MAY 2020

NORTH STAFFORDSHIRE LOCAL AIR QUALITY PLAN

UNAPPROVED OUTLINE BUSINESS CASE

APPENDIX 26 - T3 Local Plan Transport Modelling Methodology Report

Staffordshire County Council

NEWCASTLE UNDER LYME BOROUGH COUNCIL

City of Stoke-on-Trent

Table of contents

1 Introduction

Sweco have been appointed by Newcastle-under-Lyme Borough Council (NuLBC) in conjunction with Stoke-on-Trent City Council (SoTCC) and Staffordshire County Council (SCC) to undertake transport modelling and appraisal work. This is to support the development and implementation of local plans to address nitrogen dioxide (NO_2) exceedances in the North Staffordshire conurbation. This is in accordance with the Ministerial Direction for third wave local authorities.

The transport modelling will inform the air quality modelling and economic appraisal work as part of the delivery of an Outline Business Case (OBC) submission to the Joint Air Quality Unit (JAQU) due by 31st of October 2019. The transport modelling work will centre on the use and update of the North Staffordshire Multi-Modal (NSMM) transport model.

This Local Plan Transport Modelling Methodology Report (T3) outlines the methodology for the transport modelling work to be undertaken to support the above. The proposed methodology is based on JAQU's guidance, documented the "Third Wave Local Authorities – Guidance, Evidence Package, Transport and Air Quality".

This report should be read alongside the T1 tracker table, a live document that demonstrates all the transport modelling requirements are being met, and the T2 Local Plan Transport Model Validation report which details how the NSMM base model was modified using Automatic Number Plate Recognition (ANPR) data and validated against real-world data. The rest of the report is divided into the following sections:

Chapter 2 provides background information on the NSMM model, its extent, structure, modelled time periods and zoning system.

Chapter 3 details some of the baseline forecasting assumptions for the transport modelling including the segmentation of base and future year demand using the ANPR surveys as well as forecast assumptions for the vehicle compositions.

Chapter 4 provides details on the future year uncertainty log, including what land use development and network improvements are included in the future year core scenario, as well as details of the sensitivity testing.

Chapter 5 provides a description of the NSMM demand model including its representation of travel cost assumptions.

Chapter 6 outlines the options to be tested and how the behavioural responses for both a charging Clean Air Zone (CAZ) and the other mitigation policies will be captured.

Chapter 7 details the use of Stated Preference (SP) survey data including the use and adaption of raw data from other cities, so it is adjusted to North Staffordshire, the conducting of a North Staffordshire SP survey and its incorporation into the NSMM demand model.

Chapter 8 summarises how the transport model outputs will be processed and used for the air quality modelling.

2 Background information

The NSMM transport model is to be used to derive appropriate traffic information to support the development and implementation of local plans to reduce pollution.

The NSMM transport model has been developed to allow the forecasting and assessment of the impact of proposed planning and infrastructure developments to be carried out. The demand model forecasts change in trip patterns in terms of trip generation, distribution and modal shift as a result of changes to the highway network, public transport service provision and changes to planning data. The transport model has been developed in accordance with appropriate WebTAG guidance.

The original base-year of the NSMM transport model is related to a 2009 base-year situation.

To support the design and assessment and the development of the Transport Business Case for the Etruria Valley Link Road (EVLR) project and following extensive liaison with the Department for Transport (DfT), the NSMM transport model has been updated to a 2015 base-year. To support the update of the NSMM transport model an extensive traffic data collection exercise has been carried out in order to calibrate modelled traffic flows, journey times and travel demand against observed information. The updated 2015 NSMM transport model has been validated in accordance with WebTAG guidance with further additional checks of the transport model carried out at the request of DfT.

The current scope and specification of the NSMM transport model is outlined further below.

2.1 Extent of the NSMM transport model

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 extent of the modelled network is shown in Figure 2-1 with the detailed and peripheral model extents shown in Figure 2-2. Both road and rail links are modelled.

2.2 Structure of the NSMM transport model

The structure of the NSMM Transport Model consists of three main modules:

- Highway Assignment Model
- Public Transport Model
- Demand Model

The highway model is both link and junction based.

2.3 Transport modelling software

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

2.4 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)

It should be noted that appropriate factors based on extensive observed traffic count information will be used to factor the modelled traffic data to an Annual Average Daily Traffic (AADT) situation for informing the air quality assessments.

2.5 NSMM transport model zones

The 2015 NSMM transport model has 288 zones which are split as follows:

- Internal zones 1 – 207 and 275 – 288 (See Figure 2-3 to Figure 2-5)
- Peripheral zones 208 – 233 (see Figure 2-6)
- Regional zones 234 – 255 (see Figure 2-7)
- National zones 256 – 274 (see Figure 2-8)

The internal zones and modelled transport network represent the greatest level of detail to capture the 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.

