INFO NOTE

DERBY ROADSIDE NO2

T3 - LOCAL PLAN TRANSPORT MODELLING METHODOLOGY REPORT FEB 19

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1. INTRODUCTION

1.1 Background

1.1.1 SYSTRA has been commissioned by Derby City Council to provide transport modelling support for the Roadside NO_2 Feasibility Study. The purpose of the modelling is understand the transportation and air quality impacts associated with the implementation of a scheme to improve roadside NO_2 air quality in the city, including the possibility of a charging Clean Air Zone (CAZ).

1.2 Requirements of this Technical Note

1.2.1 The Specification for Clean Air Zone Feasibility Modelling Studies report requires the production of a T3 Local Plan Transport Modelling Methodology Report. This Technical Note provides:

- An indication of the range of scenarios that have been assessed;
- Details of how we used the existing strategic transport models and ENEVAL to inform the development of the Preferred Scheme and other measures;
- Details of how the outputs from the transport models have been used to inform the detailed air quality modelling; and
- The transport modelling related outputs and reporting that has been provided during the study.

1.2.2 This report reflects on the requirements in the Specification for Clean Air Zone Feasibility Modelling Studies prepared by the Joint Air Quality Unit of Defra and DfT (JAQU). This report has been updated to reflect the approach that has been undertaken as the project has developed and the most recent proposals for Derby City.

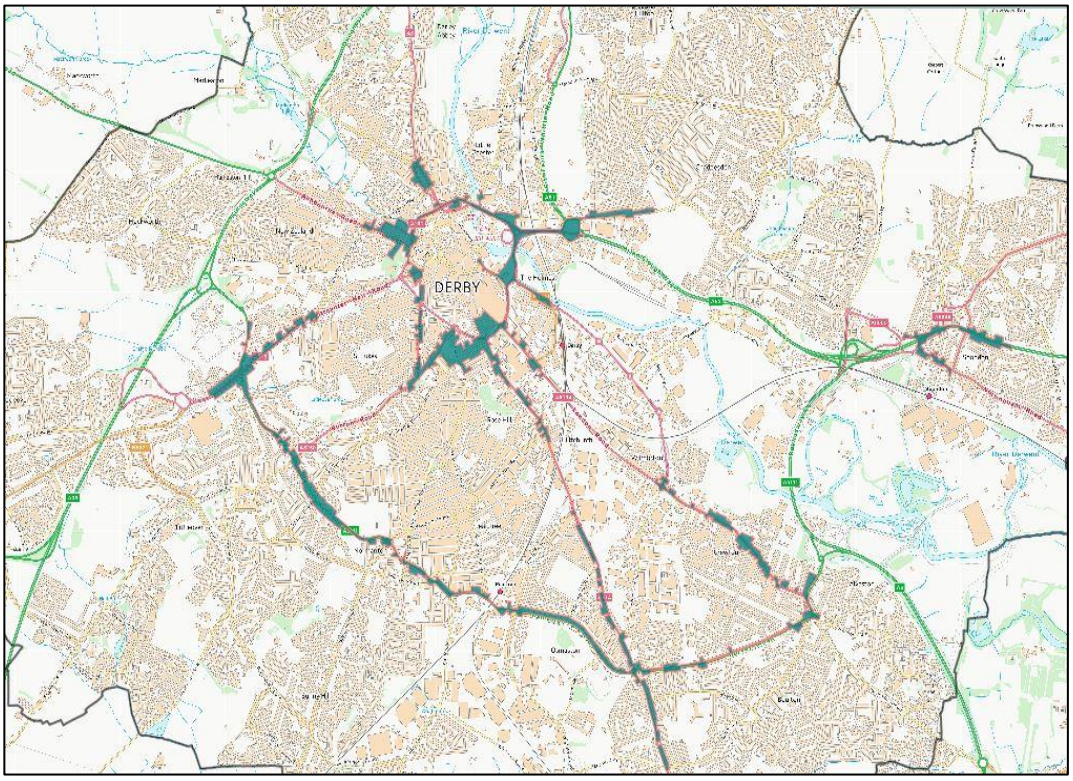
2. DFT TRANSPORT MODELLING REQUIREMENTS

2.1 Area to be Covered

2.1.1 As air quality assessments are required, the transport models need to be able to provide flow information for the following areas as a minimum:

- all roads included in the national Pollution Climate Mapping (PCM) model within the area of interest (see Figure 1 below).
- all roads where the local authority is aware of local exceedances/locations identified locally as at risk of exceeding the NO_2 limit value (concentrations over 40 µg/m^3).
- potential displacement routes that could be affected by any scheme.

