costs and times and checking that the overall demand response accords with general experience. The acceptability of the demand model’s responses is determined by its demand elasticities. These demand elasticities are calculated by changing a cost or time component by a small global proportionate amount and calculating the proportionate change in travel made.

In line with Section 6.4 of TAG Unit M2 – Variable Demand Modelling, three realism tests have been undertaken for the updated 2015 demand model by calculating its demand elasticities based on applying the following changes in travel costs and times as follows:

- Private transport fuel costs increased by 10% and 20%
- Public transport fares increased by 10% and 20%
- Private transport journey times increased by 10%

The realism tests for private transport fuel costs and public transport fares have been carried out by trip purpose (employer’s business, commuting and other) and by time period (AM peak-hour, Inter-Peak hour, PM peak-hour and 12-hour time period) as well as for all traffic for an annual situation. The realism test for private journey times has been carried out for all traffic for an annual situation.

3.8.1 Calculation of demand elasticities

The modelled AM peak hour, inter-peak hour and PM peak hour demand figures have been converted to 12-hour figures using the following formula:

$$D_{12hr} = F_{AM}D_{AM} + F_{IP}D_{IP} + F_{PM}D_{PM}$$

Where: D_{12hr} , D_{AM} , D_{IP} and D_{PM} refer to the 12-hour, AM peak hour, inter-peak hour and PM peak hour demands, respectively.

The corresponding F values (detailed in Table 3-10) are factors which have been derived from observed traffic count information. A factor of 253 has been applied to the derived 12-hour demand figures to estimate an annual situation.

Table 3-10: 12-hour time period factors

Factor	Correction	Value	
		Private Transport	Public Transport
F_{AM}	Modelled morning peak-hour to 07:00 to 10:00 morning peak	2.605	2.784
F_{IP}	Modelled inter-peak hour to 10:00 to 16:00 inter-peak	5.828	5.861
F_{PM}	Modelled evening peak-hour to 16:00 to 19:00 evening peak	2.696	2.721

The formula used to calculate the model's elasticity is the arc elasticity formation:

$$e = \frac{\log(T^1) - \log(T^0)}{\log(C^1) - \log(C^0)}$$

Where: e = elasticity

T = demand

C = cost

the superscript 0 refers to the base model and 1 to the test model

This can also be expressed as:

$$e = \frac{\log\left(\frac{T^1}{T^0}\right)}{\log\left(\frac{C^1}{C^0}\right)}$$

3.8.2 Private transport fuel costs

Two tests are required for the calculation of private transport fuel cost elasticities; one using matrix-based model outputs and the other using network-based outputs.

3.8.2.1 *Matrix-based outputs*

In order to calculate the private transport fuel cost elasticity for the matrix-based test, the converged synthetic matrices from the test run are compared to the converged synthetic matrices from the base year model and the zonal car kilometre totals compared across all zones.

3.8.2.2 *Network-based outputs*

To calculate the private transport fuel cost elasticity on a network basis then this is carried out on the model outputs pertaining only to the area of the modelled network that has been calibrated and validated using car vehicle kilometres from the output networks before and after the fuel cost change.

3.8.3 Public transport fares

In order to calculate the public transport fare cost elasticity, the converged demand model test is compared to the converged base demand model and the public transport demand compared across the full range of zones using a matrix-based approach.

The demand elasticities calculated for private transport fuel costs and public transport fares by trip purpose and time period using the above approaches and assuming a 10% and 20% increase in costs are detailed in Tables Table 3-11 and Table 3-12, respectively.

Table 3-11: Demand elasticities for private transport fuel costs and public transport fares (10% increase in costs)

Trip Purpose	Time Period	Private Transport Fuel Costs		Public Transport Fares
		Matrix Based	Network Based	
Employer's Business	AM	-0.18	-0.12	-1.26
	IP	-0.24	-0.21	-0.83
	PM	-0.27	-0.21	-1.49
	12-hour	-0.24	-0.19	-1.00
Commuting	AM	-0.21	-0.13	-0.20
	IP	-0.29	-0.18	-0.15
	PM	-0.31	-0.17	-0.22
	12-hour	-0.27	-0.16	-0.19
Other	AM	-0.18	-0.11	-0.13
	IP	-0.18	-0.15	-0.12
	PM	-0.36	-0.20	-0.16
	12-hour	-0.21	-0.15	-0.13
All	Annual	-0.23	-0.14	-0.18
Recommended Annual Average Elasticity Ranges (TAG Unit M2)		-0.25 to -0.35	-0.25 to -0.35	-0.2 to -0.9

Table 3-12: Demand elasticities for private transport fuel costs and public transport fares (20% increase in costs)

Trip Purpose	Time Period	Private Transport Fuel Costs		Public Transport Fares
		Matrix Based	Network Based	
Employer's Business	AM	-0.17	-0.13	-1.79
	IP	-0.27	-0.30	-0.92
	PM	-0.30	-0.29	-0.60
	12-hour	-0.26	-0.27	-0.99
Commuting	AM	-0.26	-0.21	-0.20
	IP	-0.31	-0.28	-0.15
	PM	-0.30	-0.23	-0.18
	12-hour	-0.29	-0.24	-0.18
Other	AM	-0.23	-0.18	-0.10
	IP	-0.28	-0.27	-0.12
	PM	-0.41	-0.29	-0.11
	12-hour	-0.30	-0.26	-0.11
All	Annual	-0.28	-0.24	-0.17
Recommended Annual Average Elasticity Ranges (TAG Unit M2)		-0.25 to -0.35	-0.25 to -0.35	-0.2 to -0.9

As can be seen from Table 3-11, for the 10% increase in private transport fuel costs the elasticities are generally lower than the recommended annual average elasticity range of -0.25 to -0.35 for the majority of trip purposes and time periods for both the matrix and network based approaches. The elasticity of -0.23 for the annual demand for all trip purposes using the matrix-based approach is marginally outside the accepted range and the value of -0.14 using the network-based approach is significantly outside the accepted range. However, these weaker values of fuel cost elasticities can readily be attributed to the significant number of shorter car trip lengths in the North Staffordshire conurbation due to its polycentric nature.

Similarly, for the 10% increase in public transport fares the elasticities do not fall within the recommended annual average elasticity range of -0.2 to -0.9 for the majority of trip purposes and time periods. The elasticity of -0.18 for the annual demand for all trip purposes is also marginally outside the accepted range.

As can be seen from Table 3-12, for the 20% increase in private transport fuel costs the elasticities are generally within the recommended annual average elasticity range of -0.25 to -0.35 for the majority of trip purposes and time periods for both the matrix and network-based approaches. The elasticity of -0.28 for the annual demand for all trip purposes using the matrix-based approach is within the accepted range and the value of -0.24 using the network-based approach is only marginally outside the accepted range. However, as previously discussed this slightly weaker value of fuel cost elasticity can readily be attributed to the significant number of shorter car trip lengths in the North Staffordshire conurbation.

For the 20% increase in public transport fares the elasticities still do not fall within the recommended annual average elasticity range of -0.2 to -0.9 for the majority of trip purposes and time periods. The elasticity of -0.17 for the annual demand for all purposes is also still marginally outside the accepted range. However, it should be noted that the elasticity for the annual demand is within the short-term elasticities reported in Table 6.1 of TAG Unit M2 where a low value of -0.16 is reported for a 1 year range. Furthermore, the elasticities are also logical when comparing peak period elasticities with inter-peak period values, with the latter generally being lower as per the guidance.

It should also be noted that the demand model parameters have been estimated from local data collected from public transport and household interviews as recommended by TAG. Concessionary fares are not excluded which will likely have a significant impact. The public transport and car trip length distributions and mode splits of the demand model have also been calibrated and validated against observed data to a very good level of accuracy. Therefore, since the demand model is based on local data rather than using imported model parameters then it is not appropriate to make adjustments to the parameters or values of time to ensure that the model satisfies the expected elasticities for each mode.

3.8.4 Private transport journey times

To calculate the private transport journey time cost elasticity a single run of the demand model test is compared to the converged base demand model and the private transport demand compared across the full range of zones.

Assuming a 10% increase in private transport journey times, this gives an elasticity of -0.16 for an annual situation which is compatible with the requirements of TAG that it be less elastic than -2.0.

3.9 **Sensitivity tests**

As stated in section 6.6 of TAG Unit M2 – Variable Demand Modelling, sensitivity testing, as distinct from realism testing, is aimed at identifying the relative impact of altering key demand

model parameters on the outcome of a scheme appraisal. It is important to understand how sensitive the appraisal results are to these uncertainties so that confidence can be invested in the conclusions.

It is therefore proposed that as part of the appraisal of the project that appropriate sensitivity tests will be undertaken as part of scheme forecasting and appraisal including changes in values of time and different economic growth forecasts.

3.10 Segmentation by vehicle type and CAZ compliance status

In order to provide the necessary euro vehicle classifications and associated vehicle compliance splits Automatic Number Plate Recognition (ANPR) data was collected. ANPR surveys were carried out at 15 locations across North Staffordshire, as agreed with JAQU (see Figure 3-12).

The ANPR data was collected by Nationwide Data Collection (NDC) and processed by DEFRA. The surveys were conducted over a 7-day period between the 2nd and 8th of April 2019 and between 00:00 and 24:00 each day. April was chosen as it is a neutral survey month. The survey utilised mast-based high definition (HD) ANPR cameras supplied by MAV Systems Ltd with infra-red illumination to give excellent quality image capture both day and night. After collection, accuracy checks were carried out before the data was passed to Defra for further processing.