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

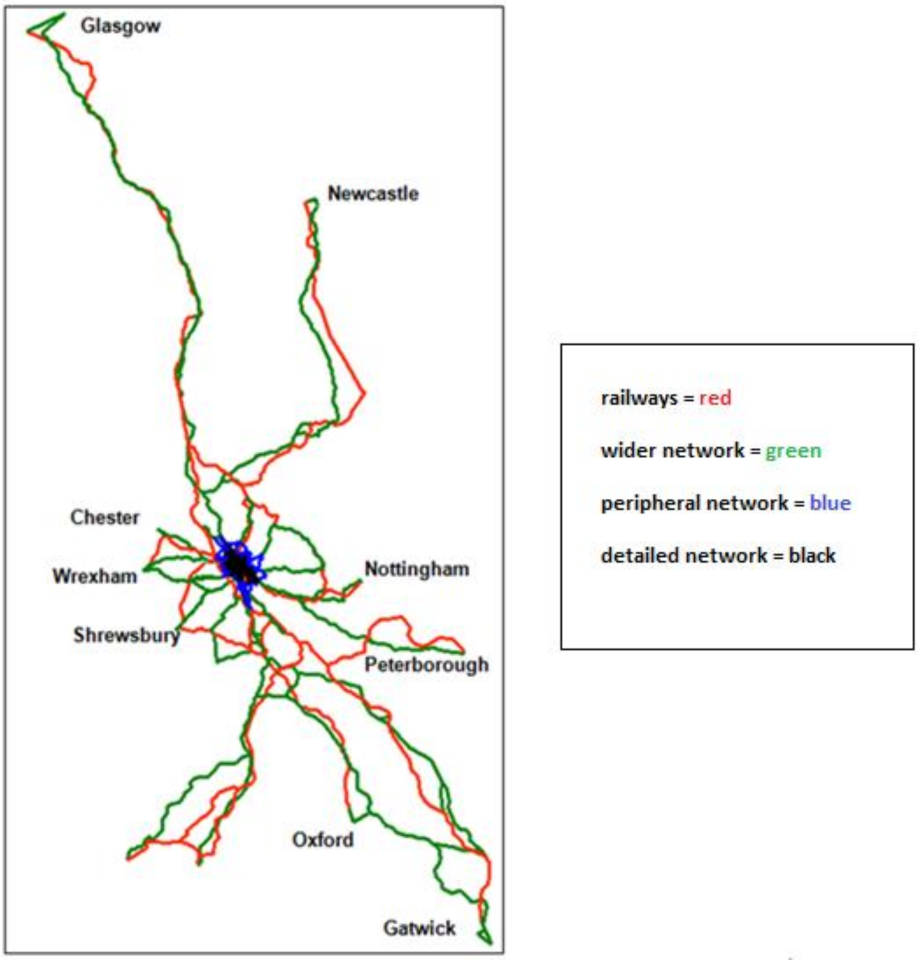


Figure 2-2: Extent of modelled peripheral and internal road and rail networks

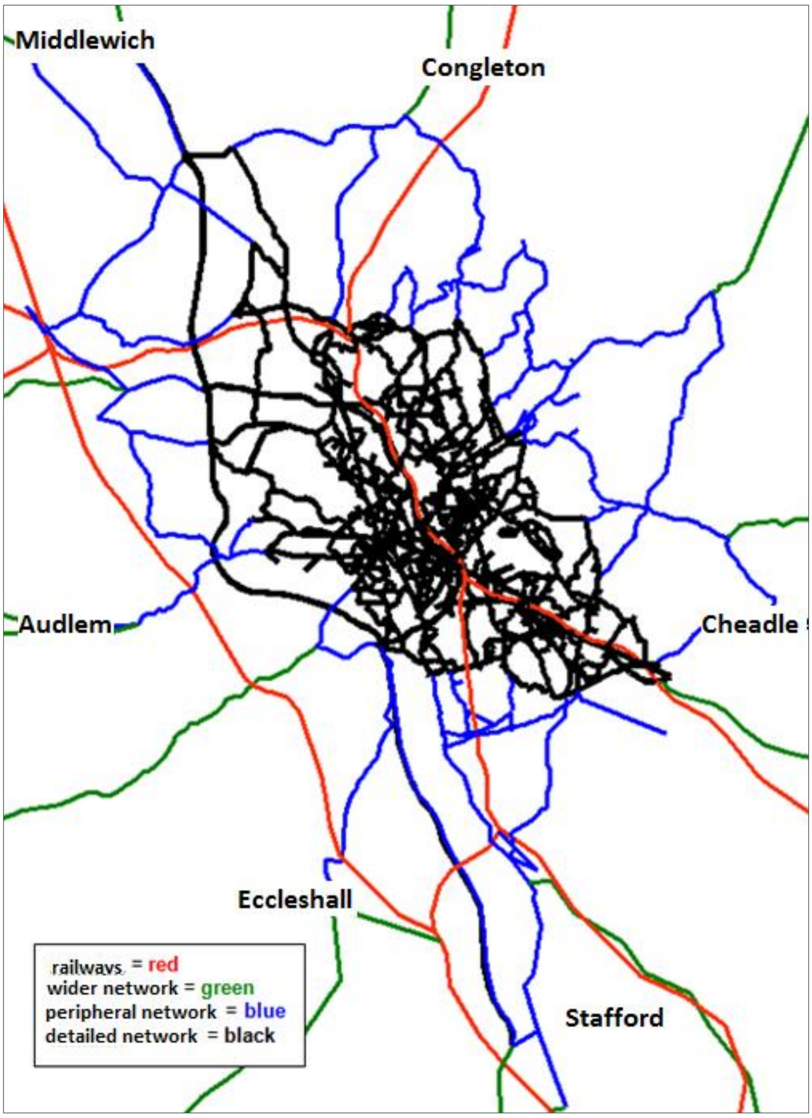


Figure 2-3: Internal transport model zones (north)

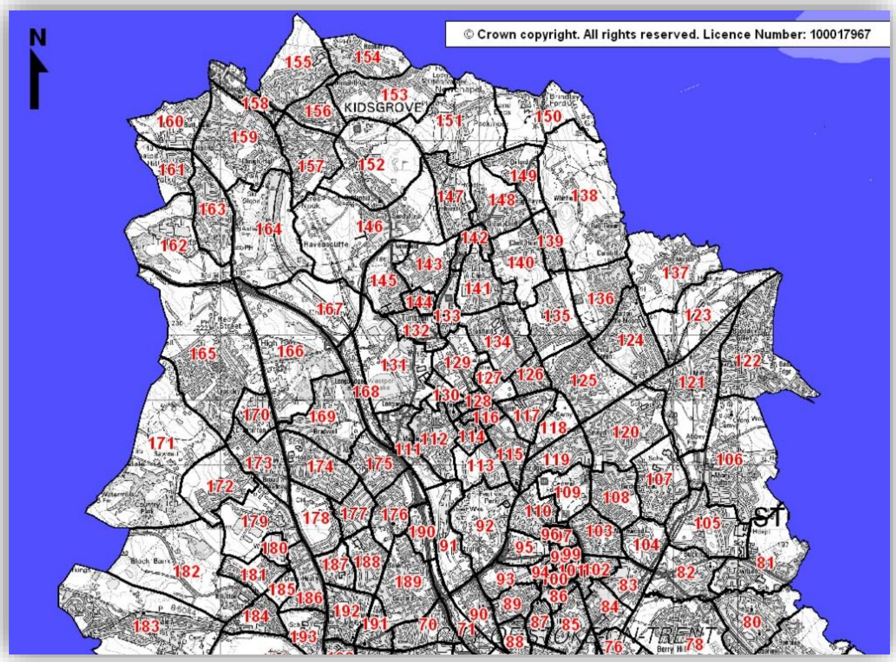


Figure 2-4: Internal transport model zones (south)

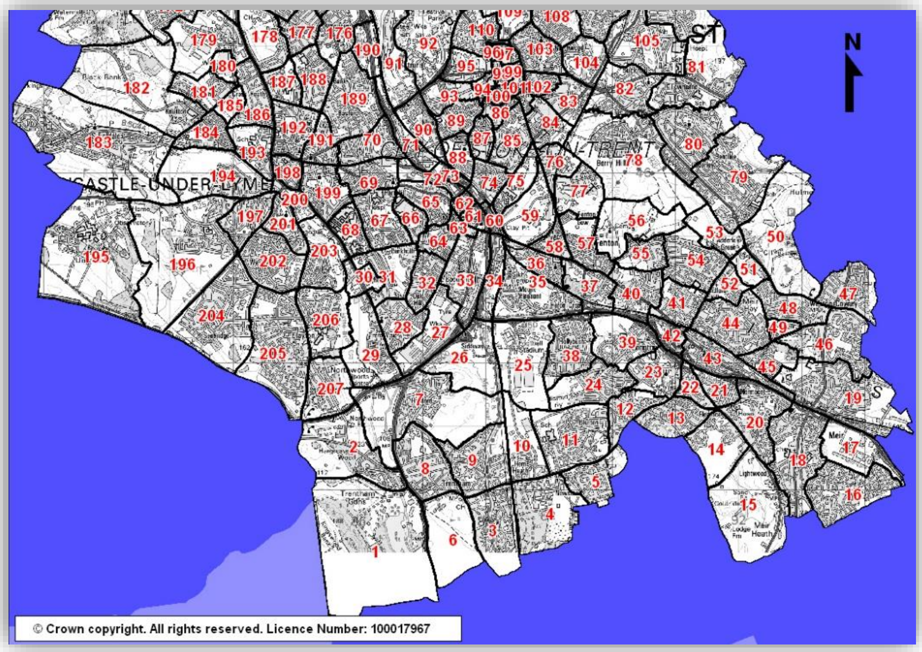


Figure 2-5: Internal transport model zones (central area)