Figure 1. AQMA Areas



2.2 Transport Model Specification

2.2.1 The Specification for Clean Air Zone Feasibility Modelling Studies report has highlighted the following specification for the transport model:

- The model should include strategic routes and screen lines and be validated for the key study area against recent (less than 5 years old) collected traffic data.
- This validation should be based on comparison between observed and modelled vehicle composition, flows, traffic pattern and journey time within the key study area.
- If the model does not meet the WebTAG requirements in the key study area, please provide mitigation measures / implications.
- Detail of the assignment convergence are to be provided.

2.2.2 The details above are covered in a separate Local Plan Transport Model Validation Report which has previously been approved by JAQU and the DfT.

2.3 Base Year Modelling

2.3.1 The Specification for Clean Air Zone Feasibility Modelling Studies report identifies the following base year modelling requirements:

- For air quality modelling the base year should be 2013 or a more recent year if more recent data are available.
- For transport modelling, it is recommended that the base year should be no more than 5 years old (WebTAG, unit M3.1, section 8).

2.4 Forecast Modelling

2020 Air Quality Core Assessment Year

2.4.1 The transport model is required to predict the future highway network characteristics for the following scenarios:

- **Baseline projections scenario** – projections to 2020 and any other dates identified locally as necessary (if for instance there are planned development projects that may impact on compliance before or after 2020), based on current policies and assuming no further action.
- **With measures projections scenarios** – projections to assess the impact of vehicle fleet changes relative to the baseline, which will inform potential options to achieve compliance with the AQD limit value for NO_2 (40 µg/m^3) by 2020.

2.4.2 The following basic assumptions have been highlighted to form the approach to generating these forecast scenarios:

- **Projected vehicle fleet composition:** projected fleet composition may be calculated using the national fleet composition projections from EFT
- **Traffic activity projections:** road traffic fleet growth rates calculated using TEMPRO to generate the projected fleet based on current fleet information. Alternatively local assumptions may be made but need to be justified.
- **Impact of Euro 6c (Real Driving Emissions, RDE):** assumptions on Euro 6c fleet penetration and emission factors have been generated from the EFT.

2025 With A38 Grade Separation Reference Case

2.4.3 The A38 Grade Separation scheme will significantly upgrade the capacity at three existing roundabout junctions at A38/A5111 Kingsway, A38/A52 Markeaton and A38/A61 Little Eaton. At present these junctions experience heavy congestion especially in peak hours with significant 'rat-running' on local roads to avoid delays. The Grade Separation Scheme, planned by Highways England for completion by the end of 2024, is forecast to have a significant impact on the traffic routeing within the local area by drawing traffic from the local roads back onto the strategic road network. The resultant changes in flow are also expected to have a measurable impact on air quality levels.

2.4.4 To provide an indication of the impact that the A38 Grade Separation may have on air quality, we have developed a further Reference Case year of 2025 based on the 2020 core scenario with the following adjustments:

- Highway Networks updated to include the A38 improvements as per the latest scheme plans.
- The land use assumptions and outturn trip demand matrices have been updated to reflect traffic growth relating to development completions to 2025, constrained to forecasts from Tempro 7.2.