From the processed data, the vehicle types were split into multiple categories which were then collated into five vehicle types, namely:

- Car
- Light Goods Vehicle (LGV)
- Heavy Goods Vehicle (HGV)
- Taxis
- Bus and coach

The propulsion type was also defined and then refined into three categories:

- Petrol, Petrol Gas and Gas
- Diesel, Gas Diesel
- Electric, Gas Bi-Fuel, Hybrid, Electric Diesel, New Fuel Technology

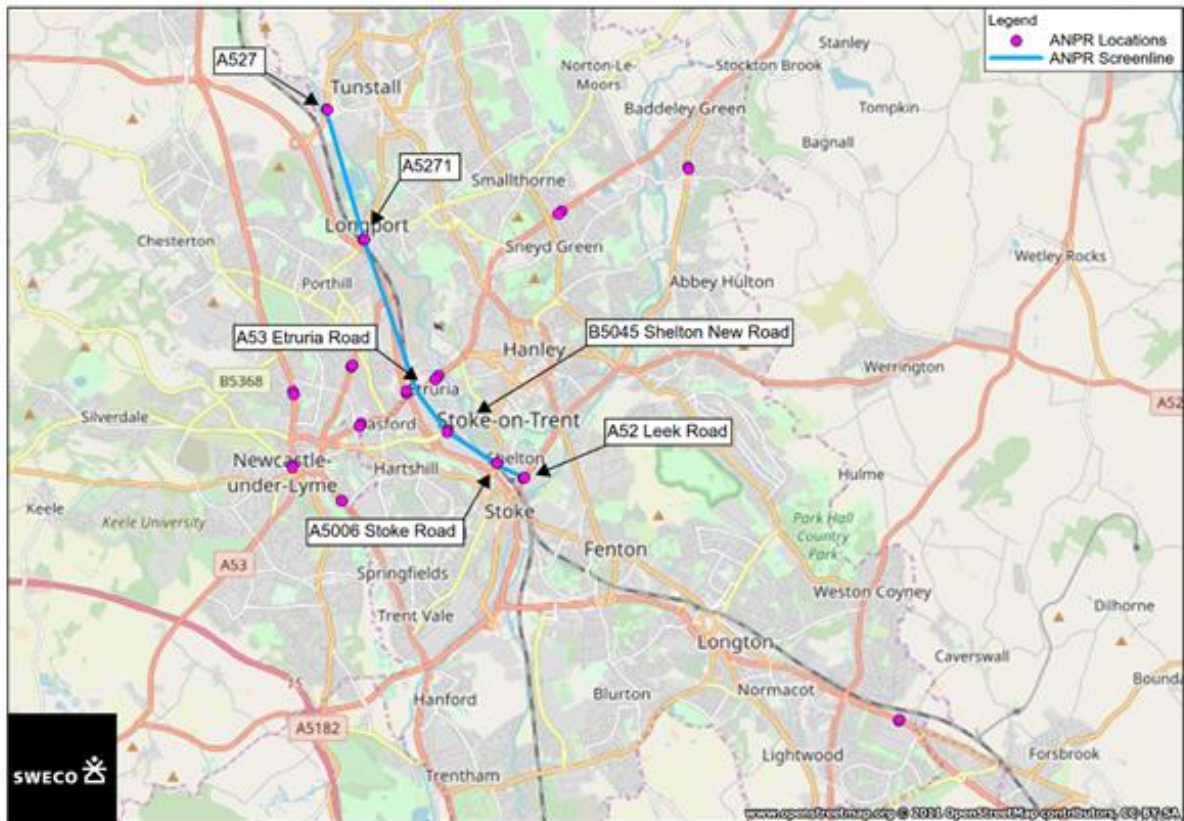
The collected ANPR data and information from the DVLA database has been used to identify different compliance types by fuel type and Euro Standard for emissions. This information was processed to determine the compliancy split by vehicle type to segment the NSMM transport model trip matrices into the following demand segments:

- Car compliant
- Car non-compliant
- LGV compliant
- LGV non-compliant
- HGV compliant
- HGV non-compliant

- Taxi compliant
- Taxi non-compliant

A screenline was used to determine the compliance splits, as it avoids double counting vehicles which might pass through multiple ANPR locations. Six sites to the east of the A500 were formed to construct a screenline, as shown in Figure 3-12, to ensure a robust and comprehensive sample of traffic movements are intercepted.

Figure 3-12 ANPR screenline data collection locations



The taxi compliance percentage split could not be derived from the ANPR surveys. Therefore, the percentage split was derived from licence data provided by NuLBC. This percentage split was then applied to the ANPR taxi count to identify the number of compliant taxi vehicles.

The resulting compliance splits are shown in Table 3-13 based on processed data for Monday to Thursday to be commensurate with the NSMM transport model modelled weekday.

Table 3-13 ANPR compliance splits (2019)

Car		HGV		LGV		Taxi		Bus/Coach	
Comp	Non-comp	Comp	Non-comp	Comp	Non-comp	Comp	Non-comp	Comp	Non-comp
61%	39%	63%	38%	30%	70%	18%	82%	19%	81%

4 Traffic assignment model validation (T2b)

4.1 Overview

This Section compares observed and modelled traffic flows at a screenline and link level, presents the results of the validation of modelled journey times, compares observed and modelled vehicle compliance splits and details the convergence of the highway assignment model.

It is important to understand the development of the NSMM model from its original build in 2009 to its update in 2015 as part of the modelling work for EVLR, sections 4.2 and 4.3 describe the network and matrix development.

4.2 Network development

This section provides a brief summary of the NSMM transport model network development.

The modelled highway network is defined by a series of link types which are defined on the basis of the following link characteristics:

- Location (detailed, peripheral or wider network and position in relation to central business districts)
- Road quality (good, typical, poor)
- Road width (wider than usual)
- Number of lanes
- Number of bus lanes
- Speed limit
- Allowed modes (i.e. bus only or not)
- Level of development
- Being a slip road

Road quality is primarily based on road class with adjustments for roads which are of an unusually good or poor quality for their class. Roads are classified as wide along stretches which have central pedestrian refuges or ghost islands.

Each individual link type has an associated speed flow curve. Link types 1 to 5 include railways, station access links, connectors and links in the wider network and all use fixed speeds.

All other link types vary speed according to link flow. These curves are based on COBA 11 curves and all take the following form down to a defined minimum speed, V_{\min} :

$$\text{below } Q = Q_b \text{ then } V = V_{\max} - QS$$

$$\text{above } Q = Q_b \text{ then } V = V_b - (Q - Q_b)S_b$$

- $V = \text{speed on link in kph}$

- V_{max} = free flow speed on link in kph
- V_b = speed on link in kph at break point
- Q = flow on link in vehicles
- Q_b = flow on link in vehicles at break point
- S = slope of curve below break point
- S_b = slope of curve above break point

Slip roads are constructed to allow vehicles to gain or lose speed before joining or after leaving a high-speed link. As a general rule these are constructed to the same standard and have the same speed limit as the high-speed links, they join but it is necessarily the case that vehicles maintain lower average speeds while on them than is the case for the high speed links themselves. To correct for this speed on slip roads are further corrected by multiplying by a factor of 0.6 (down to V_{min}).

Within Cube Voyager it is not possible to code speed flow curves in this way and the following (essentially identical) format has been used.

$$V = \text{MAX} \left[V_{\min}, \frac{V_{\max} - QS - \text{MAX}(Q - Q_b, 0)(S_b - S)}{\text{MAX}\left(1, \frac{S^p}{0.6}\right)} \right]$$

- $S^p = 1$ for slip roads, 0 otherwise
- Q = flow on link in vehicles (weighted sum of all iterations up to the current one)

In the peripheral network where junctions are not modelled the curves are tailed down to a comparatively low value for V_{min} . In the detailed network the curves are not tailed.

The following four types of junctions are explicitly modelled in the detailed network of the NSMM transport model:

- Priority Junctions
- Signals (Adaptive signals)
- Roundabouts (Empirical coding)
- Merges

Standard ‘give-way’ and ‘stop’ controlled priority junctions are modelled using Cube Voyager’s “Priority/Two-Way Yield Controlled, Saturation Flows” option. This function uses a standard linear relationship to determine delay, based on the saturation of conflicting movements. The function requires information on the layout of the junction and turn saturation flow (per lane). Saturation flows are calculated using the PICADY formulae as shown in Table 4-1. For priority junctions, it is considered that vehicles are able to enter any flare lane faster than they can leave it and so any flare lanes present can be treated as though they are a full additional lane.

Signalised junctions were modelled using Cube Voyager’s “Adaptive Signal, Saturation Flows” option which required information on junction geometry, phasing, minimum and maximum green times and saturation flows. This option optimises the signal settings at each junction to minimise delay for the modelled traffic flows using the junction. This replicates the behaviour of “real-world” signal controllers and produces representative levels of delay. The capacity of a signalised junction is affected by “flare lanes” which effectively provide an additional lane of capacity for a short period at the start of each green signal until they are discharged. Calculation of the capacity provided by the flare is therefore quite complicated and is dependent on the length of the flare, the cycle time of the signals, the length of the relevant signal stage and the number of vehicles making the relevant turning movement. Most of these parameters are likely to change between, and even during model assignments, but the junction modelling requires a fixed value for a saturation flow.

For longer flares (greater than 50m) at signalised junctions it has been assumed that the flare operates as effectively as a full additional lane and is modelled as such (see Table 3-1). Shorter flares will only provide additional capacity for a short time during each signal cycle and so the additional capacity will be lower. In order to model this effect, the short flare lanes were not explicitly coded as a separate lane in the junction layout. However, to approximate the effect on capacity of the flare the saturation flow of the flaring lane was adjusted as shown in Table 4-1.

Table 4-1: Saturation flows for priority and signalised junctions

Junction Type	Turn	Saturation Flow
Priority / Give-way	Minor arm left	$745(1 + 0.094(w - 3.65))$
	Minor arm, ahead and right	$627(1 + 0.094(w - 3.65))$
	Major arm right	$745(1 + 0.094(w - 3.65))$
	Major arm left and ahead	As signals
Signals	From nearside lanes to all destinations (including flare lanes >50m in length)	$\frac{2080 - 140 - 42g + 100(w - 3.25)}{1 + 1.5/r} + FLA$ <i>g = gradient (%)</i> <i>w = lane width (m)</i> <i>r = turning radius (m)</i>
	From offside lanes to all destinations (including flare lanes >50m in length)	$\frac{2080 - 42g + 100(w - 3.25)}{1 + 1.5/r} + FLA$ <i>g = gradient (%)</i> <i>w = lane width (m)</i> <i>r = turning radius (m)</i>
	Adjustment for flare lanes <50m in length	$FLA = 8l/N$ <i>l = flare length (m)</i> <i>N = number of turning movements from lane</i>
A 5% slope was assumed for significant gradients		

Small roundabouts with no more than four arms which do not have significant U-turn movements are modelled using Cube Voyager’s “Roundabout/Merge, Empirical” option. This function uses the standard equations developed by TRL and which are used in ARCADY and

other standard transport modelling software packages. Roundabouts are coded using the geometry of entry width, approach width, flare length, inscribed diameter, entry radius and entry angle for each approach arm. The same process is also used for large “exploded” roundabouts but the parameters for the circulating arm are set so that minimal delays are calculated.

For nodes representing merges, the methodology specified by COBA 11 is used to calculate delays. This specifies that the delay on both the main and merging arms of merges (in seconds per vehicle) is equal to $227(\text{CapacityRatio} - 0.75)$, with CapacityRatio being the total approach flow divided by the capacity of the downstream link (which is taken as 1900 multiplied by the number of lanes). As this methodology is not available within Cube Voyager these delays are calculated within a separate script and applied on the link downstream of the merge. In practice a value in minutes is required and when flows are low the value of $(\text{CapacityRatio} - 0.75)$ can drop below zero resulting in a negative delay. Within the model the delay is therefore calculated as:

$$d = \text{MAX} \left(\frac{1}{60}, \frac{227(\text{CapacityRatio} - 0.75)}{60} \right)$$

4.2.1 Public transport

The model contains local bus services and rail services. Long distance coach services are excluded due to the low levels of service. Bus service routes, stopping patterns and frequencies are based on published timetables. Overall route run times are corrected to the full route run time as taken from the published timetables. Two wait curves are used in the model, namely; for initial and transfer waits. For initial waits (where users board their first bus or train) there is a minimum wait of 0.5 minutes. For services with headways between 1 and 20 minutes it is assumed that the user has no knowledge of the timetable and the wait is taken as half the headway. For less frequently running services it is assumed that the user has knowledge of the timetable and will only wait for 10 minutes. For transfers it is assumed that waits will be half the headway for headways of 1 to 60 minutes with a minimum wait of 0.5 minutes and a maximum wait of 30 minutes.