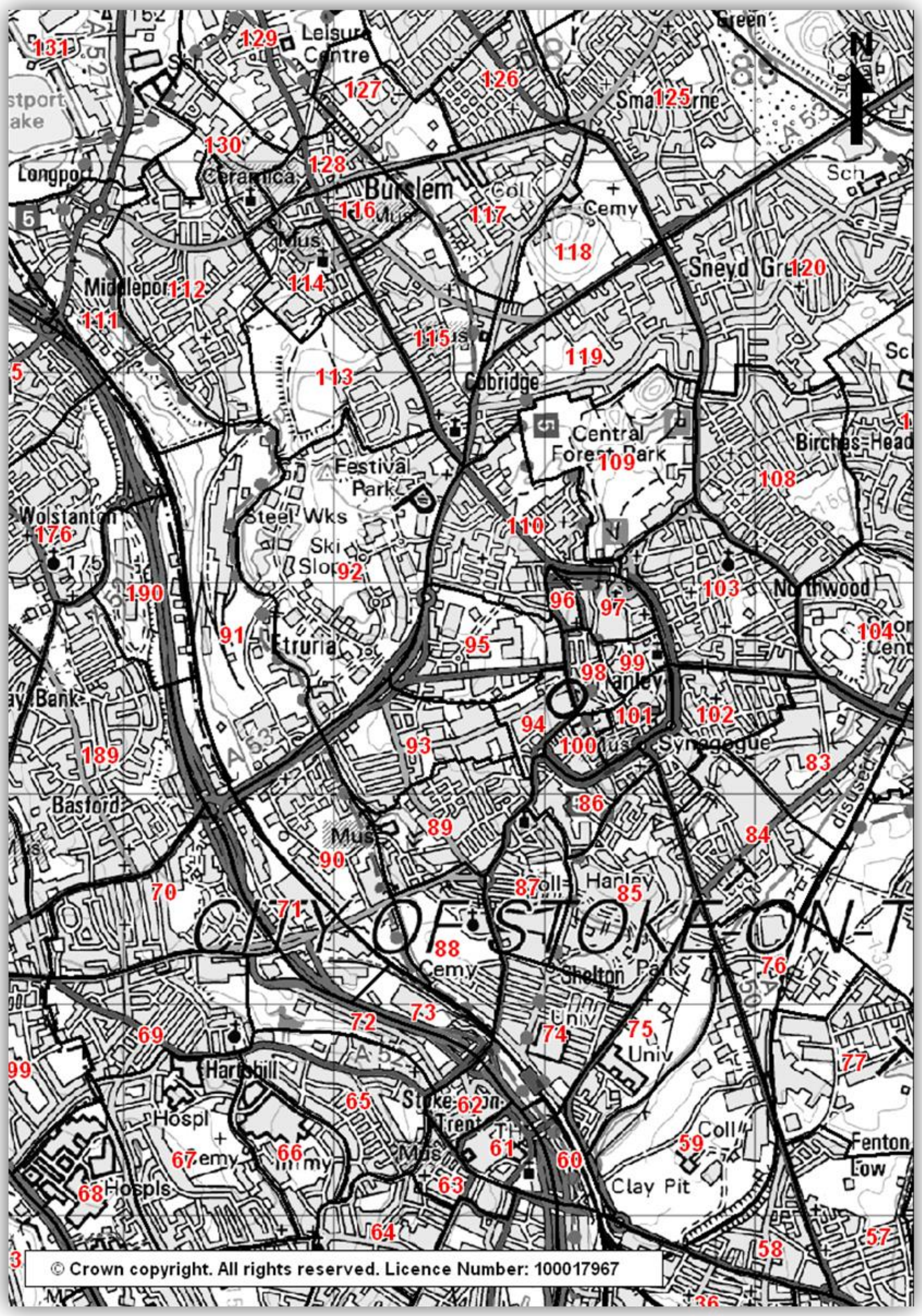


Figure 2-6: Peripheral transport model zones

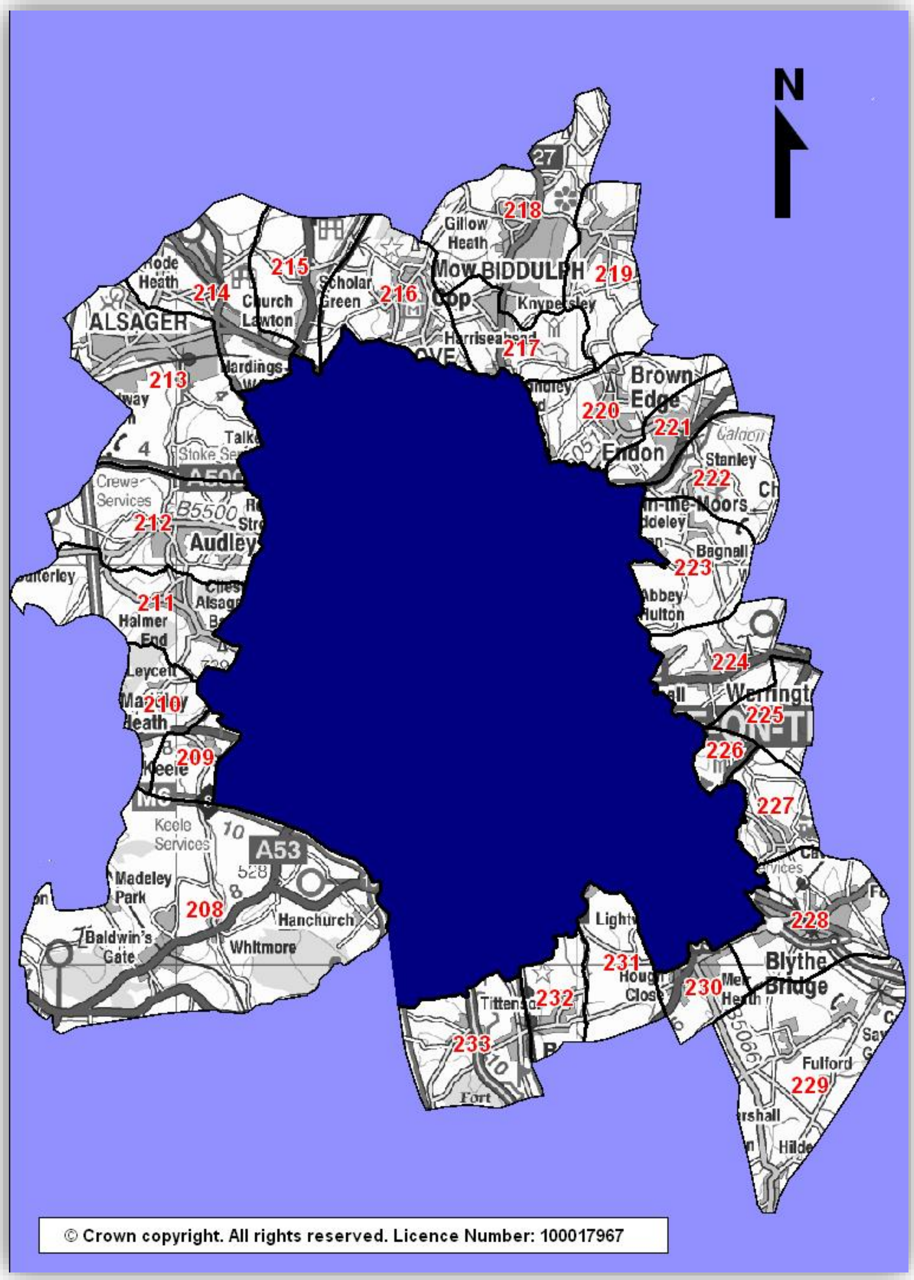


Figure 2-7: Regional transport model zones

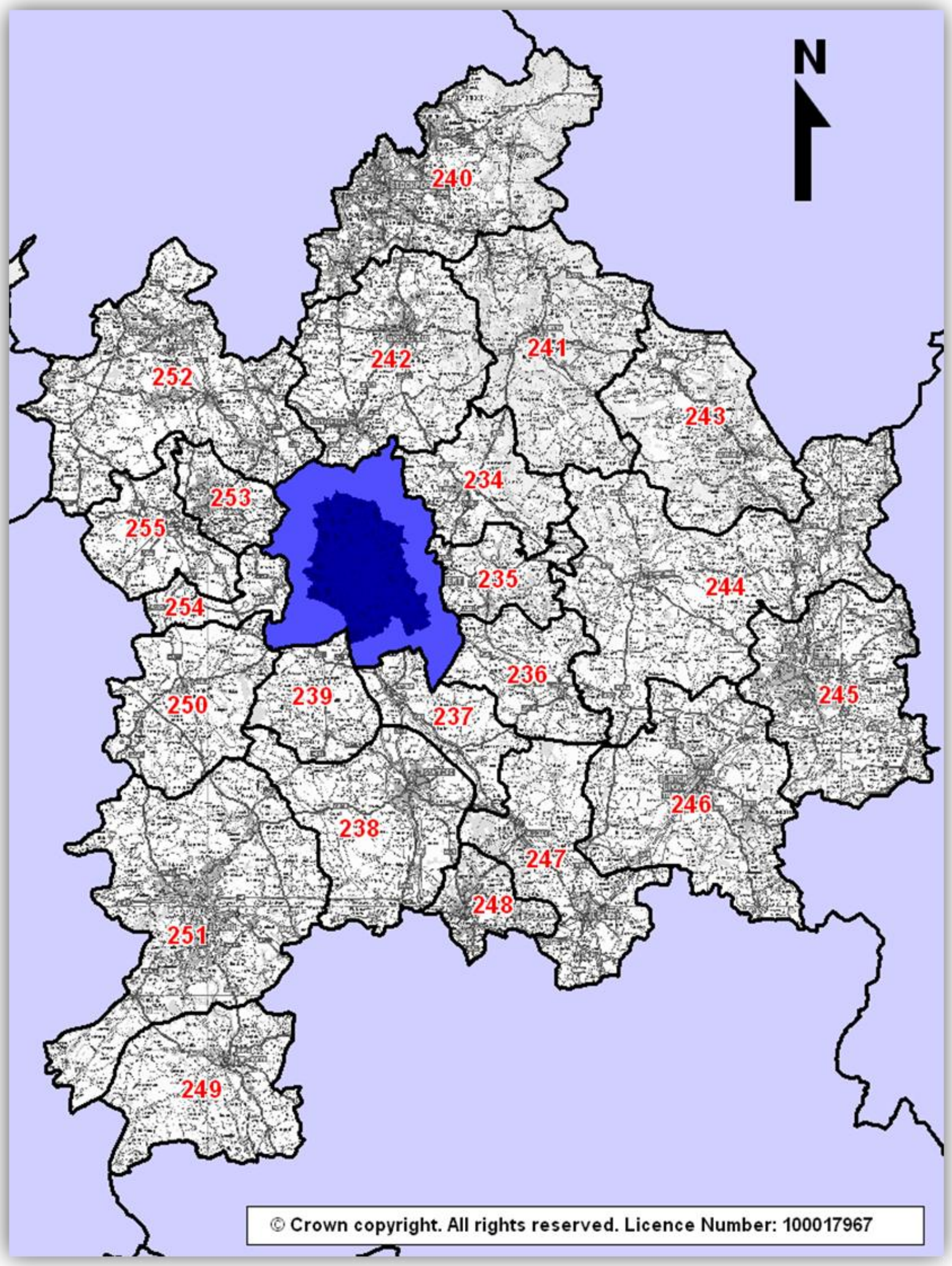
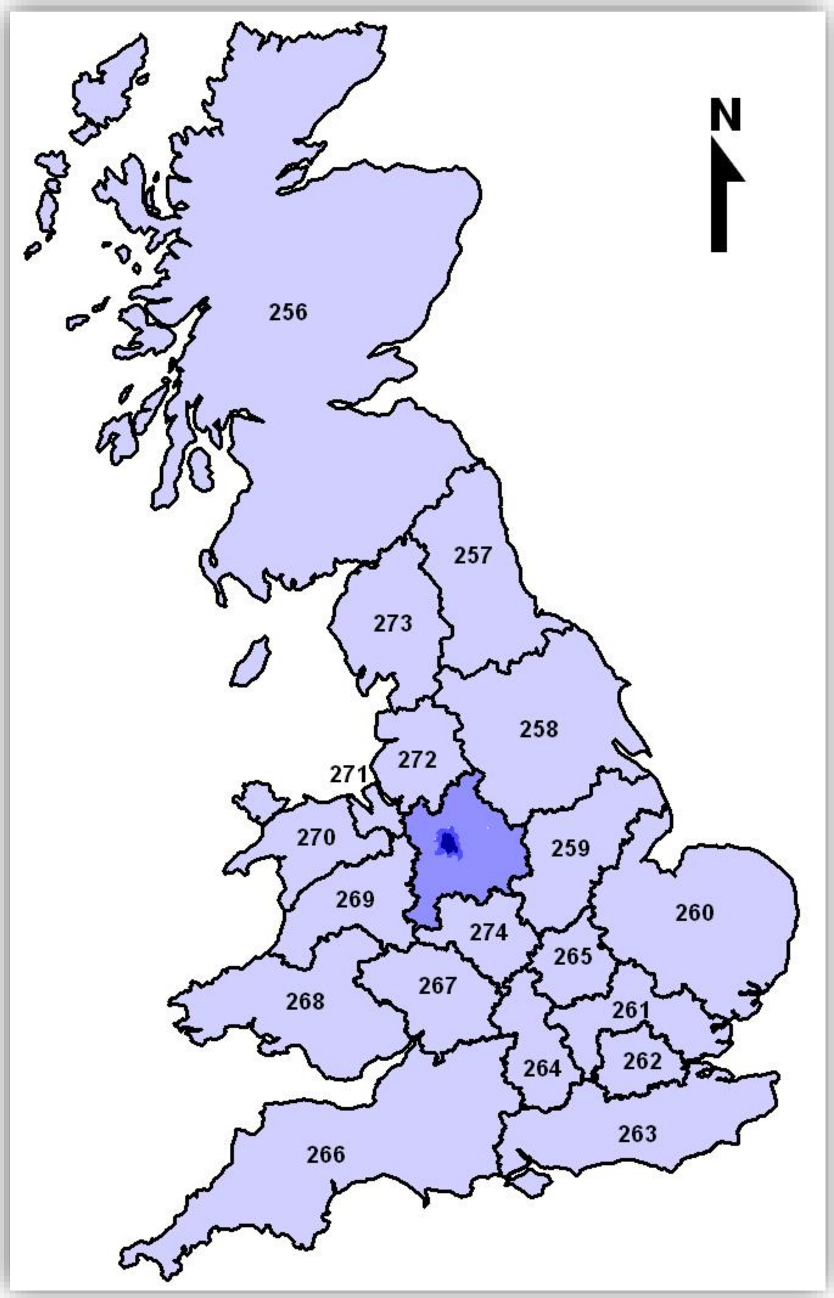


Figure 2-8: National transport model zones



3 Baseline forecast

3.1 Demand model

The following modes of transport are assigned in the final highway assignment:

- Car
- Light Goods Vehicles (LGVs)
- Heavy Goods Vehicles (HGVs)
- Public transport – for the highway assignment buses are loaded onto the highway network as fixed flows, for the separate public transport assignment bus and rail passenger demand is assigned to the public transport network.

Taxis would be partially represented in the car matrices. Coaches are not included in the public transport or highway assignments. Cycling and walking trips are not modelled, however, public transport passengers are assumed to access, and egress stops and stations at walking speed.

Freight demand is estimated from the trip end model and distributed rather than just growthed. All synthetic good vehicle trips are calculated using origin and destination trip rates calculated from the roadside interview data and applied to planning data. The origin and destination trip end values calculated are factored to match the average total. Goods vehicle trip ends are distributed using a gravity model with friction factors calibrated against observed trip length distribution data.

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 value of the LGV and HGV cost skims is taken
3. Intra-zonal costs are set to the lowest inter-zonal cost multiplied by 0.5

Like the car and public transport matrices, the growth from the demand model good vehicle matrices is applied incrementally to the observed LGV and HGV matrices.