3. SCHEME OPTIONS ASSESSED

3.1 The Preferred Scheme

3.1.1 The primary focus of the Preferred Scheme is to use both the Stafford Street/Friar Gate and the Meridian Way/Uttoxeter New Road signal controlled junctions at either end of Stafford Street to limit the levels of traffic using Stafford Street. The scheme introduces traffic management measures to manage the flow of traffic in and around Stafford Street, including the roads closest to the exceedance location, to include:

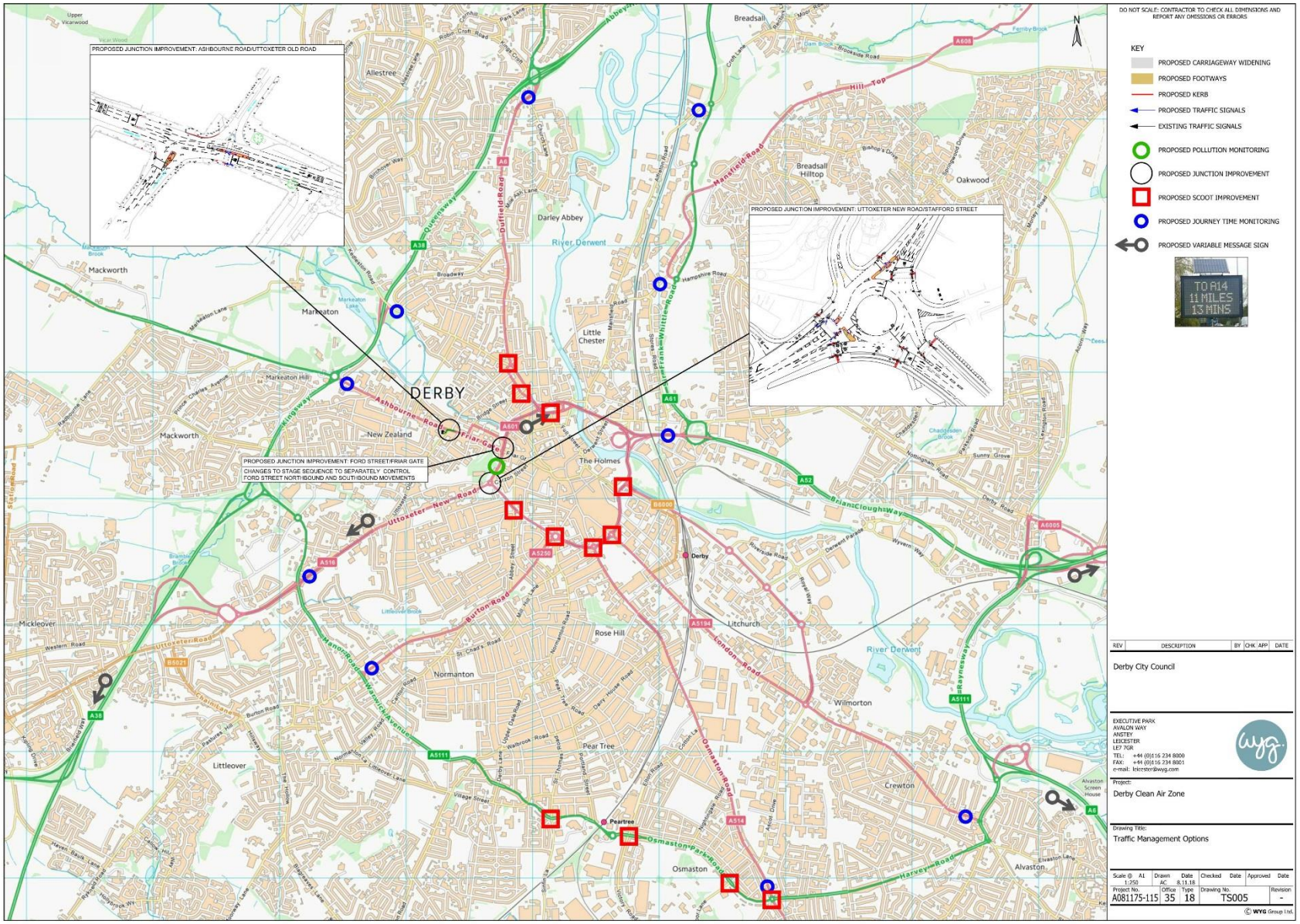
- changes to the junctions at either end of Stafford Street to limit traffic flow in the most sensitive area
- changes to improve capacity at the Ashbourne Road/Uttoxeter Old Road junction to help provide alternative route choices
- traffic management measures to support alternative routes such as Uttoxeter Old Road.