Bus fares are based on a simplified distance-based fare derived on the basis of the main operator and whether it is peak or off peak. Rail fares are derived in a similar way.

4.3 **Matrix development**

The NSMM transport model was originally developed in 2009. The 2009 observed trip matrices were derived from roadside interviews and traffic counts, with the resultant prior observed matrices being matrix estimated.

The 2009 NSMM base-year highway model has successfully been calibrated and validated in accordance with WebTAG. It represents the following vehicle classes:

- Car
- LGV
- HGV

Further details on the development of the 2009 base-year trip matrices are provided in the NSMM Model Calibration and Validation Report (SKM Colin Buchanan, March 2011).

Following liaison with the Department for Transport (DfT), it was agreed to develop the updated 2015 transport model using the existing forecast models. This required two runs of the demand model:

- 1) A 2009 run (identical to the calibrated version of the model) with the refined 288 zones (i.e. taking account of the disaggregation of the model zones in the Etruria Valley and Middleport areas)
- 2) A 2015 run with the latest planning data and transport network changes

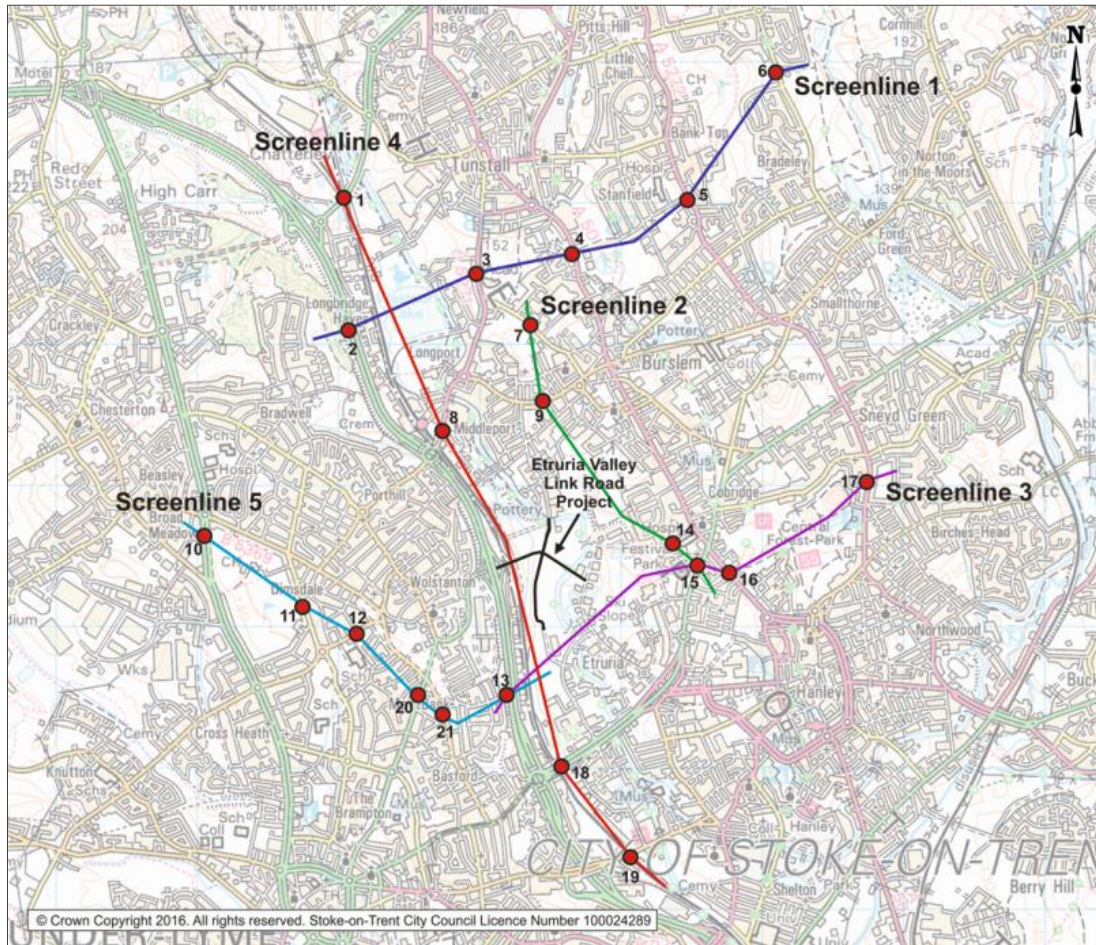
As the model is incremental, the change in the demand between scenarios (1) and (2) above was constrained to NTEM traffic forecasts and was additively applied to the 2009 assigned base-year trip matrices to produce updated 2015 trip matrices for each of the modelled time periods.

As part of the modelling work undertaken for EVLR, a Present Year Validation (PYV) was carried out of the updated 2015 NSMM transport model based on the 'forecast' 2015 trip matrices. The results of the PYV showed that an unacceptable level of fit was achieved between the modelled traffic flow and journey time data when compared with the corresponding observed data.

In order to improve the validation of the 2015 NSMM transport model, and as recommended by DfT, a calibration exercise was undertaken through the application of screenline factoring to the derived 2015 trip matrices using the five calibration screenlines shown in Figure 4-1. The screenline factoring was undertaken separately for cars, LGVs and HGVs, for each modelled time period and was applied by direction. This factoring was only undertaken once.

For the modelling work undertaken for air quality local plan, the 2015 EVLR modelling was used as a starting point. The 2015 matrices were segmented by vehicle type and CAZ compliant status, using ANPR data, as outlined in section 4.9. As agreed with JAQU, there was not time to undertake a full data collection exercise of new traffic count data for this work, nor to update and fully recalibrate and validate a 2018 model, given the timeframes of the ministerial direction.

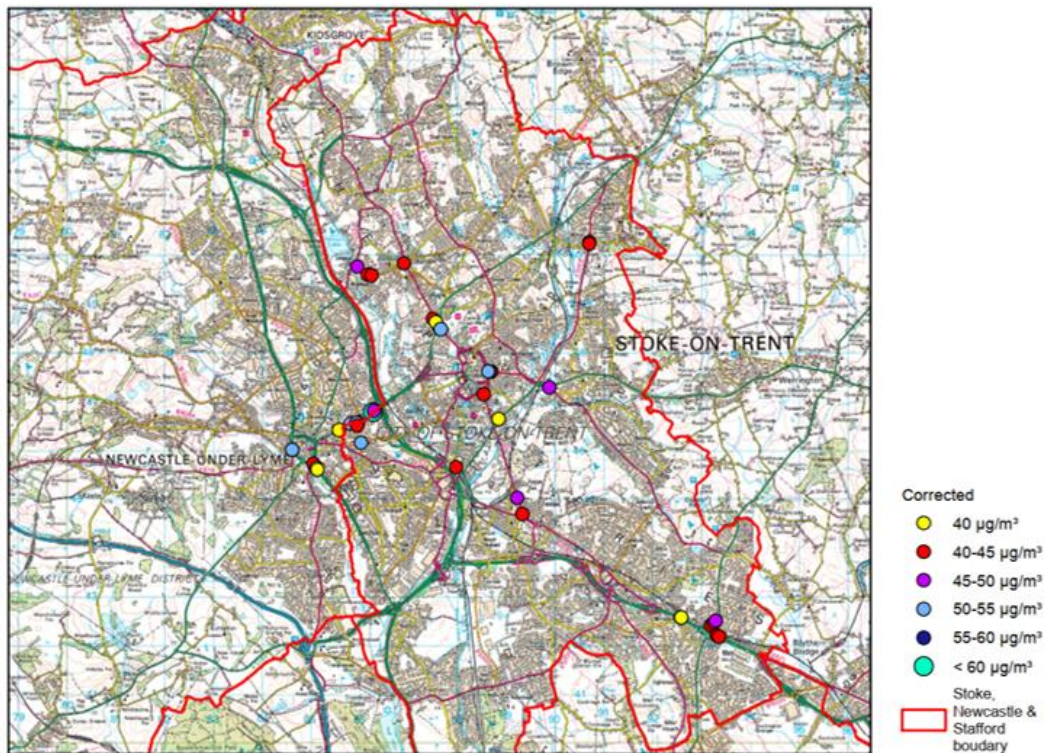
Figure 4-1: EVLR modelling calibration screenlines used for screenline factoring



4.4 Model validation

The model validation work for the air quality local plan centres on key local roads in the North Staffordshire conurbation including those links in exceedance of the annual average NO₂ limit value in 2017 based on the monitored locations shown in Figure 4-2. Further comparisons will be undertaken at the exceedance locations identified from the 2022 air quality modelling work.

Figure 4-2 Locations of monitored NO_2 exceedances in 2017 (SoTCC)



4.5 Observed traffic counts

Figure 4-3 shows the locations of the observed link counts and screenlines used to validate the NSMM transport model. In total there are 156 link counts for the AM, 141 for the PM and 156 for the inter-peak modelled periods. Four lots of bi-directional screenlines and a cordon have been formed from some of the counts, namely:

- Northbound/Southbound Screenline (to the north of Hanley City Centre and Newcastle-under-Lyme Town Centre)
- Eastbound/Westbound (to the east of the A500)
- West of A500 Screenline (to the east of the A500)
- East of A50 Screenline (Along the A50 from Tunstall towards Hanley)
- Cordon (around the North Staffordshire conurbation)

