Southampton Clean Air Zone

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TRANSPORT MODELLING METHODOLOGY REPORT (T3)

SYSTRA

SOUTHAMPTON CLEAN AIR ZONE

TRANSPORT MODELLING METHODOLOGY REPORT (T3)

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1. INTRODUCTION

1.1.1 SYSTRA, working in partnership with Ricardo Energy and Environment Consultants, were commissioned by Southampton City Council for the Southampton Clean Air Zone Feasibility Study, assessing the air quality and transport modelling needs for the feasibility study, delivering the air quality modelling and co-ordinating transport modelling inputs and developing a business case.

1.1.2 This document provides the modelling methodology for the transport inputs, and is structured into the following Chapters:

- Chapter 2: Model review and specification;
- Chapter 3: Base Year Modelling, and;
- Chapter 4: Transport Forecast Modelling.

2. MODEL REVIEW AND SPECIFICATION

2.1.1 Solent Transport commissioned SYSTRA to develop a Sub-Regional Transport Model (SRTM) that covered the areas of Southampton, Portsmouth and South Hampshire. The SRTM has been developed to support a wide-ranging set of interventions across the Solent Transport sub-region, and is specifically required to be capable of:

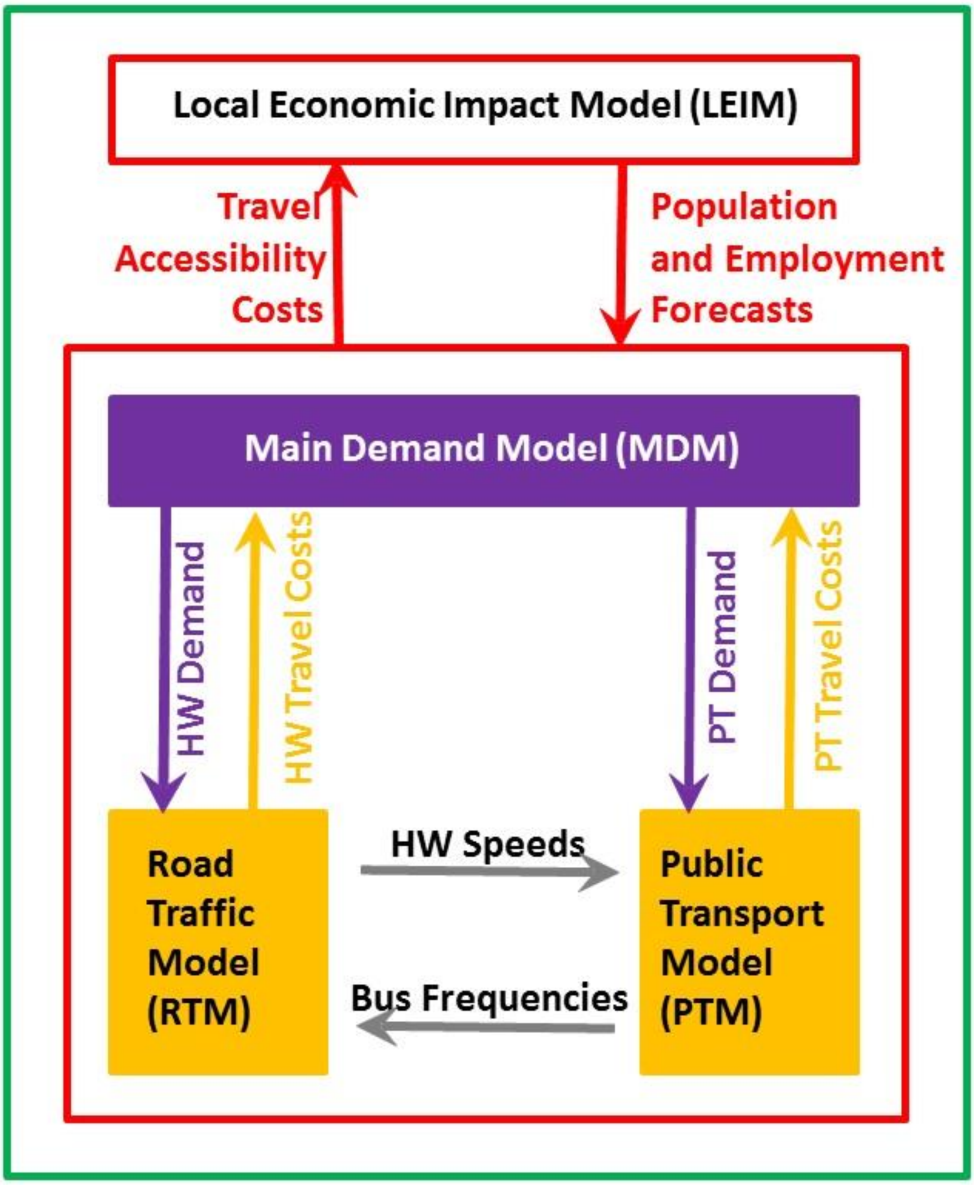
- Forecasting changes in travel demand, road traffic, public transport patronage and active mode use over time as a result of changing economic conditions, land-use policies and development, and transport improvements and interventions;
- Testing the impacts of land-use and transport policies and strategies; and
- Testing the impacts of individual transport interventions in the detail necessary for preparing submissions for inclusions in funding programmes.