3.1.2 Wider network management also forms part of the package of measures to enable the focused traffic management measures to be more effective by facilitating the limiting of traffic flow on Stafford Street, without creating further exceedances. The wider network management measures include:

- Upgrade and extension of the UTMC network management system that manages traffic signals to help ensure there is a better system in place to enable the Council to manage the traffic flows and the road network to support the air quality agenda
- Signal alterations with strategies in place to prioritise air quality management
- Traffic volumes, fleet data and euro standards data collection via ANPR to feed back into the UTMC system and public communications.

3.1.3 The locations of the proposed interventions are shown in Figure 2.

Figure 2. Preferred Scheme



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3.2 Benchmark Chargeable Access Restriction Option – Within the Outer Ring Road CAZ D

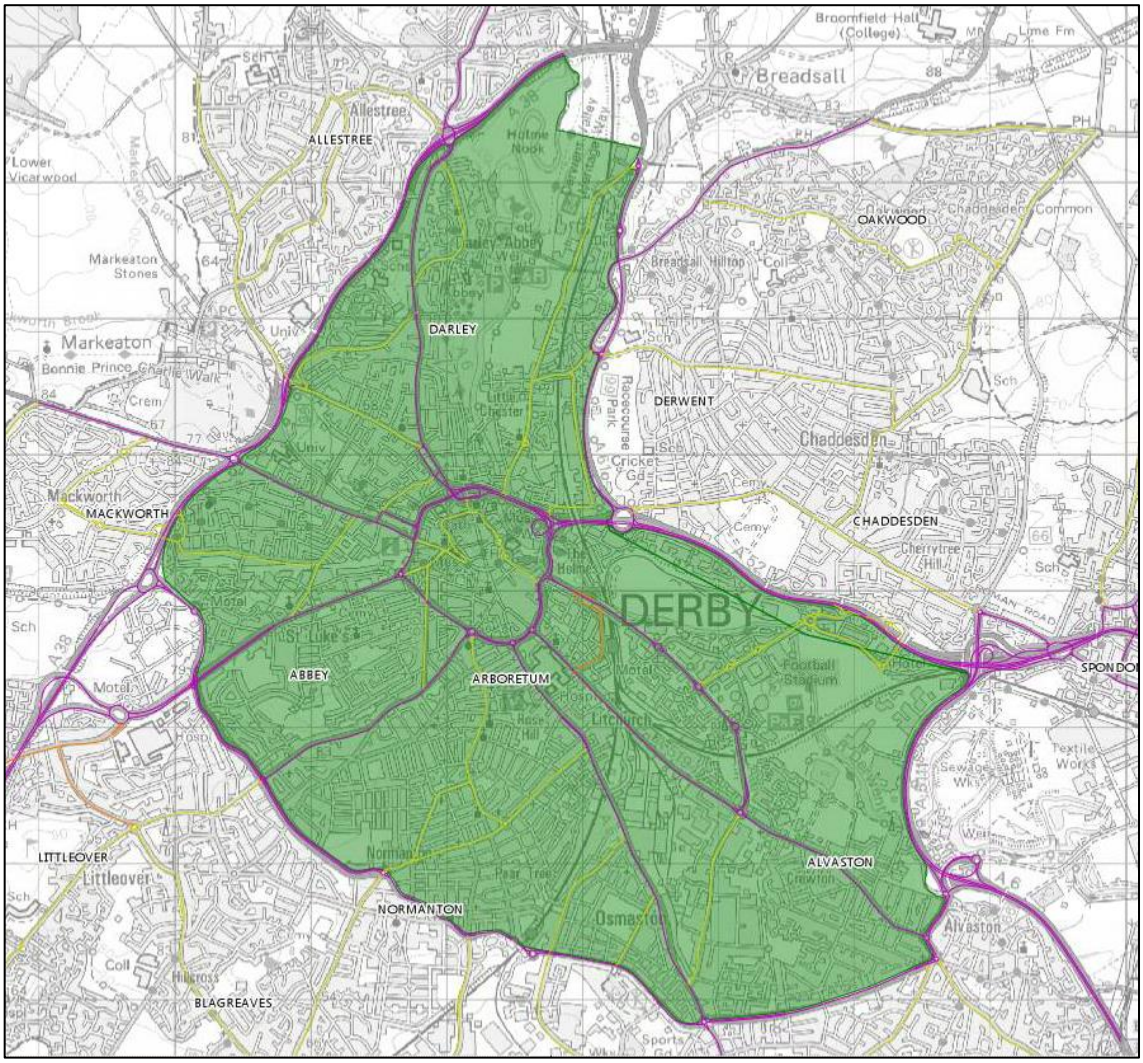
3.2.1 Initially three charging CAZ options were considered including a City Centre only, within the Outer Ring Road and full city options. However, following an initial appraisal of the air quality issues within Derby City as part of the Target Determination Stage of the study only the Outer Ring Road option (Option 2) has been taken forward for further assessment.