The three modelled time periods are used for both the demand and assignment models.

The trip generation, distribution and mode split parts of the demand model includes the following trip purposes for trips by car and public transport:

- Home based work (HBW)
- Home based education (HBE)
- Home based shopping (HBS)
- Home based other (HBO)
- Non-home-based employers' business (NHBEB)
- Non-home based other (NHBO)

For the trip generation stage, the home-based trips are further segmented by three car ownership categories (0,1 and 2+) and six socio-economic groupings (HH1 to HH6), outlined in Table 3-1. The information below can 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.

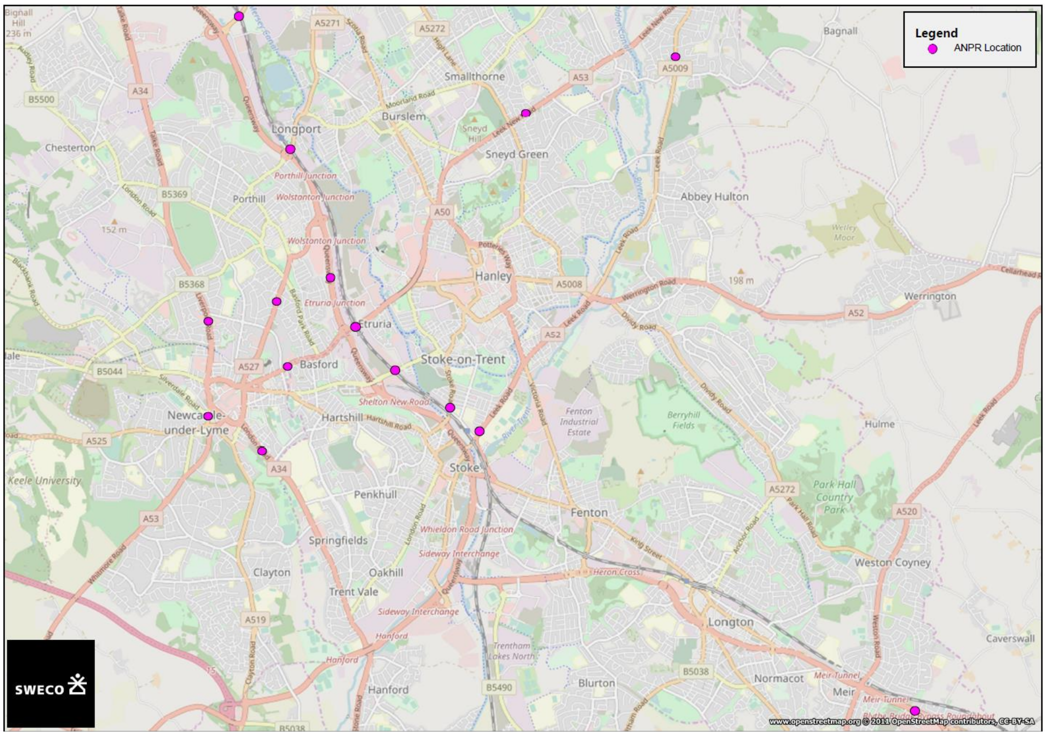
Table 3-1: NSMM transport model socio-economic groupings

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+

3.2 Updated demand segmentation

The NSMM demand and assignment models are not segmented to a suitably detailed level to distinguish between fuel type and CAZ compliance status. Therefore, the demand and assignment matrices will need to be further disaggregated. To achieve this categorisation, ANPR surveys were carried out at 15 locations across North Staffordshire, as per the location map shown in Figure 3-1. The locations were established to capture the main dispersal routes around the A53 corridor where there are the highest air quality exceedances and other locations of exceedance. A screenline of ANPR sites was also formed to the east of the A500 which will primarily be used to inform the further disaggregation of the modelled vehicle types. The ANPR surveys were carried out twenty-four hours per day for seven days in both directions. Surveys were carried out between the 2nd and 8th of April 2019.

Figure 3-1: ANPR survey locations



It is proposed that the vehicle assignment matrices are disaggregated as detailed in Table 3-2.

Taxis are currently part of the car trip matrices; taxi demand will be separated out primarily using a universal factor from the ANPR survey data with some adjustment at locations of high taxi demand, such as the where taxi ranks are in the city/town centres and at Stoke-on-Trent rail station.

Currently coaches are not included in the public transport model. Although they are not expected to form a significant number of vehicles they will be added as fixed routes to the public transport assignment and loaded on as pre-loads to the highway assignment.

Further processing of the trip matrices will be done to split them into polluting and non-polluting vehicles, this will be achieved through:

- The processing of the ANPR data carried out and information from the DVLA database to identify different compliance types by fuel type (diesel or petrol) and by euro standards by emissions (such as Euro IV, etc). These vehicles can then be categorised into polluting and non-polluting. Global factors will then be applied to disaggregate the NSMM transport model trip matrices as appropriate.
- DfT forecast of changes in the makeup of the vehicle fleet. This change will be applied to the current vehicle composition to provide future year 2022 vehicle compositions.

Table 3-2: Changes to vehicles classes in the NSMM transport model

Existing Segmentation	Updated Segmentation	Polluting Type
Car matrix	Cars	Clean Vehicle
	Cars	Polluting Vehicle
	Taxis	Clean Vehicle
	Taxis	Polluting Vehicle
LGVs	LGVs	Clean Vehicle
	LGVs	Polluting Vehicle
HGVs	HGVs	Clean Vehicle
	HGVs	Polluting Vehicle
PT Services – fixed routes	Buses – fixed routes	Clean Vehicle
	Buses – fixed routes	Polluting Vehicle
	Coaches – fixed routes	Clean Vehicle
	Coaches – fixed routes	Polluting Vehicle

3.3 Demand growth assumptions

Traffic forecasts using the NSMM transport model will be produced for the AM peak-hour, Inter-Peak hour, PM peak hour modelled time periods for the following forecast years:

- 2022 – When compliance should be reached
- 2025 – A second forecast year, required for benefit extrapolation

In accordance with Government guidance the forecasting approach used involves three basic steps:

- Development of future year transport networks
- Derivation of future year travel demand
- Assignment of the future year travel demand to the future transport networks

The following TAG Units will be adhered to in the development of the required traffic forecasts:

- TAG Unit M2 – Variable Demand Modelling
- TAG Unit M4 – Forecasting and Uncertainty
- TAG data book (July 2019)

The traffic forecasts will be constrained at a local authority level (i.e. Stoke-on-Trent and Newcastle-under-Lyme) to the forecast growth in the National Trip End Model (NTEM) dataset (last updated 1st March 2017)

LGV and HGV trip matrices will be constrained to the latest NTM growth forecasts which are the same for each modelled period and applied as a single factor to each goods vehicle matrix.

4 Uncertainty log

4.1 Overview

The purpose of an uncertainty log is to highlight all the local and external uncertainties and factors which could affect the traffic/patronage, revenues and delivery of scheme benefits. Typically, these factors include proposed land-use developments and transport infrastructure improvements.

An uncertainty log for the future year land-use developments has been prepared using the uncertainty levels defined in Table 4-1 as per TAG Unit M4. Only developments that are completed, near certain or more than likely have been included, as they form the core scenario.

An uncertainty log for the future year transport networks have been prepared using the uncertainty levels defined in Table 4-2. The focus of the work will be on the core scenario where transport schemes and land use developments are committed in terms of planning permission and funding (as per TAG Unit M4 – Forecasting and Uncertainty).

Sensitivity tests will be carried out on key assumptions around the core scenario to test the potential uncertainties in the associated outcomes. Sensitivity analysis will also be undertaken on different CAZ charging levels and assumptions around upgrading response and fleet composition changes.