2.1.2 The SRTM is a suite of linked models comprising of the following components:

- Main Demand Model (MDM) which predicts when (time of day), where (destination choice) and how (choice of mode) journeys are made;
- Gateway Demand Model (GDM) which predicts demand for travel from ports and airports;
- Road Traffic Model (RTM) which determines the routes taken by vehicles through the road network and journey times, accounting for congestion;
- Public Transport Model (PTM) which determines routes and services chosen by public transport passengers; and
- Local Economic Impact Model (LEIM) which uses inputs including transport costs to forecast the quantum and location of households, populations and jobs.

2.1.3 The interaction of the sub-models is illustrated in Figure 1 below. The SRTM was originally developed, calibrated and validated against 2010 data and conditions and a Local Model Validation Report (LMVR) is available for this 2010 base-year model.

Figure 1. Interactions of Sub-Models within the SRTM



2.1.4 SYSTRA have recently updated the base year to 2015 survey data. The Validation Report is provided as T2 Model Validation Report.

2.1.5 New survey data has been collected in the Southampton and New Forest area's in 2015. The maps below in Figure 2 and Figure 3 shows the locations of the data that has been used as part of the 2015 re-base validation for Southampton and New Forest respectively.

Figure 2. Location of Validation Data Points for 2015 SRTM Validation - Southampton

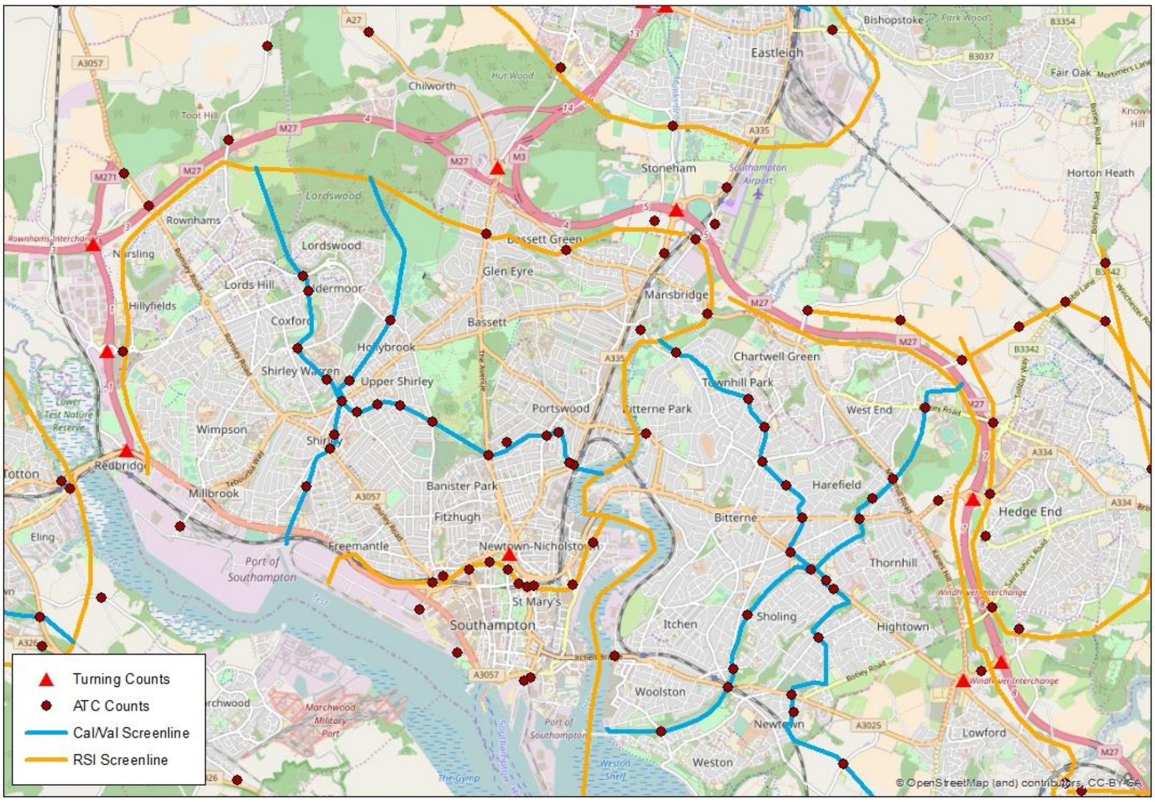
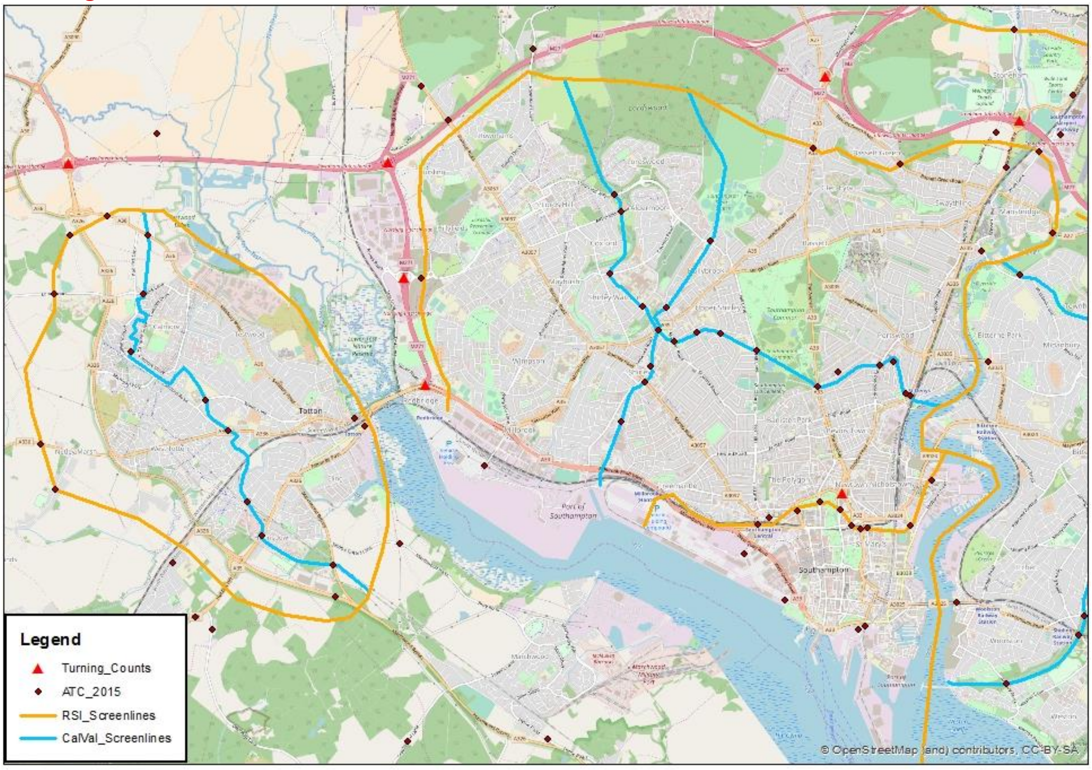