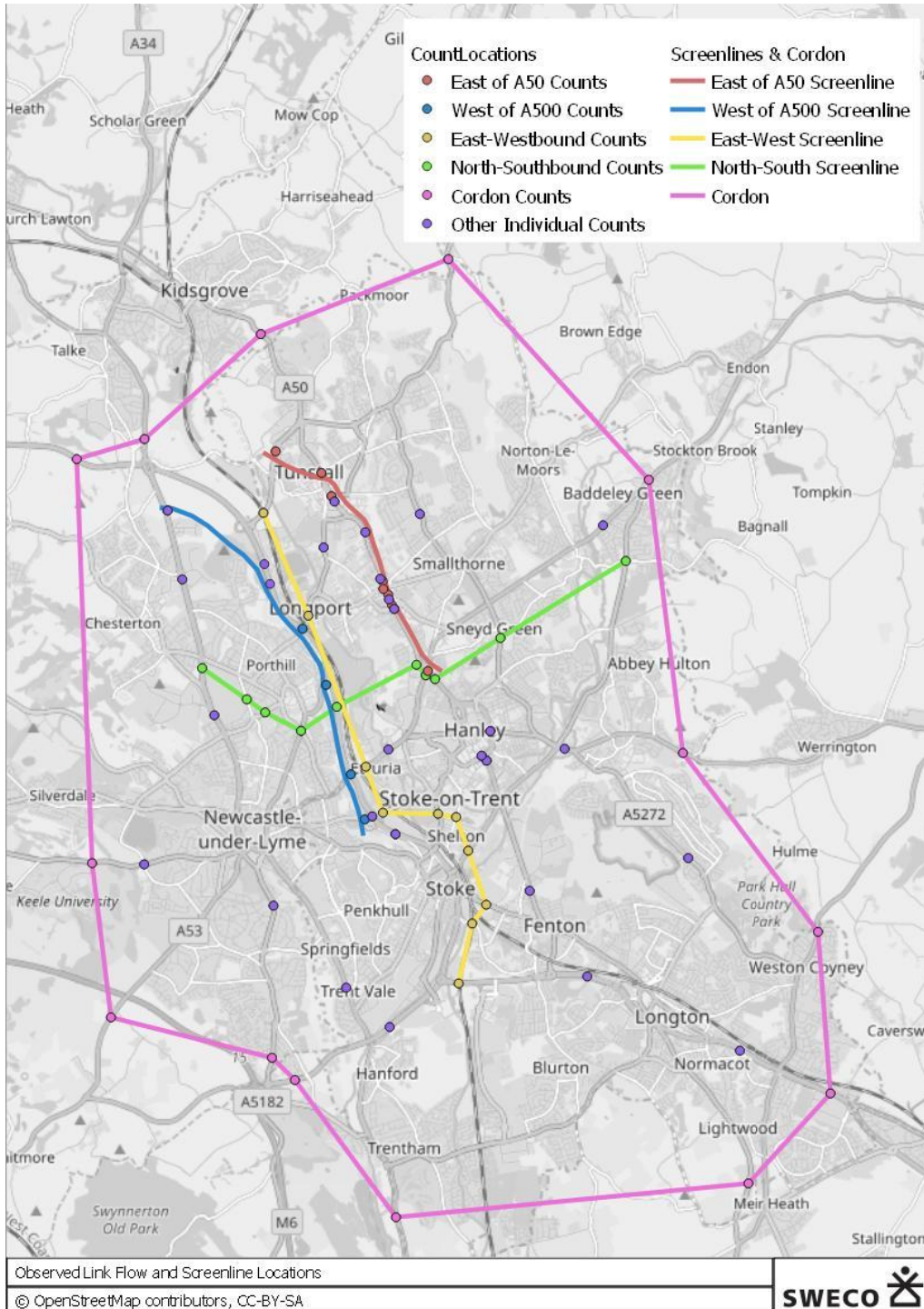
It should be noted that the cordon is not watertight but it does however capture the key roads into the conurbation.

The observed traffic counts are generally from 2015 and are formed from a range of sources, namely:

- Passing counts from data.gov.uk
- Staffordshire County Council turning counts
- Stoke-on-Trent City Council manual and automatic passing counts
- Sky High passing and turning counts

As detailed in Section 3.5, there has been no traffic growth between 2015 and 2018, hence the use of the 2015 NSMM model as a starting point for this work to inform the development of a 2018 base year air quality model.

Figure 4-3: Observed link flow and screenline locations



4.6 Screenline validation

The modelled screenline flows have been calibrated against the two criteria documented in the Design Manual for Roads and Bridges (DMRB) Volume 12, Section 2, Part 1, Chapter 4, Table 4.2 with the target that all (or nearly all) of the screenlines should pass these criteria. The first criterion relates to the modelled flow across the screenline being within 5% of the observed value. The second criterion is based on the GEH statistic which should have a value of less than 4 to pass the test.

The GEH statistic is defined by the formula:

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

- *M = the modelled flow*
- *C = the observed flow*

Table 4-2 to Table 4-4 show the performance of the model for individual vehicles and total vehicles for each screenline in the AM peak-hour, Inter-Peak hour and PM peak-hour, respectively. The total modelled flows pass screenline criteria of being within 5% of the observed for 60% of screenlines in the AM peak-hour, 70% of screenlines in the Inter-Peak hour and 60% of the screenlines in the PM peak-hour.

In the AM peak hour the model is slightly over estimating northbound total vehicles across the North- South screenline and overestimating eastbound total vehicles across the East-West screenline. The opposite directions however provide a good match between total modelled and observed flows.

The inter-peak hour and PM peak hour show a good match between modelled and observed total vehicles, with screenline validation criteria only very narrowly outside the 5% or GEH 4 or less thresholds in the inter-peak.

The goods vehicles total do not validate so well across the screenlines due to the small numbers of LGVs and HGVs making it difficult to meet the tight criteria.

Table 4-2: AM peak hour screenline validation (total vehicles)

	Observed Total				Modelled				Difference				Difference-%				DMRB or GEH-4															
	Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total	% Diff	% Diff	% Diff	% Diff	GEH	GEH-4	DMRB or GEH	DMRB or GEH-4												
Cordon Validation Counts - In	10,401	1,350	695	14,953	11,674	890	1,316	16,445	1,273	12%	-34	-2%	195	28%	1,492	10%	12.1	*	*	*	0.9	✓	✓	✓	6.9	*	*	*	11.9	*	*	*
Cordon Validation Counts - Out	7,326	1,762	820	11,888	7,650	909	1,424	12,224	324	4%	-338	-19%	89	11%	336	3%	3.7	✓	✓	✓	8.5	*	*	*	3.0	*	✓	✓	3.1	✓	✓	✓
North-South Screenline NB	6,271	1,032	505	7,810	6,989	484	809	8,282	718	11%	-223	-22%	-21	-4%	472	6%	8.8	*	*	*	7.3	*	*	*	1.0	✓	✓	✓	5.3	*	*	*
North-South Screenline SB	8,578	1,053	485	10,912	8,864	555	596	10,872	286	3%	-457	-43%	70	14%	-40	0%	3.1	✓	✓	✓	15.9	*	*	*	3.1	✓	✓	✓	0.4	✓	✓	✓
East-West Screenline EB	8,660	1,364	530	10,617	9,589	668	1,171	11,431	929	11%	-193	-14%	138	26%	814	7.66%	9.7	*	*	*	5.4	*	*	*	5.6	*	*	*	7.7	*	*	*
East-West Screenline WB	9,184	1,522	518	11,224	9,684	688	1,080	11,464	500	5%	-442	-29%	170	33%	240	2%	5.2	*	*	*	12.2	*	*	*	6.9	*	*	*	2.3	✓	✓	✓
West of A500 Screenline - EB	4,040	488	131	4,659	4,215	156	428	4,799	175	4%	-60	-12%	25	19%	140	3.00%	2.7	✓	✓	✓	2.8	*	✓	✓	2.1	*	✓	✓	2.0	✓	✓	✓
West of A500 Screenline - WB	3,381	548	128	4,057	3,671	177	431	4,279	290	9%	-117	-21%	49	38%	222	5%	4.9	*	*	*	5.3	*	*	*	3.9	*	✓	✓	3.4	*	✓	✓
East of A50 Screenline - EB	2,896	503	137	3,536	2,779	155	431	3,365	-117	-4%	-72	-14%	18	13%	-171	-4.82%	2.2	✓	✓	✓	3.3	*	✓	✓	1.5	*	✓	✓	2.9	✓	✓	✓
East of A50 Screenline - WB	4,449	617	134	5,200	5,063	198	410	5,671	614	14%	-207	-34%	64	48%	471	9%	8.9	*	*	*	9.1	*	*	*	5.0	*	*	*	6.4	*	*	*

Table 4-3: IP hour screenline validation (total vehicles)

	Observed Total				Modelled				Difference				DMRB or GEH<4				DMRB or GEH<4															
	Car	LGV	HGV	Total	Car	LGV	HGV	Total	Difference	% Diff	Difference	% Diff	Difference	% Diff	GEH	GEH<4	GEH<4	GEH	GEH<4	GEH<4	Total											
Cordon Validation Counts - In	5,648	1,254	981	9,055	6,173	646	1,314	9,424	525	9%	60	5%	-335	-34%	369	4%	6.8	*	*	*	1.7	✓	✓	✓	11.8	*	*	*	3.8	✓	✓	✓
Cordon Validation Counts - Out	5,950	1,313	772	9,239	6,636	662	1,124	9,585	686	12%	-189	-14%	-110	-14%	346	4%	8.7	*	*	*	5.4	*	*	*	4.1	*	*	*	3.6	✓	✓	✓
North-South Screenline NB	7,119	948	594	9,122	7,544	421	691	8,656	425	6%	-257	-27%	-173	-29%	-466	-5%	5.0	*	*	*	9.0	*	*	*	7.7	*	*	*	4.9	*	*	*
North-South Screenline SB	6,301	920	549	7,842	6,695	307	807	7,808	394	6%	-113	-12%	-242	-44%	-34	0%	4.9	*	*	*	3.9	*	✓	✓	11.7	*	*	*	0.4	✓	✓	✓
East-West Screenline EB	7,876	1,530	539	9,945	7,730	481	1,260	9,480	-146	-2%	-270	-18%	-58	-11%	-465	-4.68%	1.7	✓	✓	✓	7.2	*	*	*	2.6	*	*	*	4.7	*	*	*
East-West Screenline WB	7,474	1,429	509	9,412	8,038	535	1,199	9,771	564	8%	-230	-16%	26	5%	359	4%	6.4	*	*	*	6.4	*	*	*	1.1	*	*	*	3.7	✓	✓	✓
West of A500 Screenline - EB	2,524	358	139	3,021	2,912	156	389	3,457	388	15%	31	9%	17	13%	436	14.45%	7.4	*	*	*	1.6	*	✓	✓	1.4	*	✓	*	7.7	*	*	*
West of A500 Screenline - WB	2,873	357	166	3,396	3,286	129	418	3,834	413	14%	61	17%	-37	-22%	438	13%	7.4	*	*	*	3.1	*	✓	✓	3.0	*	✓	*	7.3	*	*	*
East of A50 Screenline - EB	3,722	492	173	4,387	3,641	144	429	4,214	-81	-2%	-63	-13%	-29	-17%	-173	-3.93%	1.3	✓	✓	✓	2.9	*	✓	✓	2.3	*	✓	*	2.6	✓	✓	✓
East of A50 Screenline - WB	3,032	502	122	3,656	3,042	130	500	3,672	10	0%	-2	0%	8	6%	16	0%	0.2	✓	✓	✓	0.1	✓	✓	✓	0.7	*	✓	*	0.3	✓	✓	✓

Table 4-4: PM peak hour screenline validation (total vehicles)