3.2.2 The area is abounded by the Outer Ring Road, but not including the Outer Ring Road (i.e. A61 Sir Frank Whittle Road, A52 Brian Clough Way, A5111 Raynesway, Shardlow Road, Harvey Road, Osmaston Park Road, Newdigate Street, Kenilworth Avenue, Warwick Avenue, Manor Road, Kingsway, A38 Queensway, Abbey Hill). This area is shown in Figure 3.

3.2.3 The boundary has been chosen for the following reasons:

- to utilise the existing Outer Ring Road network as the boundary for the majority of the zone:
  - in order to ensure drivers are given alternative routes to avoid travelling through the zone if necessary.
  - that the alternative routes are on suitable roads i.e. the strategic road network.
  - to minimise any issues regarding displaced traffic.
- A608 Mansfield Road is the boundary of the zone as this forms part of the strategic road network for traffic travelling in a northeast bound direction.
- The Derby City Council boundary between A38 and A61 forms the boundary of the zone in order to ensure the zone stays within the DCC adminstrative area.

Figure 3. Coverage of charging CAZ Option 2



4. MODELS APPLIED

4.1 General Overview

4.1.1 In order to assess the transport implications of the Derby proposals, the Derby Area Transport Model (DATM3) has been utilised as described in the T2 Local Plan Transport Model Validation Report.

4.1.2 An initial general assessment of the transport related air quality emissions at roadside level has utilised the SYSTRA ENEVAL Toolkit. ENEVAL is fully consistent with the DfT's Emission Factors Toolkit (EFT) and utilises the data from the EFT. It provides an interface with the transport models to provide an efficient way of applying the EFT factors to the transport model outputs. Further details are also provided below.

4.1.3 Detailed assessments of the impacts of the schemes on the specific areas of Derby where air quality issues have been identified has been undertaken using a specialist air quality dispersion modelling tool. This has utilised data from DATM3.

4.2 Transport Models

4.2.1 DATM3 has a detailed representation of the transport networks and demand within the Derby Principal Urban Area (PUA). Network coverage and demand representations are of reduced detail for areas beyond Derby, for the adjacent counties and major urban areas including Derbyshire, Nottinghamshire, Leicestershire and Staffordshire.

4.2.2 DATM3 has the following key components:

- SATURN highway assignment model capable of simulating the operation of the road links and junctions within the Derby area and determining the routes that vehicles will take based on the lowest generalised costs for the end to end journey.
- TRIPS public transport model with detailed representation of all major bus and rail services within the Derby area and also the main inter urban services linking to towns and cities outside the immediate city boundary. TRIPS is capable of providing predictions of passenger boarding and alighting patterns.
- DATM3 variable demand model (VDM) which simulates the journey choices based on the costs associated with a range of journey options. The demand model also incorporates a parking model within Derby City Centre that simulates the supply, demand and payment effects of the on and off street parking within this area. WebTAG does not specify a single hierarchical order for demand choices but does suggest that frequency should be the least sensitive to change in travel costs. WebTAG also recommends that macro time of day choice should follow frequency in the hierarchical order. The order set out in DATM3 (from least sensitive to most sensitive) includes:

    - Frequency.
    - Macro time of day choice – choice between morning and evening peak and off-peak time periods.
    - Mode – Car, public transport (rail/bus), park and ride, slow modes (walking and cycling).
    - Destination (trip distribution) –journeys can alter their ultimate destination in the short term (for purposes such as shopping and leisure) or longer term (e.g. for commuting).