Figure 3. Location of Validation Data Points for 2015 SRTM Validation – New Forest



2.1.6 The 2015 model has been constructed according to WebTAG recommendations, and validated against DMRB guidelines. The calibration process did not reveal any significant problems or shortcomings in the base year. The quality of the validation of the model is generally good, with the screenline validation performing particularly well, which is critical for ensuring that the demand in the model is correct for assessing multi-modal schemes and future changes.

2.1.7 The journey time validation and the patterns of junction delay appear consistent and plausible, although the link flow and journey time validation do not meet the WebTAG criteria. It is often considered that the WebTAG thresholds of acceptability are more suited to smaller, less complex models, and as such it may be argued that a certain level of flexibility is acceptable given the scale and complexity of the SRTM, and the criteria disguises a good model performance that is close to meeting the acceptability guidelines.

2.1.8 The calibration and validation suggest that the model is fit for the purpose of representing the highway traffic patterns in the base year, as part of the SRTM.

2.1.9 Appendix A of the T2 SRTM Validation Report presents the results of the cordon and screenline validation during the AM, IP and PM peak hours for both vehicles and cars. Within Southampton and the New Forest areas, there are 5 RSI cordons / screenlines (Southampton City Enclosure, Bitterne West Screenline, Bitterne East Screenline, Totton Enclosure and Southampton Enclosure) and 5 calibration screenlines (Totton, North of Southampton, South of Southampton, Bitterne Northwest to Southeast and Bitterne Southwest to Northeast). For all of the cordons, screenlines and time periods within Southampton, the overall validation performs well.

2.1.10 The individual link validation results for the validation and calibration cordons and screenlines within Southampton and the New Forest are also presented in Appendix A, expanding the data to report the link validation by user class (cars, LGV and HGVs). The relevant sections of the motorway link validation are also included within this appendix.

2.1.11 The journey time validation is presented in Appendix B, with routes 1 -7 being the routes in Southampton and New Forest.

2.1.12 There is another available transport model of the Southampton City Centre created in AIMSUM by WSPPB. However, the spatial coverage of this AIMSUM model is insufficient to pick up the main traffic diversions likely to be created by the proposed Southampton CAZ and the model does not include many of the changes in travel behaviour (notably mode and destination-choice) which are likely to be generated by the introduction of the CAZ. Any benefits from the modelling of the second-by-second interaction between vehicles available in the AIMSUN model are insufficient to overcome the limitations noted above or the costs associated with using a hybrid 2-traffic-model approach to modelling the traffic within the CAZ Study area.

3. BASE YEAR MODELLING

3.1.1 The base year for the SRTM model is 2015 (as discussed in the section above). This chapter summarises the main features of the SRTM and includes the following sections:

- Geographic scope
- Zoning system
- Timer period
- Traffic input data
- Vehicle disaggregation