The following sensitivity tests will be undertaken as per JAQU guidance:

- The charging Benchmark CAZ D with the assumption that no one upgrades their vehicle in response to the daily charge (zero upgrade). We will pro-rata the other demand responses.
- Benchmark CAZ D with double the daily charge (cars/taxis - £10, LGVs - £18, HGVs - £70)

Table 4-1: Uncertainty level definition and categorisation for proposed land-use developments

Uncertainty Level	Probability	Status	Core Scenario
Completed	Happened	Built/open	✓
Near Certain	The outcome will happen or there is a high probability that it will happen	Intent announced by proponent to regulatory agencies. Approved development proposals. Projects under construction.	✓
More Than Likely	The outcome is likely to happen but there is some uncertainty	Submission of planning or consent application imminent. Development application within the consent process.	✓
Reasonably Foreseeable	The outcome may happen but there is significant uncertainty	Identified within a development plan. Not directly associated with the transport strategy/scheme but may occur if the strategy/scheme is implemented. Development conditional upon a transport scheme proceeding. Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty.	
Hypothetical	There is considerable uncertainty whether the outcome will ever happen	Conjecture based on currently available information. Discussed on a conceptual basis. One of several possible inputs in an initial consultation process. Or, a policy aspiration.	

Table 4-2: Uncertainty level definition and categorisation for proposed transport schemes

Uncertainty Level	Probability	Status	Core Scenario
Completed	Happened	Built/open	✓
Near Certain	The outcome will happen or there is a high probability that it will happen	Intent announced by proponent to regulatory agencies. Approved proposals. Projects under construction.	✓
More Than Likely	The outcome is likely to happen but there is some uncertainty	Submission of planning or consent application imminent.	✓
Reasonably Foreseeable	The outcome may happen but there is significant uncertainty	Identified within a development plan. Not directly associated with the transport strategy/scheme but may occur if the strategy/scheme is implemented. Development conditional upon a transport scheme proceeding. Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty.	
Hypothetical	There is considerable uncertainty whether the outcome will ever happen	Conjecture based on currently available information. Discussed on a conceptual basis. One of several possible inputs in an initial consultation process. Or, a policy aspiration.	

4.2 Planning status of local developments

Proposed changes in the following planning data will be collated to derive the forecast trip matrices:

- Number of households
- Number of jobs (derived from Gross Floor Area (GFA) from proposed employment developments)
- Retail floor space by GFA and retail type
- Education places for primary, secondary and tertiary levels

NSMM transport model trip rates will be applied to the future year planning data in order to derive forecast year person production and attraction trip ends segemented by modelled period, journey purpose, car ownership and household type.

The change in the synthetic matrices will be added to the base matrix and constrained to NTEM growth as outlined in Section 3. Table 4-3 shows the uncertainty log for the planning data

Table 4-3: Uncertainty log for planning data

Land-Use by Local Authority Area	Completed by 2022	
	More Than Likely	Near Certain
Employment (Numbers of Jobs)		
Newcastle-under-Lyme	-642	613
Stoke-on-Trent	517	13,409
Residential (Numbers of Households)		
Newcastle-under-Lyme	515	2,467
Stoke-on-Trent	708	3,846
Retail (GFA m^2)		
Newcastle-under-Lyme	-107	-790
Stoke-on-Trent	-1,785	44,364
Education (Numbers of Student Places)		
Newcastle-under-Lyme	0	0
Stoke-on-Trent	0	1,350

4.3 Future year transport supply assumptions

The proposed schemes identified for the future year Reference Case scenarios are shown in Table 4-4.

Table 4-4: Future year Reference Case transport schemes

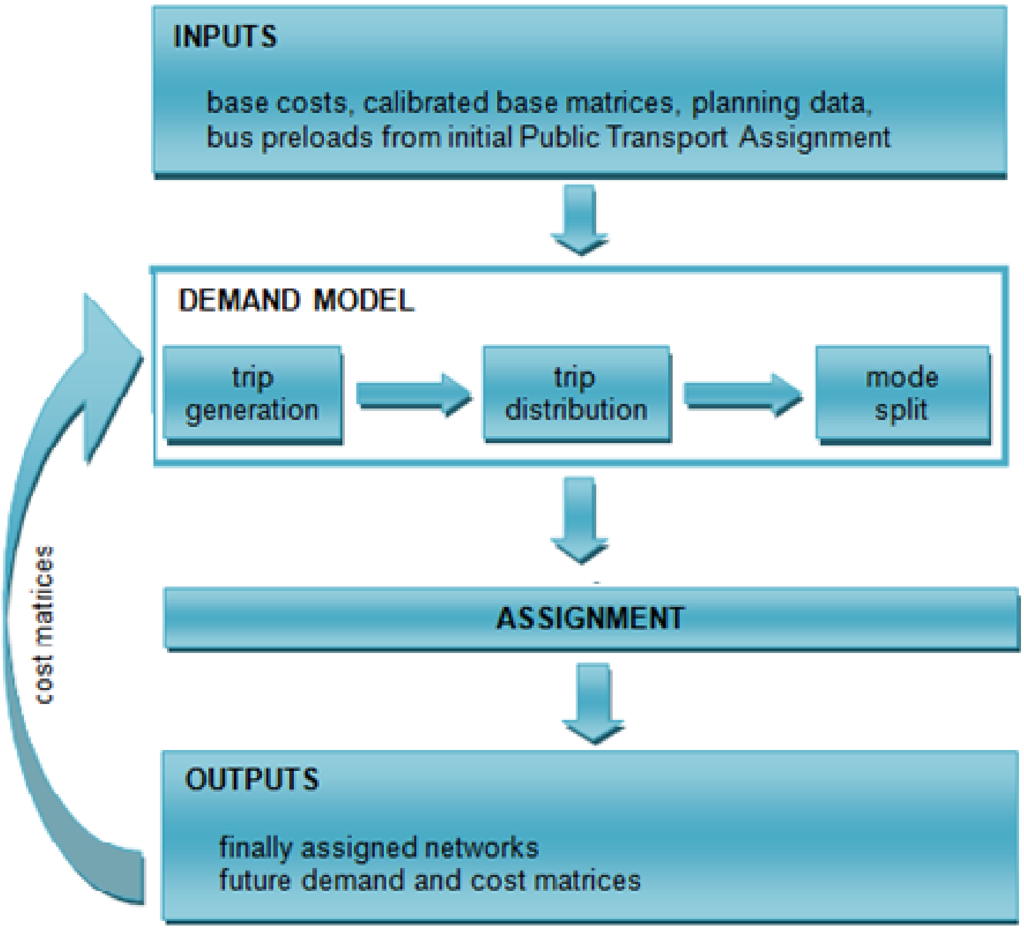
Scheme No.	Scheme Name	Uncertainty Level
1	M6 J16 Improvements	Completed
2	A520 Weston Road/Weston Coyney Road Junction Improvement	Completed
3	Knutton Lane Road Safety Scheme	Completed
4	A5007 City Roa /Glebedale Road Junction Improvement	Completed
5	A50 Safety Schemes	Completed
6	A5006 Broad Street/A5010 Marsh Street Junction Improvement	Completed
7	A5010 Marsh Street/Trinity Street Improvements	Completed
8	A53 Etruria Road/Festival Way Roundabout Improvement - Removal of Bus Lane	Completed
9	Chatterley Valley Sustainable Transport Package	Near Certain
10	Unity Walk/City Centre Network Changes	Near Certain
11	A500 Widening (Porthill to Wolstanton)	Near Certain
12	A34 London Road – Removal of On-Street Parking and Reduction in Speed Limit	Near Certain
13	Newcastle-under Lyme Ring Road – Reduction in Speed Limit	Near Certain
14	A50 Kidsgrove Traffic Management Scheme	Near Certain
15	A50 Waterloo Road/A53 Cobridge Road (Cobridge Traffic Lights) Junction Improvement	Near Certain
16	A5007 Uttoxeter Road/Meir Hay Road Junction Improvement	Near Certain
17	A500/A52 City Road Junction Improvement	Near Certain
18	A52 Leek Road/Station Road Junction Improvement	Near Certain
19	A50 Waterloo Road – Removal of Bus Lane	Near Certain
20	Sutherland Road/Weston Coyney Road Junction Improvement	Near Certain
21	A53 Etruria Road Corridor Euro 6 Bus Retrofit	Near Certain
22	Etruria Valley Link Project Road	More than Likely
23	A50 Victoria Road/A52 Leek Road (Joiners Square) Junction Improvement	More Than Likely
24	A5008 Bucknall New Road Widening	More Than Likely