	Observed Total				Modelled				Difference				DMRB or GEH-4																			
	Car	LGV	HGV	Total	Car	LGV	HGV	Total	Difference	% Diff	Difference	% Diff	Difference	% Diff	Difference	% Diff	Difference	% Diff														
Cordon Validation Counts - In	9,158	1,398	515	13,273	9,914	777	1,338	14,265	756	8%	-60	-4%	262	51%	992	7%	7.7	*	*	*	1.6	✓	✓	✓	10.3	*	*	*	8.5	*	*	*
Cordon Validation Counts - Out	10,533	1,188	446	14,690	12,162	651	1,194	16,555	1,629	15%	6	1%	205	46%	1,865	13%	15.3	*	*	*	0.2	✓	✓	✓	8.8	*	*	*	14.9	*	*	*
North-South Screenline NB	10,538	981	237	11,756	10,326	398	799	11,522	-212	-2%	-182	-19%	161	68%	-234	-2%	2.1	✓	✓	✓	6.1	*	*	*	9.0	*	*	*	2.2	✓	✓	✓
North-South Screenline SB	7,826	804	258	9,389	7,550	357	671	9,057	-276	-4%	-133	-17%	99	38%	-332	-4%	3.1	✓	✓	✓	4.9	*	*	*	5.7	*	*	*	3.5	✓	✓	✓
East-West Screenline EB	10,605	1,252	224	12,081	10,639	409	1,208	12,263	34	0%	-44	-4%	185	82%	182	1.51%	0.3	✓	✓	✓	1.3	✓	✓	✓	10.4	*	*	*	1.7	✓	✓	✓
East-West Screenline WB	10,193	985	272	11,450	10,101	414	1,131	11,649	-92	-1%	146	15%	142	52%	199	2%	0.9	✓	✓	✓	4.5	*	*	*	7.6	*	*	*	1.9	✓	✓	✓
West of A500 Screenline - EB	3,560	318	54	3,741	3,555	94	460	4,109	-5	0%	142	45%	40	74%	368	9.84%	0.1	✓	✓	✓	7.2	*	*	*	4.6	*	*	*	5.9	*	*	*
West of A500 Screenline - WB	4,834	409	77	5,320	4,387	143	527	5,057	-447	-9%	118	29%	66	86%	-263	-5%	6.6	*	*	*	5.5	*	*	*	6.3	*	*	*	3.6	✓	✓	✓
East of A50 Screenline - EB	5,098	544	41	5,683	5,363	70	583	6,032	265	5%	39	7%	29	71%	349	6.14%	3.7	*	✓	✓	1.6	*	✓	✓	3.9	*	✓	*	4.6	*	*	*
East of A50 Screenline - WB	3,561	387	48	3,996	3,319	62	450	3,831	-242	-7%	63	16%	14	28%	-165	-4%	4.1	*	*	*	3.1	*	✓	✓	1.8	*	✓	*	2.6	✓	✓	✓

4.7 Link flow validation

The DfT guidelines for the validation of highway models are described in TAG unit M3.1 and the DMRB Volume 12, Section 2, Part 1, Chapter 4.

There are two separate sets of criteria for link flow validation against which the modelled flow and count comparisons should be measured. In both cases the criteria are expected to be met in at least 85% of cases. The two sets of criteria are:

GEH Statistic:

- Links should have a GEH value of less than 5

DMRB Vehicle Flow Comparison (DMRB criteria 1-3):

- Where the observed flow is less than 700 vehicles per hour, the modelled flow should be within 100 vehicles of the observed flow
- Where the observed flow is between 700 and 2,700 vehicles per hour, the modelled flow should be within 15% of the observed flow
- Where the observed flow is greater than 2,700 vehicles per hour, the modelled flow should be within 400 vehicles of the observed flow

The DfT offers guidance on the suitability of validation statistics in TAG unit 3.19

Section 3.2.7. It provides guidance for counts meeting GEH and DMRB criteria, stating that: “These two measures are broadly consistent and link flows that meet either criterion should be regarded as satisfactory.” Validation checks have been undertaken in line with these criteria.

Table 4-5 to Table 4-7 show the AM peak hour, inter-peak hour and PM peak hour modelled link flow validation statistics for all of the observed count locations. For total flows, the model shows a good correlation between modelled and observed flows with 83%, 75% and 78% of links passing either the GEH or DMRB criteria in the AM peak hour, inter-peak hour and PM peak hour, respectively.

A good correlation can also be seen between the modelled and observed data for cars, LGVs and HGVs for each modelled time period with the GEH or DMRB criteria being met in at least of 75% of cases.

Appendix A details the validation results on a link by link basis for each modelled period.

Table 4-5: AM peak-hour link validation statistics

	No. of Counts	DMRB	GEH <5	GEH<5 or DMRB
Cars	137	73%	72%	75%
LGV	137	91%	83%	91%
HGV	137	99%	88%	99%
Total	156	79%	79%	83%

Table 4-6: Inter-peak-hour link validation statistics

	No. of Counts	DMRB	GEH <5	GEH<5 or DMRB
Cars	135	75%	74%	80%
LGV	135	90%	86%	90%
HGV	135	89%	80%	89%
Total	141	68%	69%	75%

Table 4-7: PM peak-hour link validation statistics

	No. of Counts	DMRB	GEH <5	GEH<5 or DMRB
Cars	139	73%	75%	79%
LGV	139	94%	88%	94%
HGV	139	94%	85%	94%
Total	156	74%	73%	78%

Figure 4-4 to Figure 4-6 illustrate the difference between modelled link flows and observed traffic counts based on the GEH statistic, for each modelled time period. Links coloured green have a GEH value less than 5 and therefore meet TAG criteria, links in orange narrowly fail with a GEH value between 5 and 7 and red show links with a GEH value of greater than 7, showing a poorer validation. The figures show no clear trend regarding locations that do not meet the criteria with a slight tendency for the poorer validates sites to be away from areas of monitored air quality exceedances.

Figure 4-4: AM peak hour link flow validation performance against GEH criteria

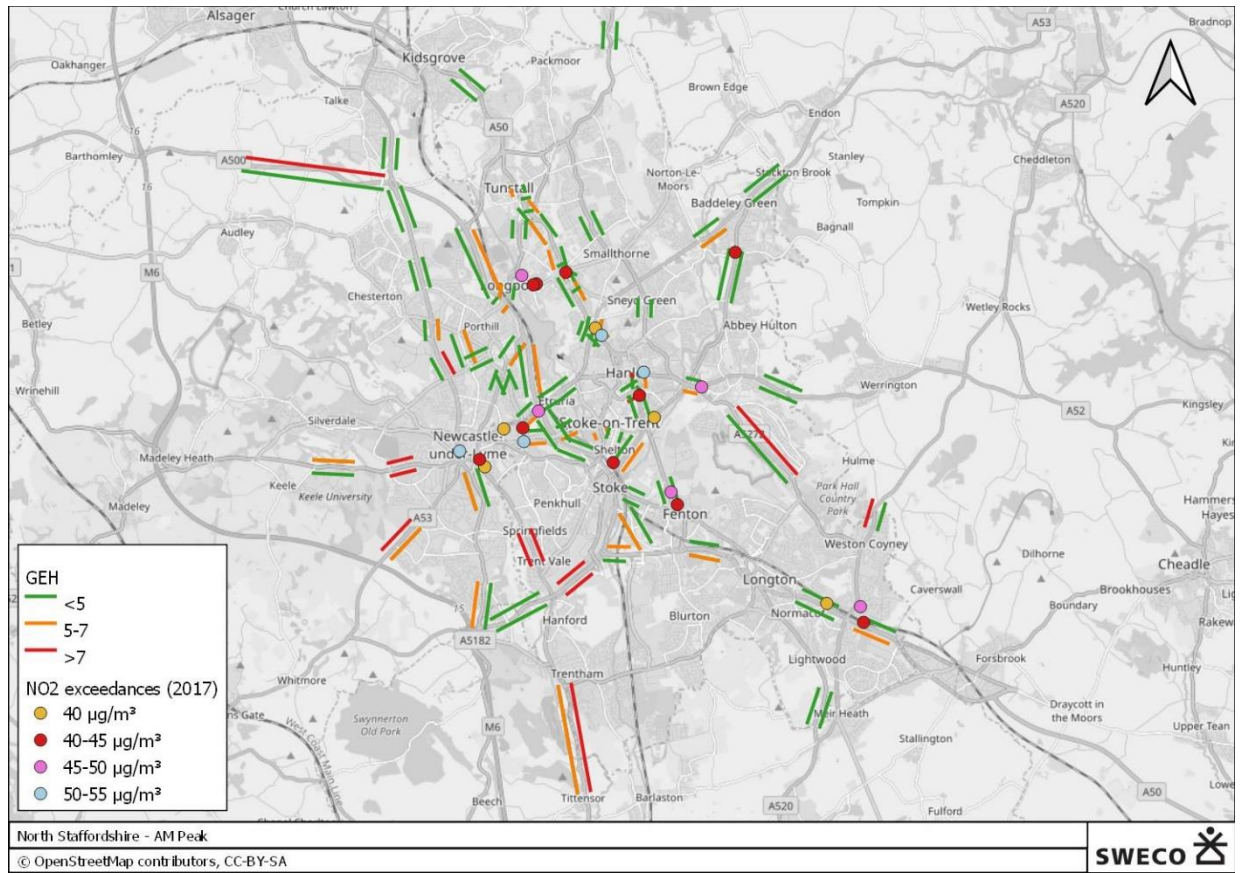


Figure 4-5: Inter-peak hour link flow validation performance against GEH criteria