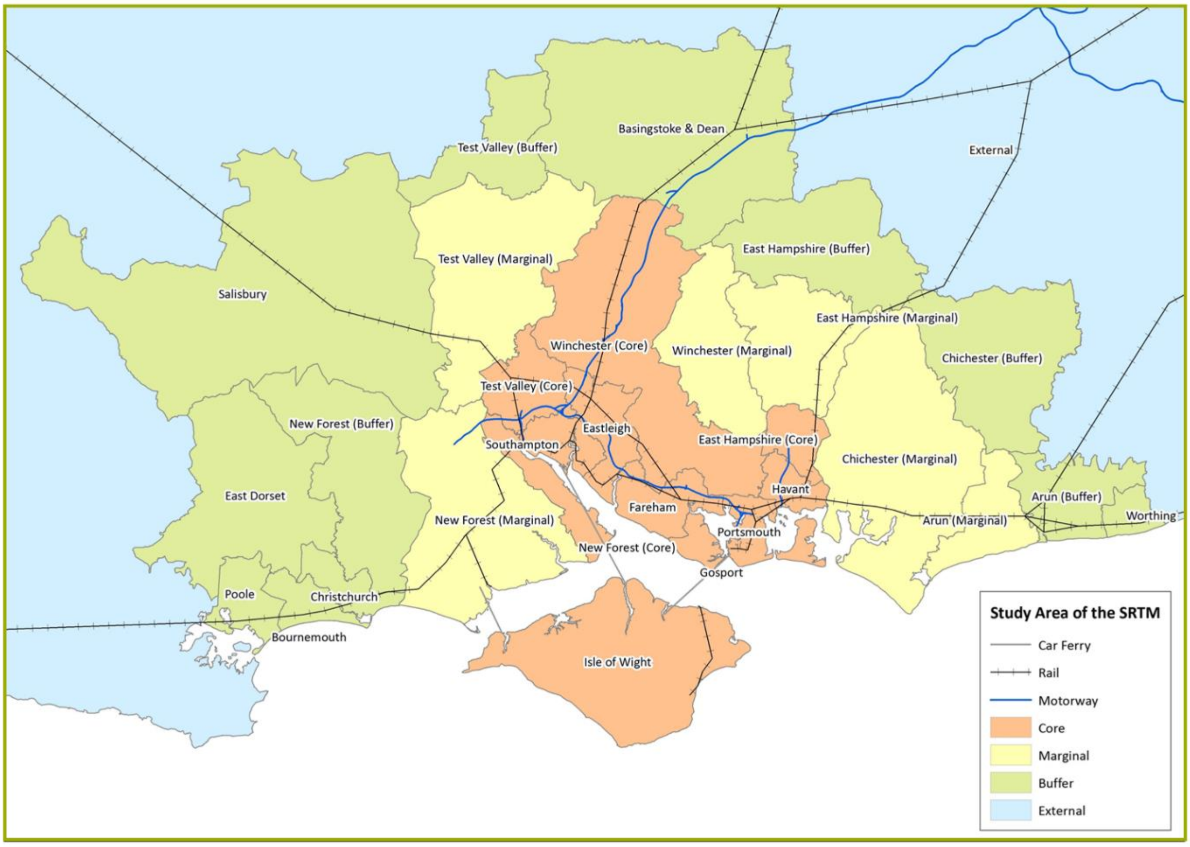
3.2 Geographic Scope

3.2.1 The modelled area of the SRTM is sub-divided into four regions which differ by zone aggregation and the level of detail within the modelling, as follows:

- Core Fully Modelled Area (detailed zoning and simulation network representation);
- Marginal Fully Modelled Area (normally based on MSOAs);
- Buffer Area (zones based on Districts); and
- External (zones based on Districts and Counties).

3.2.2 Figure 4 below shows these four regions within the SRTM. Southampton is within the Core Fully Modelled Area (the most detailed region of the model).

Figure 4. Study Area of the SRTM



3.3 Zoning System

3.3.1 The choice of zone system dictates the level of spatial resolution of the models and hence the ability of the models to realistically represent the transport situation. Current guidance states that in the 'internal' (Core Fully Modelled Area) area zone boundaries should seek to take account of the following:

- Natural barriers (rivers, railways, motorways or other major roads);
- Areas of similar land use that have clearly identifiable and unambiguous points of access onto the road network included in the model;
- Existing zone boundaries, where an existing model is being used as the basis for the new model;
- Administrative and planning data boundaries (wards, parishes, Census Output Areas);
- The location of the main parking areas, where town centres are included in the model; and
- The need for internal screenlines for trip matrix validation.

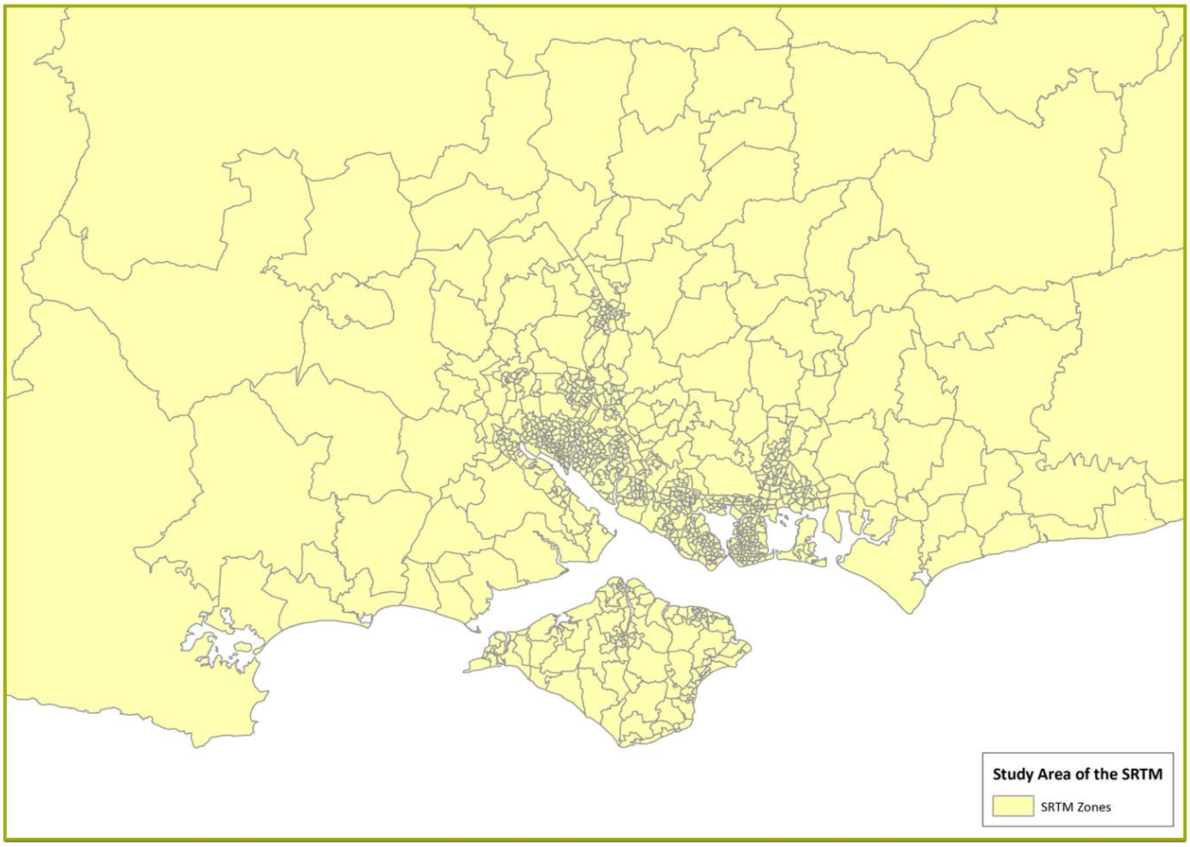
3.3.2 Within this study the zoning must also satisfy the requirements of all of the models within the model suite. Table 1 shows the various zone system requirements for each of the models.