- Micro time of day choice – choice between shoulders of the peak, reflecting peak spreading.

- Delta Land Use Model – a dynamic model which represents land use change over periods of time in response to variables including travel times and costs (predicted by the transport model). The model forecasts the take up and distribution of households, population, employment and floorspace based on economic circumstances and area accessibility.
- External Forecasting Model (EFM) – converts changes in land use to changes in trip patterns to be used in the demand model.

4.2.3 A detailed evaluation of DATM3 is provided in the T2 Local Plan Transport Model Validation Report which provides an assessment of the strategic routes and screen lines validation in the key study area against recent (less than 5 years old) collected traffic data. This includes a comparison between observed and modelled vehicle composition, flows, journey time and traffic pattern within the key study area. The model has been agreed as being 'fit for purpose' by JAQU and the DfT.

4.3 Strategic Air Quality Model

4.3.1 ENEVAL is an Environmental Assessment Tool, which has been developed by SYSTRA Ltd. This software has been through a programme of continual improvement and updating. The current version is consistent with Defra's Emissions Factors Toolkit Version 7.4.

4.3.2 ENEVAL takes link and junction-based outputs from a range of different traffic modelling platforms and estimate the likely transport emissions generated by this traffic on a link-by-link basis.

4.3.3 The ENEVAL software produces regional emissions (and other network statistics). It can do this for combination of input networks or single networks.

4.3.4 ENEVAL can output a wide range of different types of vehicle emission for each of the links on the input networks. These can also be aggregated by jurisdiction code and/or by user-defined grid squares. The list below summarises the types of emission which can be estimated by the current version of ENEVAL.

- Oxides of Nitrogen – NO_x;
- Nitrogen Dioxide - NO_2;
- Particulate Matter – PM_{10};
- Fine Particulate Matter – $PM_{2.5}$;
- Hydro-Carbons – HC;
- Carbon Monoxide – CO;
- Carbon Dioxide- CO_2;
- Benzene – C_6H_6;
- Methane – CH_4; and
- 1 3-Butadiene – C_4H_6 .

4.3.5 The ENEVAL program calculates these emissions for 778 different fleet types for which there are distinct emissions factors in the current Emissions Factor Toolkit, based on the relevant average link speeds.

4.4 Detailed Air Quality Models

4.4.1 The detailed air quality modelling is the subject of a separate technical note. The highway model has supplied the following data for each road link (two-way) in the highway model as an input into the detailed air quality modelling.

- Morning, inter and evening peak hour traffic flows.
- 24hr traffic flows based on the three hourly models provided above and local factors derived from recent traffic count data.
- Proportions of HGV, OGV, Taxi and bus vehicles.
- Splits for compliant and non-compliant vehicles for each of the above categories.
- Link speeds

5. TRANSPORT AND INITIAL AIR QUALITY MODELLING METHODOLOGY

5.1 General Overview

5.1.1 We have identified the following stages for this overall study as follows.

- Stage 1: T3 Local Plan Transport Modelling Methodology Report v8 - this document
- Stage 2: T2 Local Plan Transport Model Validation Report v5.5
- Stage 3a: Model Enhancements Strategic Model
- Stage 3b: Model Enhancements ENEVAL
- Stage 4: Base Year Air Quality Emissions Reporting.
- Stage 5: Reference Case Development and Reporting.
- Stage 6: Preferred Scheme and Benchmark/sensitivity Scenario Testing.

5.1.2 All these stages have been completed. Details of stages 3a to 6 are provided in the following section of this report.

5.2 Stage 3a: Strategic Model Enhancement (Base Year)

5.2.1 The core DATM3 model evaluated in Stage 2 has been enhanced to ensure it can be used for the assessment of a charging CAZ scheme. These enhancements generally relate to:

- Sub-dividing the matrices to provide separate taxi, compliant and non-compliant car matrices in addition to the existing LGV, HGV and bus matrices so that the various vehicle exemption categories can be fully modelled.
- Setting up CAZ cordons with the ability to apply a toll for non-compliant vehicles.
- Amendments to the demand model to enable variable demand to be applied to the amendments identified above.