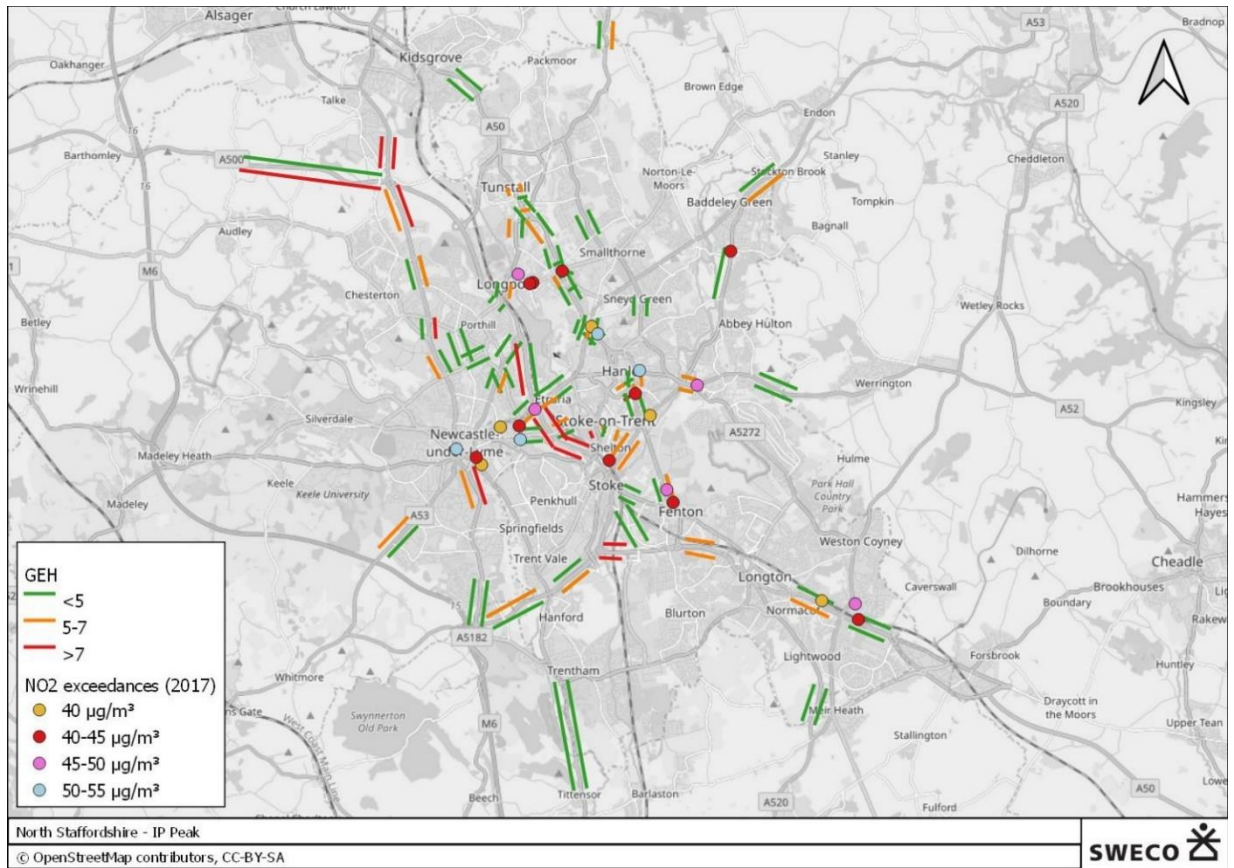
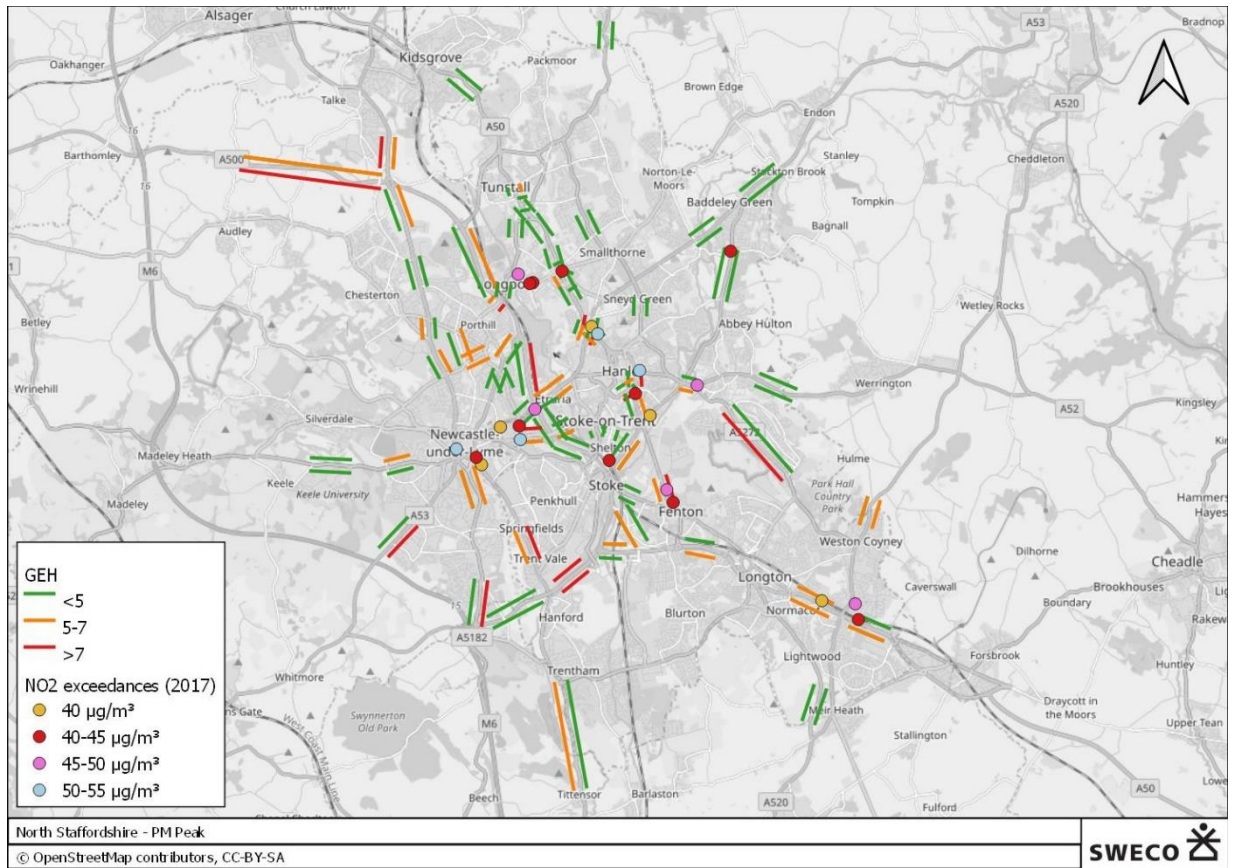


Figure 4-6: PM peak hour link flow validation performance against GEH criteria



4.8 Modelled flow validation at predicted exceedance locations

Table 4-8 identifies the locations predicted to be air quality exceedances in 2022 and provides commentary on the level of flow validation achieved in the base model. Figure 4-4 to Figure 4-6 show the difference between modelled link flows and observed traffic counts for these locations based on the GEH statistic, for each modelled time period. Links coloured green have a GEH less than 5 and therefore meet TAG criteria, links in orange narrowly fail with a GEH between 5 and 7 and red show links with a GEH of greater than 7, showing a poorer validation. Table 4-9 and Table 4-10 summarise the flow validation by vehicle type (cars, LGVs and HGVs) at the 3 exceedance locations for the AM and PM peaks.

Table 4-8: Flow validation at predicted exceedance locations

Predicted Exceedance Location	Flow Validation Summary
A53 – Basford	The nearest count site is on the A53 just to the west of the A500 which shows a good match of model flows with observed flows. In the AM and IP, eastbound has a GEH of less than 5 whilst westbound has a GEH of less than 7. Traffic going up the hill towards Newcastle, which is more crucial in terms of air quality forecasts are therefore better represented. For PM, both directions have a GEH less than 5.
Bucknall New Road	The nearest count is on Bucknall Road to the east of the A52. Generally, a reasonable match, with the AM and PM eastbound flow comparison less than a GEH of 5 and the other time periods and direction just outside the range but less than a GEH of 7.
Victoria Road	The nearest count is adjacent to the point of exceedance and has an excellent match in the AM with both directions having a GEH of less than 5. In the IP, northbound is excellent whilst southbound has a GEH slightly outside 5 In the PM, northbound falls just slightly outside a GEH of 5 whilst southbound has a less good match.

Table 4-9: Flow validation at predicted exceedance locations (AM)

Name	Direction	Observed Flow				Modelled Flow				DMRB OR GEH<5 (Total)
		Car	LGV	HGV	Total	Car	LGV	HGV	Total	
A53 – Basford	EB	2373	270	91	2734	2481	308	94	2884	✓
A53 – Basford	WB	1476	325	84	1885	1716	241	89	2047	✓
Bucknall New Road	EB	760	165	25	950	810	110	50	970	✓
Bucknall New Road	WB	1502	149	17	1668	1720	166	54	1940	✗
Victoria Road	NB	713	146	30	889	820	124	50	994	✓
Victoria Road	SB	430	191	56	677	532	169	50	751	✓

Table 4-10: Flow validation at predicted exceedance locations (PM)

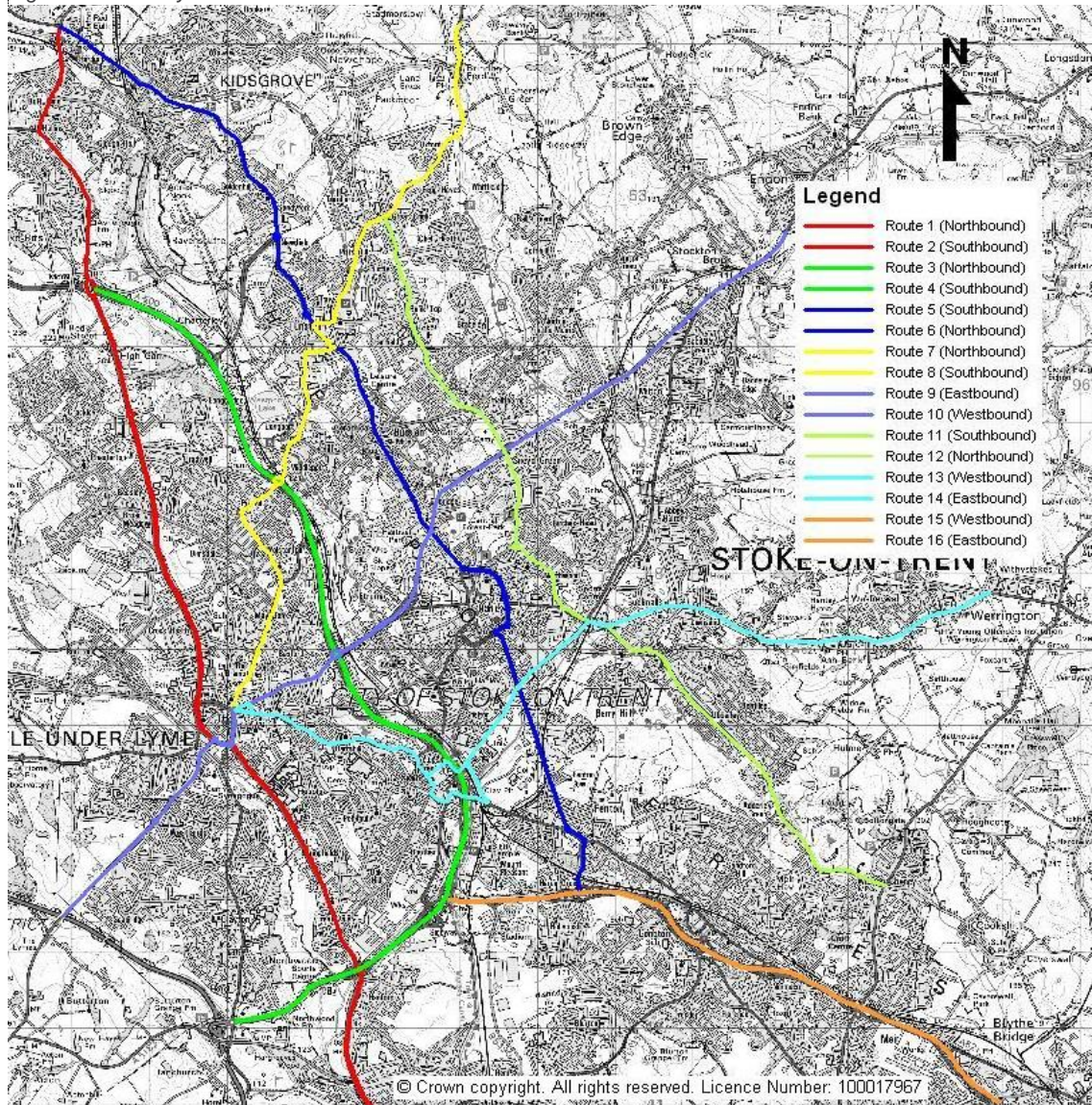
Name	Direction	Observed Flow				Modelled Flow				DMRB OR GEH<5 (Total)
		Car	LGV	HGV	Total	Car	LGV	HGV	Total	
A53 – Basford	EB	1658	198	30	1886	1850	267	33	2150	✓
A53 – Basford	WB	2436	164	31	2631	2274	284	34	2593	✓
Bucknall New Road	EB	1552	146	6	1704	1507	126	15	1648	✓
Bucknall New Road	WB	1174	118	3	1295	983	114	23	1120	✓
Victoria Road	NB	469	50	18	537	571	83	11	665	✗
Victoria Road	SB	730	95	2	827	1034	89	13	1136	✗

4.9 Journey time validation

The DfT guidelines for the validation of modelled journey times are based on those described in WebTAG Unit M3.1 and the DMRB Volume 12, Section 2, Part 1, Chapter 4. The guidance suggests that at least 85% of the total modelled journey times should be within +/- 15% or 1 minute of the observed journey time.