Table 1. SRTM Suite Zone System Requirements

MODEL COMPONENT	REQUIREMENT
MDM & LEIM	Land use characteristics for ensuring zones contain similar land use
	Known future development sites are not given their own exclusive zones. Instead zone numbers have been reserved for that purpose in future year modelling
RTM	Highway access can be realistically modelled
	RSI enclosure boundaries (RTM) and highway screenlines must be respected
PTM	Walk access/egress must be modelled in enough detail to ensure true differential between public transport and highway
	Bus stop catchments, bus stop 'clusters', bus corridors and fare zones must be taken into account
	Public transport screenlines must be respected
GDM	The GDM will work at the (air/sea) port level at one end of port-terminating trips but the different network access points for "gateway traffic" will be defined as zones

3.3.3 The SRTM zone system uses 2011 Census Output Areas (COAs) as building blocks in the fully modelled area. Elsewhere, the zone system uses aggregations of Census Wards. In the fully modelled area, disaggregation was used to ensure that no zones have more than 400 highway trip origins or destinations per hour in the base year. Figure 5 below shows the SRTM zone system around the study area.

Figure 5. SRTM Zone System



3.4 Time Period

3.4.1 Three weekday periods are modelled within the SRTM:

- AM peak;
- Inter peak; and
- PM peak

3.4.2 These three periods cover a 12 hour period and allow the relative differentials in travel cost to be represented. The periods are defined in Table 2.

Table 2. Time Period Definitions

PERIOD	FULL PERIOD FOR DEMAND MODEL	RTM ASSIGNMENT PERIOD
AM Peak	07:00 – 10:00	Peak hour (factored from period)
Inter peak	10:00 – 16:00	Average hour from full period
PM peak	16:00 – 19:00	Peak hour (factored from period)

3.4.3 The RTM is based on demand levels for one-hour periods, based on the distributions of the broader period. For the inter peak this is an average hour whilst the AM and PM peak periods are represented by the peak hours.

3.5 Traffic input data

3.5.1 There are 4 main highway user classes modelled in the SRTM:

- Car employer's business
- Car other
- HGV
- LGV

3.5.2 The SRTM also models public transport including buses, trains and ferries.

3.6 Traffic count data

3.6.1 The traffic count data used in model validation was described in the section above.

3.7 Vehicle disaggregation

3.7.1 The SRTM provides 4 core vehicle categories from the air quality modelling work: Cars, HGVs, LGVs and buses. As described in section 4.2.2 of the Air Quality Modelling Methodology Report (AQ2), this was further broken down by splitting HGV's into rigid and articulated vehicles, and an assessment of the proportion of taxis in the vehicle flows. This was done using local count and ANPR data.

4. TRANSPORT FORECAST MODELLING

4.1.1 The SRTM model endeavours to represent transport conditions up to the year 2041. Known developments and committed (funded) highway schemes are included within the models' Reference Case scenarios (2019, 2026, 2031 and 2036) to provide a representation of future year transport supply and demand. Table 3 shows the list of committed highways schemes included within the standard SRTM Reference Case in Southampton and neighbouring districts.