Step 1: Matrix Adjustments

5.2.2 In order to model the potential driver behaviour impacts of the implementation of a CAZ scheme, further segregation of the model matrices has been undertaken so that compliant and non-compliant vehicles can be modelled separately. The model has separated compliant and non-compliant matrices for the following vehicle types:

- HGV (OGV1 and 2 combined)
- LGVs
- Cars split by journey purposes (commute, business, other)
- Buses
- Taxis.

Step 1a: Creation of Non-Compliant vehicle matrices

5.2.3 To enable the model to differentiate between vehicles which do and do not comply with the emissions restrictions within a CAZ, a splitting of each of the vehicle matrices identified above was required.

5.2.4 Using the ANPR data, in conjunction with vehicle registration information, we have derived average proportions of compliant and non-compliant vehicles per vehicle type based on the emissions categories of the individual vehicles. This has been undertaken for specific post

code areas of the city and differs by vehicle category. The journey purpose mix has been maintained as the current splits for the taxi and car matrices.

Step 1b: Adjustment of the Non-Compliant matrices for the Reference and CAZ scenarios

5.2.5 The levels of compliant and non-compliant vehicles within each category will change over time as new vehicles are purchased and older vehicles are removed from the network.

5.2.6 For the future year reference cases these changes in the proportions of compliant and non-compliant vehicles have been taken from the DfT's Emission Factors Toolkit (EFT) and applied to the Derby specific compliant/non-compliant matrices derived in step 1a above. This has provided future year levels of compliant and non-compliant vehicle splits that are based on the local situation rather than UK wide averages.

5.2.7 The implementation of a tariff based CAZ is predicted to affect the rate of take up of Compliant vehicles over and above that predicted over time in the DfT's Emission Factors Toolkit (EFT).

5.2.8 For a 'with charging CAZ' scenario we have applied the changes in the levels of compliant vehicles to the traffic model matrices to reflect this increased rate of take up of compliant vehicles. Different factors have been applied to each of the vehicle categories identified above. This has been based on information provided by JAQU.

Step 2: Setting up CAZ Cordons

5.2.9 A charging CAZ will apply a tariff to non-compliant vehicles that travel within the prohibited area. These trips will include:

- Internal Trips (those with an origin and destination within the CAZ area)
- External/Internal trips (those with either an origin or destination within the CAZ area)
- Through Trips (those with neither an origin or a destination within the CAZ area).

5.2.10 The tariffs to enter the CAZ area will be a daily charge and therefore there is the potential for a single vehicle to make multiple journeys to/from and within the CAZ area during this 24hr period.

5.2.11 As the transport models are based on an average hour during the morning, evening and interpeak periods we believe the numbers of multiple movements in/out, within the cordon will be relatively small and therefore we have applied the charge at a 24 hour level. This may overestimate the overall charges applied on the network as a whole by a small amount over a 24hr period due to the small levels of multiple trips, however, it is difficult to identify these trips separately.

5.2.12 The CAZ charge is included within the transport model in two locations: within the assignment process and within the demand model. This modelling approach has been adopted to ensure that when the demand and assignment models tariffs are combined together all vehicles pay the identified daily tariff and not a lower or higher amount. The way we have applied the charges using both the highway assignment and demand models allows the model to identify through and non through movements and therefore it can replicate the potential impact of through traffic rerouting to avoid the CAZ area.

5.2.13 The charge within the highway assignment process is included to influence route choice, which applies for trips that pass through the CAZ area only (ie have both an origin and a destination outside the CAZ area) and is included as an inbound charge, with a value of half the actual CAZ charge (it is assumed that all trips will have a return leg in a 24hr period and therefore over a whole day the total charge will be applied, hence only half the charge is applied within each hour period) . For trips starting and/or ending their journey within the CAZ the charge will have no impact on routing as the origin and destination of the trip are fixed. Only demand that passes through the CAZ can reroute based on the inclusion of the charge within the assignment.