The validation of modelled journey times has been undertaken for a total of eight routes in both directions for each of the modelled time periods. These routes cross the North Staffordshire conurbation and are based on journey times extracted from Trafficmaster data (as shown in Figure 4-7).

Figure 4-7: Journey time validation routes



The results of the journey time validation for each modelled time period are summarised in Table 4-11. As can be seen, 100% of the journey time routes in the inter-peak and over 85% of the routes in the AM and PM peak hour time periods have modelled times that are within +/- 15% or 1 minute of the observed times.

The journey time validation results for each route can be found in Appendix B.

Table 4-11: Journey time validation summary

Modelled Period	% Pass DMRB Criteria (+/-15% or 1 min)
AM	88%
IP	100%
PM	88%

Figure 4-8 and Figure 4-9 shows the differences in travel time between the 2015 NSMM model and 2018 Trafficmaster data for the AM and PM periods on three routes (both directions) along the predicted exceedance locations. These times include both link time and junction delay. The data has been extracted for a short corridor. The corridor approach is better for comparing commensurate times given the differences in defined links between Trafficmaster data and the NSMM model links. The 2015 model journey times match well with the 2018 observed data. For the AM peak 2 routes out of 6 very narrowly fail the TAG criteria (for model flows being less than 15% or 1 minute of observed times) by 1 second for the A53 eastbound and 8 seconds for Bucknall New Road westbound. For the PM peak 5 out of the 6 travel times pass the TAG criteria, showing that the model represents observed speeds well.

Figure 4-8 Travel time difference between 2015 NSMM model and 2018 Trafficmaster data (AM)

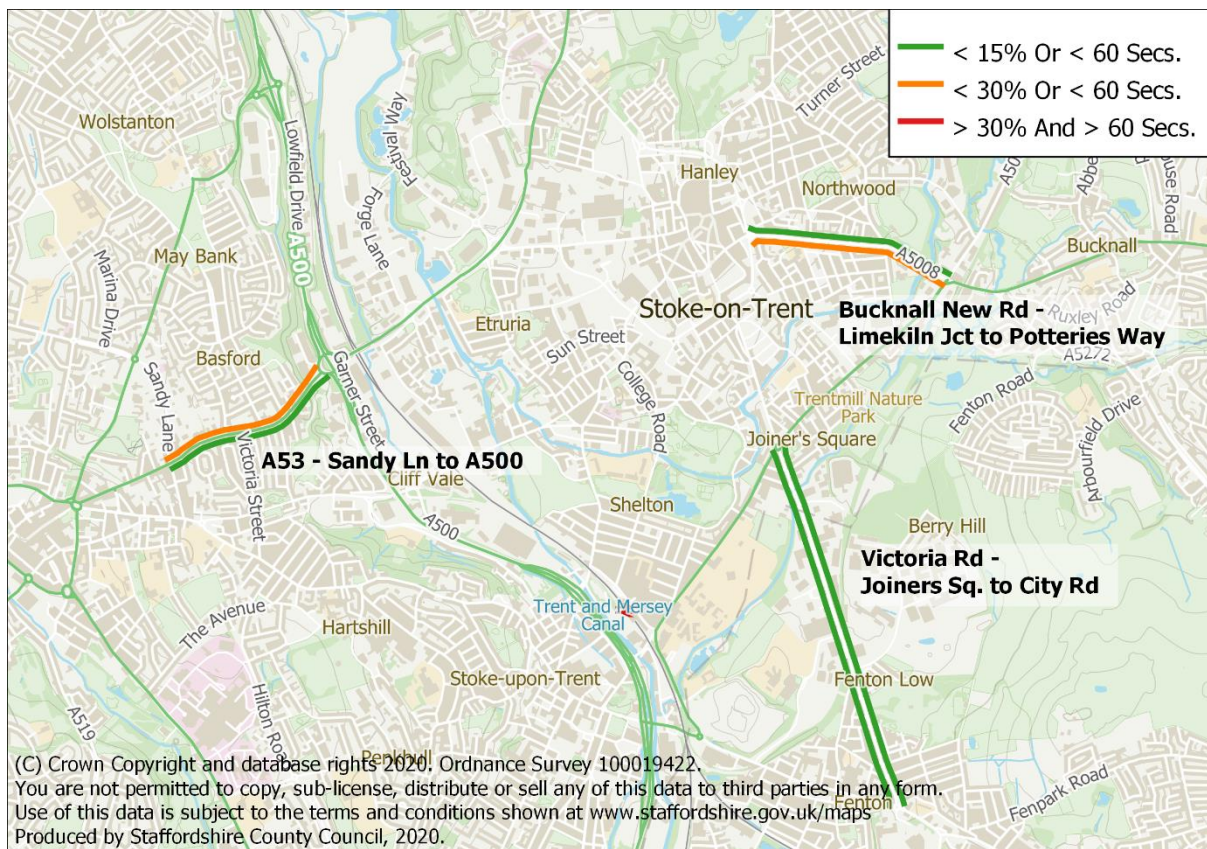
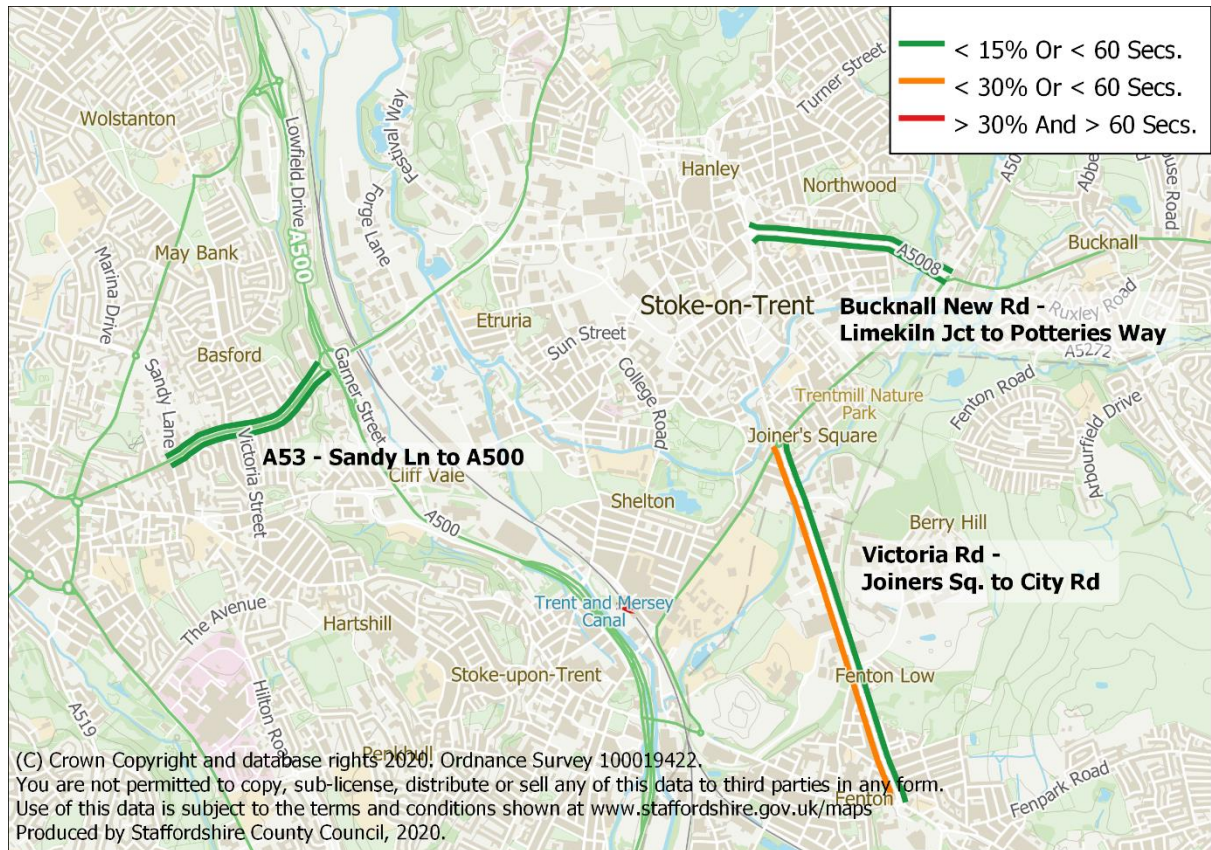


Figure 4-9: Travel time difference between 2015 NSMM model and 2018 Trafficmaster data (PM)



4.10 Highway assignment model convergence

The convergence of the final highway assignment model for each modelled time period is summarised in Table 5-9. TAG Unit M3.1 recommends a %GAP of 0.1% however experience has shown that %GAP values of less than 0.05%, which have been adopted for the NSMM transport model, often provides a more robust case for appraisal. This target was met within the last four assignment iterations as shown below.

Table 4-12 also shows that 100% of links had a flow change from the previous iteration of less than 5% (Pdiff.) for the final four iterations for all model time periods which further confirms the stability of the model.

Table 4-12: Assignment convergence

Time Period	Number of Iterations	Convergence Criteria			
		%Gap Less than 0.05	Pdiff. Greater than 95% for four consecutive iterations	AAD Equal to/Less than 1 for four consecutive iterations	RAAD Less than 1% for four consecutive iterations
AM Peak	53	0.00004	100%	0	0.001
		0.00006	100%	0	0.001
		0.00001	100%	0	0.001
		0.0001	100%	0	0.001
Inter Peak	20	0.00007	100%	1	0.003
		0.00007	100%	1	0.003
		0.00003	100%	1	0.003
		0.0001	100%	1	0.002
PM Peak	57	0.000006	100%	0	0.001
		0.0001	100%	0	0.001
		0.000008	100%	0	0.001
		0.000002	100%	0	0.001

4.11 Comparison with original aggregated NSMM transport model

The NSMM transport model was updated to 2015 as part of the modelling work undertaken for the appraisal of the EVLR Project. Given the lack of traffic growth shown by the analysis of appropriate traffic count information, this model has been used to inform the development of the 2018 base-line air quality model albeit further disaggregated into compliant and non-compliant vehicle types using ANPR data. Table 4-13 provides a comparison of the validation results between the aggregated transport model which only has 3 vehicle types (cars, LGVs and HGVs) and the disaggregated transport model which has 8 vehicle types including taxis and compliant and non-compliant splits. Following the disaggregation of the transport model, the level of validation remains at a high level with screenline and journey time validation results remaining unaltered. The link counts validation results for AM has improved but a very small reduction in the level of validation for IP and PM peak hour time periods has been achieved.