Table 3. Reference Case Schemes

Scheme	Description	2015	2019	2026	2031	2036	2041	District
M27 J3	W/B off-slip and corresponding circulating lane flared to 3 lanes, M271 S/B approach flared to 3 lanes, M271 N/B flare lengthened		✓	✓	✓	✓	✓	Test Valley (Core)
Commercial Rd / Morris Rd / Wyndham Place	Public realm scheme, change to traffic signals		✓	✓	✓	✓	✓	Southampton
M271 Junction 1 / Brownhill Way	Signalisation of M271 Junction 1, additional carriageway on Brownhill Way to Adanac rbt		✓	✓	✓	✓	✓	Test Valley (Core)
A335 Leigh Rd / Passfield Avenue	Junction capacity changes		✓	✓	✓	✓	✓	Eastleigh
SMP M27	Smart motorways M27		✓	✓	✓	✓	✓	Southampton, Test Valley (Core), Eastleigh, Fareham, Winchester (Core), Portsmouth
M271 Redbridge Rbt. (RIS)	Option 2a (completion due 2018 / 2019) - HE will confirm post June 2017 general election		✓	✓	✓	✓	✓	Southampton
A33 Western Approach / Redbridge Rd / Millbrook Rd West	Reduction in speed limit from 50mph to 40mph		✓	✓	✓	✓	✓	Southampton
Woolston - Victoria Rd / Woodley Rd	Changes to Victoria Rd to one way southbound		✓	✓	✓	✓	✓	Southampton
Sundays Hill Bypass	New road alignment with 7.3m carriageway width and 30mph speed limit		✓	✓	✓	✓	✓	Eastleigh
St John's Link Road	6.5m carriageway width and 30mph speed limit		✓	✓	✓	✓	✓	Eastleigh
Chestnut Avenue / Stoneham Lane Roundabout	Roundabout improvements		✓	✓	✓	✓	✓	Eastleigh
Chestnut Avenue / Passfield Avenue Roundabout	Roundabout improvements		✓	✓	✓	✓	✓	Eastleigh
Burnett's Lane Link Road and roundabout	New road alignment between Burnetts Lane and Bubb Lane, extending to access road to Fir Tree Lane. 7.3m carriageway width and 30mph speed limit		✓	✓	✓	✓	✓	Eastleigh
Botley Road / Burnett's Lane	Signals		✓	✓	✓	✓	✓	Eastleigh
Allington Lane / B3037 Fair Oak Road	Signals		✓	✓	✓	✓	✓	Eastleigh
Southampton Road / Chestnut Avenue	Addition of a right turn lane (4 pcus)		✓	✓	✓	✓	✓	Eastleigh

4.1.2 The Smart Motorways measures planned for the M27 (which is assumed would be one of the main diversion routes) is likely to be introduced in 2020, and have been assumed to be in place (with additional capacity changes) from the SRTM model run year of 2019.

4.1.3 The 2019 Reference Case model does not include the disruption created during the construction of these network changes or the resulting changes in network capacity.

4.2 Forecast Year Uncertainty

4.2.1 The SRTM's standard 'Reference Case' scenarios representing forecast year conditions includes both new transport infrastructure schemes and landuse development assumptions to represent expected changes in conditions compared to the Base year.

4.2.2 Reference case transport infrastructure only include those schemes that have received the necessary planning approvals and are fully funded. This provides a high degree of certainty that the schemes will be constructed. Reference Case schemes within Southampton and neighbouring districts are listed above in Table 3.

4.2.3 In the standard Reference Case, landuse inputs (sqm floorspace) are derived from the Local Plans for each of the planning authorities and the records of granted planning permissions. The landuse model (LEIM) represents floorspace either as exogenous or permissible. Exogenous floorspace is always built-out within the model and represents those sites with planning permission or completed sites since the 2015 Base Year - hence exogenous floorspace has a high degree of certainty associated to it. Permissible floorspace refers to those locations identified as suitable for future development but that have not yet been subject to planning approval. The locations and maximum land use quantum of the permissible sites are based on Local Plan allocations. The take up of permissible developments is determined by the LEIM module of SRTM and is based on the local conditions (the relative 'attractiveness' of the development e.g. accessibility). Permissible floorspace has a lower degree of certainty but is still considered the most likely representation of future landuse growth based on available data.

4.2.4 The Local Plan information currently input to the SRTM dates from April 2016 and only includes for Adopted Plans at that time (it is anticipated that periodic updates of the landuse inputs will be undertaken to account for newly adopted Plans and planning permissions etc). In later model years, and particularly those beyond current Plan periods, the model includes a process referred to as 'intensification'. This enables continued growth to be represented within existing developed areas to allow TEMPRO forecasts to be met. Intensification is limited to those areas where development already exists because it is not considered appropriate for the model to arbitrarily allocate development to undeveloped areas. It follows that there is less certainty in the actual location of this growth.

4.3 Baseline Forecast

4.3.1 At the baseline stage the four user classes were split into the 12 user classes, as described below in Section 4.5.12. These different user classes were then run through the SRTM and assigned onto the network, providing the baseline which to compare the CAZ option results.

4.4 Options Forecast

4.4.1 The options forecasts or Do Something (DS) scenarios represent the transport model runs of the CAZ schemes. The proposed CAZ zones were modelled as cordons within the model, where different levels of charging can be applied to different user classes. The CAZ charging scheme applies to all non-compliant vehicles (determined by Euro standards classifications) which travel within a defined enclosed area. The charge is incurred once per day per vehicle.

4.5 Initial Sifting Options

4.5.1 Ten simplified model runs were undertaken for initial sifting of scheme options to explore the impact of various charging area schemes, using a highway only AM peak hour, 2019 fixed demand matrix assignment, with no demand model responses modelled.

4.5.2 Only vehicle ownership and re-routing responses were considered, with the expectation that a number of chargeable non-compliant trips divert to avoid the charge. The results from this sifting options provided an indication of the traffic flow changes, highway impacts and subsequent revenue of each scheme.

4.5.3 Only non-compliant vehicles incur any charges from travelling within the CAZ area. In the highway model tests, non-compliant vehicle demand is split into those beginning or ending their trips **inside** the CAZ area (so are forced to pay the charge), and those who are potentially passing through, so starting and ending their trip **outside** the CAZ area, with the option to re-route to avoid the charge.