5 Travel cost assumptions

5.1 NSMM demand model form

The basic structure of the NSMM demand model is shown diagrammatically in Figure 5-1 and covers trip generation, trip distribution and modal split responses. 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 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 5-1: Demand model structure



5.2 Derivation of costs

In the demand model, 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 and other charges are converted to costs in minutes (i.e. CAZ charge)
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

   For the purposes for modelling a charging CAZ further income segmentation will be derived based on the number of people employed in each household, as outlined in chapter 3. Different values of time will be applied for each income category to reflect different levels of responsiveness to different charging levels.

5. 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 (i.e. parking fares) in minutes. To be comparable with public transport fares the parking/other costs used are half of the anticipated actual costs.
6. 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 based and cost-based matrices are partially transposed
4. Fares are converted to costs in minutes
5. As previously, three separate values of time are used
    - Home based work trips
    - Home based education, shopping and other and non-home based other
    - Non-home based – employer's business
6. Fares (in minutes) are added to the time-based costs to give a total time-based cost
7. 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. The goods vehicle cost matrices are calculated as follows:

1. Goods vehicle cost skims (in minutes) are taken from the appropriate model run. These would include any CAZ charge specific to goods vehicle, which will be skimmed from the network and added to the generalised cost.
2. The mean value of the LGV and HGV cost skims is taken
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.

6 Methodology on option testing

6.1 Options

The Strategic Outline Case (SOC) shortlisted several options for an air quality plan for North Staffordshire, namely:

1. Etruria Valley Link Road and A500 improvement plus council boundary scale low emission strategy
2. A city centre/A53 traffic management scheme plus council boundary scale low emission strategy
3. A city centre/A53 workplace parking levy plus council boundary scale low emission strategy
4. A conurbation wide workplace parking levy plus council boundary scale low emission strategy
5. A city centre/A53 chargeable access restriction (Class A, B, C or D) – an assessment of each of the 4 CAZ categories

It should be noted that since the SOC, the EVLRs status has become more certain and it is now considered appropriate for its inclusion in the future year Reference Case rather than being treated as an option.

The following policies, some of which form the low emissions strategy, will therefore need to be taken account of in the transport modelling:

- Highway improvements
- Traffic management measures
- Travel planning
- Workplace parking levy (both for a city centre and council boundary wide)
- Bus strategy
- Taxi policies
- Different types, charge levels and boundaries for a charging CAZ

For reference the different CAZ types are defined in Table 6-1.

Table 6-1: Clean air zone types

Class	Vehicles Affected
Class A	Buses, coaches, taxis and private hire vehicles
Class B	Buses, coaches, taxis and private hire vehicles, HGVs
Class C	Buses, coaches, taxis and private hire vehicles, HGVs, LGVs
Class D	Buses, coaches, taxis and private hire vehicles, HGVs, LGVs, Cars

6.2 Behavioural responses to CAZ

Regarding 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 routeing through a CAZ. This will include undertaking some sensitivity testing to sense check the demand responses when applying different daily CAZ charges by vehicle type. The demand responses and the methodology for modelling them are outlined in Table 6-2. Please note the table does not provide a hierarchy of response but just outlines the different demand responses which will need to be captured in the updated NSMM transport model.

Table 6-2: CAZ demand responses

Response	Demand Response to CAZ	Methodology
1	Replacing or upgrading vehicle	Choice modelling will be applied as outlined in section 7, using SP 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. LGVs, HGVs and taxis will be excluded from this demand response as they don't have a choice to change their destination as their delivery/customer 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. Given the locations of exceedances (on busy roads in narrow corridors with a lack of space for cycle lanes for example) widescale active travel measures have not formed part of the Preferred Option or other options, beyond improvements to pedestrian crossing facilities on the A53. The NSMM transport model does not explicitly model walking and cycling trips, given the above, such measures have not been assessed,
5	Change route to avoid CAZ	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. 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. 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 for inbound links 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.
6	Pay the CAZ charge	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. Those cars, taxis, LGVs and HGVs paying the charge as derived from the multinomial model and SP analysis will be segmented and assigned to the network separately. CAZ revenue will be separately derived through looking at the pay CAZ charge matrices output from the model for each time period but removing reverse trips to ensure only one charge is paid over the day, this revenue with then be annualised using appropriate factors to convert to 365 days.

6.3 Behavioural responses to other measures

Table 6-3 provides an outline of how alternative policy measures to a charging CAZ would be modelled.

Table 6-3: modelling of alternative policy measures

Policy	Methodology
Highway Improvements	New highway schemes will be coded into the highway model and run through the NSMM demand model to understand the likely trip redistribution and re-assignment effects
Traffic Management	Banned turns, one-way links and other traffic management measures will be coded into the highway model and run through the NSMM demand model to understand the likely trip redistribution and re-assignment
Travel Planning	A percentage reduction to car trips will be applied on corridors or areas where travel planning would be implemented based on an agreed reduction with JAQU.
Workplace parking levy	A Select link analysis on the 2022 Reference Case was conducted to establish demand for routes that go into the central parking areas of Etruria, Newcastle-under-Lyme and Hanley. These are potential locations where a Workplace Parking Levy (WPL) could be introduced. The select link matrices were filtered to focus on only home to work non-compliant car trips to those parking zones, with non-work and through trips excluded. Assumptions regarding the excluded parking, the ratio of public and private spaces, the percentage of WPL spaces that will get paid by the employer and how much will be passed onto the employee were applied from the existing Nottingham WPL example. From analysis, the actual demand for non-compliant commuting cars that would be parking in these zones would be very small especially when allowed for the spatial restrictions of the policy, the balance between private/parking spacing and the percentage of spaces that the employer rather than the employee would pay. The overall impact would be small and therefore it is was not worth undertaking further detailed modelling or appraisal as part of the option testing. The analysis is detailed in a separate technical note which is appended to the strategic case.
Bus strategy	The NSMM public transport model includes all bus services in North Staffordshire, possible measures such as new or more frequent services or bus priority can be explicitly modelled to capture mode shift and forecast changes in outturn bus and passenger kilometres/hours.
Taxi policies	A taxi matrix will be segmented from the car matrix using the ANPR survey data proportions. It should be noted that the proportion of total traffic that are taxis in North Staffordshire is quite low. The segmentation is required in order to assess any charging CAZ for type A to C

Scenario and sensitivity tests can be conducted on the above, with the analysis of specific origin-destination movements, to compare the demand responsiveness to measures against what has been observed elsewhere, as part of a benchmarking exercise.

7 Methodology for stated preference

7.1 Overview

In order to understand the demand responses to a charging CAZ in North Staffordshire we undertook a local SP survey. Sweco, the local authorities and JAQU worked together to devise the SP surveys. JAQU provided SP questionnaires used for Bradford and Bath as a useful reference for the SP questionnaire design.