Table 4-13: Validation comparison

Validation	Aggregated for EVLR (3 vehicle types)			Disaggregated Model for CAZ (8 vehicle types)		
	AM	IP	PM	AM	IP	PM
Screenline	60%	60%	60%	60%	60%	60%
Link Count	81%	81%	79%	83%	77%	78%
Journey Times	88%	100%	88%	88%	100%	88%

4.12 Validation against 2018 screenline counts

The 2015 disaggregated transport model will be used to inform the development of the 2018 baseline air quality model. A further validation check has therefore been undertaken on the 2015 disaggregated transport model flows against 22 counts undertaken in 2018 forming a screenline to the east of the A500 as shown in Figure 2-12. Table 4-14 and Table 4-15 summarises the level of validation against the 22 count sites using both the DRMB flow and GEH criteria. Given that no calibration has been undertaken and the 2015 modelled traffic flow data is being compared with 2018 count data, a good fit is still shown between the modelled and observed data. This underlines the point that there is no case for rebasing the 2015 transport model to a 2018 base year, as the 2015 transport model already provides a good representation of 2018 observed flows, which has been demonstrated to be due to the lack of traffic growth in the North Staffordshire area.

Table 4-14: Comparison of 2015 modelled traffic flows against 2018 observed traffic counts - westbound

Vehicle Type	No. of Counts	DMRB	GEH <5	GEH <5 or DMRB
AM Peak-Hour				
Car	11	55%	45%	55%
LGV	11	64%	64%	64%
HGV	11	100%	91%	100%
Total	11	73%	64%	73%
Inter-Peak Hour				
Car	11	73%	64%	73%
LGV	11	91%	73%	91%
HGV	11	100%	91%	100%
Total	11	64%	64%	73%

PM Peak-Hour				
Car	11	55%	55%	55%
LGV	11	91%	73%	91%
HGV	11	91%	91%	91%
Total	11	64%	64%	73%

Table 4-15: Comparison of 2015 modelled traffic flows against 2018 observed traffic counts - eastbound

Vehicle Type	No. of Counts	DMRB	GEH <5	GEH <5 or DMRB
AM Peak-Hour				
Car	11	73%	82%	82%
LGV	11	91%	91%	91%
HGV	11	100%	91%	100%
Total	11	82%	82%	82%
Inter-Peak Hour				
Car	11	64%	64%	73%
LGV	11	82%	82%	82%
HGV	11	91%	91%	91%
Total	11	55%	55%	64%
PM Peak-Hour				
Car	11	91%	82%	91%
LGV	11	91%	91%	91%
HGV	11	100%	100%	100%
Total	11	91%	82%	100%

The detailed analysis of the 2015 disaggregated transport model against the 2018 screenline counts is detailed in Appendix C.

4.13 Validation of vehicle compliance splits

The primary purpose of the 2019 ANPR data was to derive compliance splits by vehicle type. Analysis was also undertaken on the total flow data from the 2019 ANPR surveys, however, following checks it became clear that there had been some under-reporting. It is known that

ANPR surveys are not as accurate as other methods for capturing total vehicle flows. This is because not all number plates get picked up, those that have plates on the rear of the vehicle only (i.e. motorcycles), have dirty or missing plates or plates in an irregular location can get missed. Comparing the 2019 ANPR data against 2018 count data confirmed this, with the ANPR flow data being consistently slightly lower than other observed sources. The ANPR data is, however, still appropriate for deriving compliance splits. A validation was therefore undertaken comparing the vehicle compliance splits recorded by the ANPR surveys across the A500 screenline (as shown in Figure 3-12) by direction against the 2015 disaggregated modelled flows.

Table 4-16 shows the difference between the 2015 disaggregated model flow vehicle compliance percentages and the equivalent percentages derived from the 2019 observed ANPR surveys. The table demonstrates that the 2015 disaggregated model compliance percentages are closely replicating the observed values within an acceptable tolerance level. This further demonstrates that the disaggregation process has been correctly carried out, including the disaggregation of the transport model trip matrices and the refinement of the assignment process.

Table 4-16: Percentage difference between the 2015 disaggregated model and the 2019 ANPR data

Time Period / Direction	% Difference in Compliance Splits					
	Car Comp	Car Non-Comp	LGV Comp	LGV non-Comp	HGV Comp	HGV Non-comp
AM – Westbound	1%	-1%	1%	-1%	-7%	7%
AM – Eastbound	3%	-3%	1%	-1%	-6%	6%
IP – Westbound	-2%	2%	1%	-1%	-7%	7%
IP – Eastbound	-1%	1%	-1%	1%	0%	0%
PM – Westbound	3%	-3%	-1%	1%	2%	-2%
PM – Eastbound	2%	-2%	1%	-1%	-2%	2%
All Periods	1%	-1%	0%	0%	-3%	3%

5 Conclusion

5.1 Summary

Validation of the updated 2015 base NSMM transport model, which has had the modelled trip matrices segmented into CAZ compliant and non-compliant vehicle types, has been undertaken based on the following:

1. Comparison of the original 2015 NSMM base transport model and the updated 2015 disaggregated transport model
2. Comparison of the 2015 disaggregated transport model against 2018 traffic counts
3. Comparison of the 2015 disaggregated transport model flows by vehicle type and compliance splits against ANPR data
4. Validation of the 2015 disaggregated NSMM transport model against conurbation wide link counts, screenlines and journey times

The 2015 segmented transport model shows a good and similar level of validation between observed and modelled data (i.e. individual traffic counts, screenline flows and journey times) as per the original NSMM transport model, which is as would be expected. This confirms the demand segmentation carried out to update the transport model has only resulted in small changes in flows.

The comparison of 2015 and 2018 traffic count data on the screenline to the east of the A500 shows no net traffic growth, therefore confirming that the 2015 transport model could be used instead of creating a 2018 base or forecast year to inform the air quality modelling of a baseline situation. This is reaffirmed by a good fit between 2015 segmented model flows and the 2018 A500 screenline counts. Finally, the comparison of CAZ vehicle compliance splits across the A500 screenline shows a close match with the ANPR data. This demonstrates the demand segmentation process has been correctly carried out regarding updates to the model trip matrices and the refinement of the assignment process within the NSMM transport model.

5.2 Fit for purpose

The updated 2015 base-year NSMM transport model validates within acceptable tolerance levels and as a result is suitable to be used for modelling emission strategies across compliant and non-compliant user classes to support the reduction of NO₂ emissions. The output data from the updated NSMM transport model can be used for a 2018 baseline and future year air quality modelling.

Appendix B – Journey time validation

AM peak hour

Route No.	Route	Direction	Modelled Time (mins)	Observed Time (mins)	% Diff.	Within 15%	Within 1 Minute	Within 15% or 1 Minute
Routes Across the Wider North Staffordshire Conurbation								
1	A34	Northbound	24.35	26.97	-10%	Yes	No	Yes
1	A34	Southbound	25.83	26.40	-2%	Yes	Yes	Yes
2	A500 (T)	Northbound	10.20	9.44	8%	Yes	Yes	Yes
2	A500 (T)	Southbound	12.12	14.00	-13%	Yes	No	Yes
3	A50	Southbound	28.52	26.60	7%	Yes	No	Yes
3	A50	Northbound	27.31	25.61	7%	Yes	No	Yes
4	A527/ B5370/ A5271	Northbound	19.37	20.67	-6%	Yes	No	Yes
4	A527/ B5370/ A5271	Southbound	20.57	22.36	-8%	Yes	No	Yes
5	A53	Northbound	28.45	28.72	-1%	Yes	Yes	Yes
5	A53	Southbound	28.21	30.37	-7%	Yes	No	Yes
6	A5272	Northbound	18.57	22.32	-17%	No	No	No
6	A5272	Southbound	20.54	21.18	-3%	Yes	Yes	Yes
7	A52	Westbound	22.26	23.20	-4%	Yes	Yes	Yes
7	A52	Eastbound	19.43	19.70	-1%	Yes	Yes	Yes
8	A50(T)	Westbound	8.77	12.97	-32%	No	No	No
8	A50(T)	Eastbound	5.86	6.43	-9%	Yes	Yes	Yes
AM Peak-Hour Total			320.36	336.94	% Pass	88%	44%	88%

Inter-peak hour

Route No.	Route	Direction	Modelled Time (mins)	Observed Time (mins)	% Diff.	Within 15%	Within 1 Minute	Within 15% or 1 Minute
Routes Across the Wider North Staffordshire Conurbation								
1	A34	Northbound	23.06	21.15	9%	Yes	No	Yes
1	A34	Southbound	23.23	22.33	4%	Yes	Yes	Yes
2	A500 (T)	Northbound	9.16	9.40	-3%	Yes	Yes	Yes
2	A500 (T)	Southbound	9.28	9.45	-2%	Yes	Yes	Yes
3	A50	Southbound	28.37	25.62	11%	Yes	No	Yes
3	A50	Northbound	26.62	25.36	5%	Yes	No	Yes
4	A527/ B5370/ A5271	Northbound	18.29	17.54	4%	Yes	Yes	Yes
4	A527/ B5370/ A5271	Southbound	18.32	17.36	6%	Yes	Yes	Yes
5	A53	Northbound	25.49	23.43	9%	Yes	No	Yes
5	A53	Southbound	25.16	22.60	11%	Yes	No	Yes
6	A5272	Northbound	19.01	17.88	6%	Yes	No	Yes
6	A5272	Southbound	19.64	17.89	10%	Yes	No	Yes
7	A52	Westbound	19.95	19.75	1%	Yes	Yes	Yes
7	A52	Eastbound	17.92	17.87	0%	Yes	Yes	Yes
8	A50(T)	Westbound	5.79	6.08	5%	Yes	Yes	Yes
8	A50(T)	Eastbound	5.71	6.38	11%	Yes	Yes	Yes
Inter-Peak Hour Total			295.00	280.08	% Pass	100%	56%	100%

PM Peak hour

Route No.	Route	Direction	Modelled Time (mins)	Observed Time (mins)	% Diff.	Within 15%	Within 1 Minute	Within 15% or 1 Minute
Routes Across the Wider North Staffordshire Conurbation								
1	A34	Northbound	25.45	28.27	-10%	Yes	No	Yes
1	A34	Southbound	25.18	25.45	-1%	Yes	Yes	Yes
2	A500 (T)	Northbound	12.42	10.98	13%	Yes	No	Yes
2	A500 (T)	Southbound	11.90	12.48	-5%	Yes	Yes	Yes
3	A50	Southbound	28.16	28.83	-2%	Yes	Yes	Yes
3	A50	Northbound	27.81	28.34	-2%	Yes	Yes	Yes
4	A527/ B5370/ A5271	Northbound	20.42	23.51	-13%	Yes	No	Yes
4	A527/ B5370/ A5271	Southbound	19.81	19.24	3%	Yes	Yes	Yes
5	A53	Northbound	28.03	34.63	-19%	No	No	No
5	A53	Southbound	27.02	25.47	6%	Yes	No	Yes
6	A5272	Northbound	19.41	19.57	-1%	Yes	Yes	Yes
6	A5272	Southbound	20.84	19.31	8%	Yes	No	Yes
7	A52	Westbound	20.74	22.57	-8%	Yes	No	Yes
7	A52	Eastbound	19.25	21.39	-10%	Yes	No	Yes
8	A50(T)	Westbound	6.44	6.45	0%	Yes	Yes	Yes
8	A50(T)	Eastbound	8.72	6.79	29%	No	No	No
PM Peak-Hour Total			321.60	333.28	% Pass	88%	44%	88%