4.5.4 Within the tests, non-compliant vehicles which begin or end their trips inside the CAZ (and are forced to pay the charge), do not consider changing their route. This avoids discouraging trips which may pass out of the enclosure then back in. However, these vehicles are included as non-compliant charged types in the outputs.

4.5.5 To establish the compliant and non-compliant vehicle split within the model, JAQU's assumptions for the behavioural responses of vehicle owners to the CAZ charges set out below in Table 4 were utilised. Our understanding is that these assumptions are based on data provided by TfL in relation to expected responses to the London ULEZ. When modelling the CAZ in Southampton, the ULEZ charges were used so that consistency is maintained with the JAQU behavioural response data. The charging structure is modelled as follows:

- **Cars and LGVs:** £12.50
- **HGVs;** £100

4.5.6 Within the highway assignment model, the charge is applied by half on all CAZ entrance and exit network links, ensuring that over a single journey the full charge is incurred.

4.5.7 Table 4 below outlines JAQU assumptions for behavioural responses to the CAZ. The national fleet mix in 2020 is taken as a starting point for compliant/ non-compliant proportions, then the CAZ behavioural response acts on the non-compliant trip makers within the non-compliant group.

4.5.8 Since the demand model captures trips paying the charge, avoiding the zone and cancelling the trip in response to local conditions, just the vehicle upgrade is required to be applied externally according to JAQU guidance. Here trip makers using non-compliant vehicles to make trips which are deemed to be affected by the CAZ respond by upgrading their vehicle to become compliant, using the figures highlighted in bold.

Table 4. JAQU Assumptions on Behavioural Response to the CAZ

PROPORTION OF NON-COMPLIANT VEHICLE KILOMETRES WHICH REACT TO THE ZONE								
	Petrol Cars	Diesel Cars	Petrol LGVs	Diesel LGVs	RHGVs	AHGVs	Buses	Coaches
Pay charge – Continue into zone	7.1%	7.1%	20.3%	20.3%	8.7%	8.7%	0.0%	15.6%
Avoid Zone – Vkms removed, modelled elsewhere	21.4%	21.4%	10.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Cancel journey – vkms removed completely	7.1%	7.1%	6.0%	6.0%	8.7%	8.7%	6.4%	12.5%
Replace Vehicle – vkms replaced with compliant vkms	**64.3%**	**64.3%**	**63.8%**	**63.8%**	**82.6%**	**82.6%**	**93.6%**	**71.9%**

Source: JAQU, CAZ Technical working group minutes – 15/02/2017

4.5.9 The resulting assumed compliance split is provided in Table 5. Across the highway demand the national fleet split is assumed, except where drivers are deemed to respond to the CAZ charging scheme according to the below criteria. For example, for HGVs the national non-compliant level is 14.86% but if affected by the CAZ then 82.6% of those that upgrade vehicles, leaving a non-compliant level of 2.59% (97.41% compliant).

Table 5. Compliance Split Assumptions Used

	% OF COMPLIANT VEHICLES	
VEHICLE TYPE	NATIONAL FLEET MIX IN 2020	REACTING TO CLEAN AIR ZONE
Cars	73.81	90.65
Vans	70.13	89.19
HGVs	85.14	97.41

4.5.10 In the transport model, the higher compliance rate applies to vehicle demand satisfying one of two criteria:

- Where the trip starts or ends within the CAZ area (i.e. an **'inside'** trip)
- Where the trip passes through the CAZ area in the Do Minimum (without charging) scenario (i.e. they travel across the CAZ area but are an '**outside'** trip)

4.5.11 The national fleet split applies to all other demand which is not passing through the CAZ area in the Do Minimum.

4.5.12 To support greater understanding of vehicle behaviour when the CAZ is introduced, the matrices were split into compliant and non-compliant vehicles. As only non-compliant vehicles incur any charges from travelling within the CAZ area, this is further split into those beginning or ending their trips inside the CAZ area and those who pass through the CAZ area (so start and end their trip outside the CAZ area). The compliance split is applied to the existing four Solent highway model user classes, as described below in Table 6, thus ending up with 12 user classes.

Table 6. User Class Compliance Split

VEHICLE TYPE	SOLENT MODEL USER CLASS	NEW USER CLASS – NON COMPLIANT OUTSIDE CAZ AREA	NEW USER CLASS – NON COMPLIANT TO/FROM INSIDE CAZ AREA	NEW USER CLASS - COMPLIANT
Car (in work)	1	1	5	9
Car (not in work)	2	2	6	10
LGV	3	3	7	11
HGV	4	4	8	12

4.5.13 Ten initial sifting runs were undertaken in the SRTM, comparing the lowest demand vehicle class charged (class B&C) against the highest demand vehicle class charged (class D).

4.6 Citywide CAZ – Class B

4.6.1 Based on the ten sifting options, SYSTRA undertook further testing for the preferred scenario, citywide charging of class B (HGVs) within the full demand model. While the sifting analysis only tested the effect of compliance shift (travellers replacing non-compliant vehicles) and re-routing within the AM peak hour, the full demand model run incorporates the inter-peak (1000-1600), PM period (1600-1900) and off peak (1900-0700) time periods as well as the potential for travellers to further alter their behaviour in response to experience of the network. Behavioural responses within the model includes changing modes (to/from public transport or active modes), changing the time of day in which they travel or by changing destination.

4.6.2 Goods vehicle demand is not incorporated within the demand model. When examining HGV charging, the only demand model effect is by travellers in response to the change in HGV behaviour (re-routing to avoid the toll where possible).