7.2 North Staffordshire stated preference survey implementation

Sweco appointed Watermelon to undertake an SP survey in Autumn 2019 of the North Staffordshire public, businesses and taxi firms about how they would respond to a charging CAZ. The following SP surveys were undertaken in North Staffordshire:

1. A SP questionnaire focussed on car and LGV drivers for residents including how they would respond to a charging clean air zone of different charge levels, how they might trade off different charging levels with different vehicle upgrade costs. The Bradford approach has been followed by splitting LGVs into small and medium enterprises (SMEs)/services and large delivery companies given the different behavioural responses.
2. A SP questionnaire focussed on HGV and LGV drivers targeting businesses looking at demand responses for different CAZ charges. Drivers are often the decision makers for service vans while businesses decide on their LGV fleets (see #2 below for the SP survey of this market).
3. A SP questionnaire focussed on taxis targeting taxi drivers and asking how they would respond to different charge levels, including paying a charge and trading off vehicle upgrade cost with CAZ charge costs.

The SP surveys described above captured the following demand responses to a charging CAZ by vehicle type:

Cars:

- Change route
- Change destination
- Pay charge
- Cancel trip
- Change mode
- Upgrade vehicle
- Switch vehicle

LGVs/HGVs:

- Change route
- Pay charge
- Cancel trip

- Relocated business
- Upgrade vehicle
- Switch vehicle

Taxis:

- Cancel trip/stop operating
- Upgrade vehicle
- Switch vehicle

Due to time constraints, the SP surveys did not consider different size charging zones however people's response should not change significantly. The model will capture the impact of different sized charging zones in terms of the amount of demand going to, from, within, through or across the cordon for different sizes charging areas. The percentage demand responses will be constant unless the actual charge changes for any or all the vehicle types. This is the same approach as undertaken by Bradford and Bath and detailed in their SP surveys provided by JAQU.

A separate (non-SP) discussion was had with the main bus operators of North Staffordshire including First and D&G regarding their likely response to a charging CAZ in general, to different charging types and levels and the cost and likelihood of them upgrading their vehicles.

When conducting the SP surveys, several screening questions will be asked based on the participant's previous journey to the proposed CAZ area, whether the participant could drive and that they had a non-compliant vehicle.

A mixture of the following survey methods will be used:

- Face to face interviews
- Online surveys
- Telephone interviews

The face to face surveys, which will take between 10 to 20 minutes will be undertaken at identified strategic locations within the study area such as town and city centres and retail parks where there is a high footfall.

The taxi driver face to face surveys will be undertaken at the Newcastle-under-Lyme depot and Hanley Town Hall where taxi drivers obtain their licenses. In addition, we will make use of the regular trade association meetings too.

For the online panel surveys, respondents will be recruited using an online market research panel, which utilises members of the public who have signed up to undertake such surveys online. Respondents will be identified based on their location, demographic, behavioural and vehicle ownership details which enables a broad and comprehensive sample. For this survey, a representative sample of the population based on 2011 census data using age, gender and location will be contacted and invited to participate.

Prior to the telephone interview which would primarily focus on local businesses the survey company will undertake an investigation of local businesses identifying offices within or near the study area, or businesses that might feasibly travel through the study area.

A target sample of 475 responses across all three surveys for the above is considered appropriate for this study to obtain statistically significant outputs. In addition to the total sample target, percentage quotas by origin location based on demand analysis from the NSMM transport model will be also used. It should be noted that each survey elicits multiple responses.

7.3 Incorporation into the NSMM demand model

The following process will be adopted once the raw SP data for North Staffordshire has been collected:

- **Sense checking** – logic checks will be undertaken on responses as well as checks to ensure participants are making trade-offs rather than always selecting one outcome. Non-sensical responses where a respondent would be willing to pay a charge at a higher level but not a lower one, will be removed.
- **Segmentation** – the results will be segmented by income group. The groupings will be in accordance with TAG's corresponding annual household income bands, namely:
    - £0 - £20,000
    - £20,000 – £45,000
    - £45,000 +
- **Factoring** – we will review the results to the CAZ charging question including looking at factoring the reported trip frequency
- **Weighting** – we will review the SP responses to assess whether the sample will be weighted by trip purpose (including frequency), respondent age and fuel type. Any assessment and weighting will draw on the ANPR survey results and census household income distributions.

Statistical significance tests on variables will be undertaken coupled with the regression described above in order to derive the percentages of demand for each demand response and to ensure that only significant factors have been considered.

A comparison of the coefficients and outturn forecasts from the North Staffordshire SP survey analysis will be made with the data from other UK cities.

After this analysis, logistic regression will be applied to the SP data to derive the coefficients for a choice model to forecast the likely trade-off between the CAZ charge and the cost to replace the vehicle to a compliant one. This will permit a prediction of the compliance rate for any given charge. A multinomial logistic regression will also be undertaken accounting for household income categories, to derive the percentages of demand into the different responses such as cancel trip, change mode, re-route, change destination, pay charge and replace vehicle.

In addition to the above primary behavioural responses, JAQU have produce guidance on secondary responses to a charging CAZ which we have incorporated into our work.

For the upgrade vehicle behavioural response, the following has been assumed:

- 75% of these respondents will replace their non-compliant vehicle with a second-hand compliant vehicle
- 25% will scrap their vehicle and buy a new one of the same fuel-type
- For car owners, 75% of those replacing will purchase the cheapest compliant vehicle (so diesel will switch to petrol) while the remainder will stay with the same fuel type. For non-car owners there are limited alternatives, so this assumption does not apply.

8 Traffic model outputs for use in air quality modelling

8.1 Traffic model outputs

Traffic flow information will be output from the updated NSMM model for the following modelled years and scenarios:

1. 2015 Base Year – which count analysis and validation shows represent 2018
2. 2022 Reference Case
3. 2022 Do Something (DS) scenarios – see section 6
4. 2025 Reference Case
5. 2025 Do Something (DS) scenarios – see section 6

Traffic flow and speed information by cars, LGVs, HGVs and taxis for polluting and non-polluting vehicles can be extracted as well as further information on bus and coach vehicles.

The traffic data will be processed as 1-way links with allowance for junction delays.Traffic flows will be provided in units of vehicles and speeds in units of kph.

Factors will be applied using local traffic count data to convert from the model period traffic flows to daily flows.

Junction delays will need to be included in addition to link speeds and again consideration will be needed regarding the averaging of one-way or two-way link speeds and how these are converted to daily speeds.

8.2 Traffic data for air quality model

The following information will be provided from the NSMM transport model for use in the air quality model (RapidAir):

Traffic flows, the emission factor toolkit uses traffic flows split into the following vehicle subcategories:

- Petrol Cars (split post assignment using the ANPR data)
- Diesel Cars (split post assignment using the ANPR data)
- LGVs
- Rigid HGVs – HGV flow split applied post assignment based on an observed split
- Articulated HGVs - HGV flow split applied post assignment based on an observed split
- Buses
- Coaches
- Taxis
- Motorcycles – using a percentage uplift on total flows based on an observed split

Analysis of 2015 and 2018 traffic count data on the A500 screenline shows zero net traffic growth, the 2015 base year disaggregated traffic model flows can therefore be used to represent the 2018 base year for the air quality modelling work.

Hourly traffic profiles on a by-road or regional basis based on local traffic count profiles.

Traffic Speed:

- AM average speed
- IP average speed
- PM average speed
- Daily average speed

Congestion:

- Queue length from junctions, using an assumed average vehicle length
- Assumptions will need to be made around idling times and the number of lanes queuing on each link

Vehicle fleet data (following assimilation of ANPR data):

- Euro split for each vehicle type and by road (split post assignment)
- Fuel split by vehicle type (split post assignment)