4.6.3 For the preferred scenario, only non-compliant goods vehicles incur any charges from travelling within the city-wide CAZ area. As in the sifting option analysis tests, non-compliant heavy goods vehicular demand is split in to those beginning or ending their trips **inside** the CAZ area (so are forced to pay the charge) and those who are potentially passing through, starting and ending their trip **outside** the CAZ area (and may reroute to avoid the charge).

4.6.4 In the preferred scenario, non-compliant heavy goods vehicles which begin or end their trips inside the CAZ area (so are forced to pay the charge) do not consider the charge in their route choice. This avoids discouraging trips which may pass out of the enclosure then back in. However, these vehicles are included as non-compliant charged vehicles in provided network statistics and revenue calculations.

4.6.5 HGVs are assumed to be charged £100 for one day of travel within the CAZ area. This has been implemented as a £50 charge for each trip within the highway assignment model, assuming that HGVs make two trips per day.

4.6.6 The assumed compliance split for all vehicular demand, following JAQU guidance, is provided in Table 5, as per the sifting tests. The national fleet split is generally assumed, except where drivers would respond to the CAZ charging scheme (note that in this test only HGV demand responds). In this case the compliance rate increases to account for drivers replacing their non-compliant vehicle with a compliant vehicle.

4.6.7 HGV demand that is classified as 'reacting to the clean air zone' is identified by analysis of routing in the Do Minimum situation. A 'cordon' is set up within the Saturn assignment software at the proposed CAZ boundaries and trips passing through are identified and flagged where at least 5% of the total OD movement demand passes through.

4.6.8 The demand is split in to classifications which are treated differently:

- **Outside – Outside:** demand does not interact with the CAZ area in the Do Minimum scenario. Remains at national split of compliant/ non-compliant despite the introduction of the CAZ scheme. Non-compliant vehicles would be charged within the highway assignment model if attempting to enter the CAZ area.
- **Through:** Demand passes through the CAZ area in the Do Minimum scenario. In the 'compliance shift' demand matrix, a proportion of the non-compliant demand moves to the new 'compliant shift' compliant userclass which is not charged. The 'compliant shift' userclass is anticipated to have a different vehicle composition than the original 'compliant' userclass, as these are vehicles which have upgraded most recently in response to the CAZ scheme.
- **To/ from CAZ:** These trips are not charged within the assignment model as they would pay the charge with no choice and continue making their trips post-implementation. A portion of the non-compliant demand in this category moves in to the 'compliant shift' compliant userclass.

4.7 Model Outputs

4.7.1 The transport modelling outputs were used for the air quality modelling, with a network review of the SRTM undertaken to check the modelled highway network matches the spatial road layout to ensure successful validation required for the air quality modelling.

4.7.2 The outputs that were provided from the SRTM was in the form of a link based dataset and covered:

- AADT (annual average daily traffic) on each road link in the traffic model;
- AAWT (annual average weekday traffic) on each road link in the traffic model; and
- Journey time on each road link, alongside junction delay, in the traffic model.

4.7.3 For both the AADT and AAWT, the data was reported in the number of vehicles using a link by each user class.

4.7.4 The AADT was calculated from peak hour, inter-peak and off peak model flows, using factors derived from local traffic counts in the Southampton area.

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For more information visit www.systra.co.uk

Birmingham – Newhall Street
5th Floor, Lancaster House, Newhall St,
Birmingham, B3 1NQ
T: +44 (0)121 233 7680 F: +44 (0)121 233 7681

Birmingham – Innovation Court
Innovation Court, 121 Edmund Street, Birmingham B3 2HJ
T: +44 (0)121 230 6010

Dublin
2nd Floor, Riverview House, 21-23 City Quay
Dublin 2,Ireland
T: +353 (0) 1 905 3961

Edinburgh – Thistle Street
Prospect House, 5 Thistle Street, Edinburgh EH2 1DF
United Kingdom
T: +44 (0)131 220 6966

Edinburgh – Manor Place
37 Manor Place, Edinburgh, EH3 7EB
Telephone +44 (0)131 225 7900 Fax: +44 (0)131 225 9229

Glasgow – St Vincent St
Seventh Floor, 124 St Vincent Street
Glasgow G2 5HF United Kingdom
T: +44 (0)141 225 4400

Glasgow – West George St
250 West George Street, Glasgow, G2 4QY
T: +44 (0)141 221 4030 F: +44 (0)800 066 4367

Leeds
100 Wellington Street, Leeds, LS1 1BA
T: +44 (0)113 397 9740 F: +44 (0)113 397 9741

London
3rd Floor, 5 Old Bailey, London EC4M 7BA United Kingdom
T: +44 (0)203 714 4400

Manchester – 16th Floor, City Tower
16th Floor, City Tower, Piccadilly Plaza
Manchester M1 4BT United Kingdom
T: +44 (0)161 831 5600

Newcastle
Floor B, South Corridor, Milburn House, Dean Street, Newcastle, NE1 1LE
United Kingdom
T: +44 (0)191 260 0135

Perth
13 Rose Terrace, Perth PH1 5HA
T: +44 (0)1738 621 377 F: +44 (0)1738 632 887

Reading
Soane Point, 6-8 Market Place, Reading,
Berkshire, RG1 2EG
T: +44 (0)118 334 5510

Woking
Dukes Court, Duke Street
Woking, Surrey GU21 5BH United Kingdom
T: +44 (0)1483 728051 F: +44 (0)1483 755207

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