5.2.14 Within the demand model the charge is applied differently depending on the type of trip. For trips starting within the CAZ a residents charge is added. For trips ending in the CAZ, but not starting there the non-residents charge is added (this allows differential charging for residents and non-residents if required) . For through trips the value is taken directly from the assignment skims to best reflect the multi-routing options and the impact this has on the average charge paid (e.g. if for a given OD 10% of demand pass through and pay the charge and 90% travel around the CAZ then the skimmed value from the assignment will reflect this).

5.2.15 As with the assignment, a value of half the total charge is used for each leg of the journey. Within the demand model the generalised costs used are calculated at an OD level, but are then combined into tour-based costs (i.e. an outbound and return leg). This cost is then used within the VDM for mode, destination and time period choice.

5.2.16 When all assumptions are applied together, this means that all non-compliant vehicles choosing to travel in the charging zone will be subject to 100% of the CAZ charge over a 24 hour period.

5.2.17 The daily charge for taxis have been reduced to take account of multiple movements in and out of the cordon. An average number of movements has been derived from the ANPR data based on taxi movements which cross the ANPR cordon. The daily tariff has been reduced to assume that all taxis make the average number of crossings.

5.3 Stage 3b: Model Enhancement ENEVAL Model

5.3.1 As indicated previously the ENEVAL tool uses outputs from the Strategic highway model to predict the roadside emissions from transport based on the detailed fleet mixes derived by the DfT in the Emissions Forecasting tool.

5.3.2 For the initial options assessments we have used this tool to provide a quick indication of the impacts of the various package combinations on the roadside emissions. This has supported the assessment of the potential benefits of the options in achieving the air quality targets for the area, which has then enabled the final schemes to be identified. This has been used for early option assessment only and does not replace the use of the detailed AQ modelling.

5.3.3 The ENEVAL model has been enhanced to ensure that it is fully consistent with the latest Emissions Forecasting Tool (EFT v7.4) and it can be used to provide a simple initial assessment of the emissions of a range of options for the area. This included:

- Updating the ENEVAL tool to ensure it is consistent with the latest factors in the EFT to ensure full consistency with the EFT and current best practice.
- Enhancement of the model to utilise the inputs from the enhanced Strategic Transport Model.

- Enhancement of the ENEVAL tool to enable changes to vehicle class proportions to be changed easily within a specific area, to allow efficient assessment of the air quality implications of various future vehicle fleet mixes.
- Calibration of the models vehicle fleet mixes from local data to ensure that the emissions estimates accurately reflect local fleet profiles.

5.4 Stage 4: 2016 Base Year Air Quality emissions reporting.

5.4.1 The base strategic highway model outputs derived in Stage 2 have been used to provide inputs to the detailed Air Quality models to enable base year calibration of these models.

5.5 Stage 5: Reference Case development

5.5.1 A single future year Reference Case for 2020 has been created to be consistent with the JAQU primary assessment year.

5.5.2 The Reference Case has been based on the 2016 base year models. The derivation and outputs of these 2020 Reference Case models are detailed in the '**T4 Local Plan Transport Model Forecasting Report**'.

5.6 Stage 6: Scenario Testing

Preferred Scheme

5.6.1 The Preferred Scheme has been modelled through a series of network and signal setting adjustments in the DATM highway model, representing the package of measures identified in Chapter 3. No changes to the vehicle compliant splits have been assumed over and above those in the 2020 Reference Case.

5.6.2 These changes have been run through the full DATM model so that any driver demand responses, such as a choice to move to public transport or to change destination, that may occur as a result of the Preferred Scheme are included in the predicted impacts of the scheme.

5.6.3 As the DATM highway model fully simulates all the junctions within the city including those within the traffic management scheme and the measures have a wide impact on the highway network throughout the city of Derby by rerouting traffic away from Stafford Street to other main road routes the use of Micro simulation modelling to assess only the local impacts of these measures is not appropriate as it could not estimate these wider rerouting impacts.

5.6.4 Outputs of this modelling have been utilised in the detailed air quality modelling of the scheme undertaken by Ricardo.

Benchmark Chargeable Access Restriction Option – Within the Outer Ring Road CAZ D

5.6.5 In addition to the preferred option test, a single CAZ charging option has been identified for a benchmark test by JAQU. This option is for the Type D charging CAZ applied to the area within the Outer Ring Road as described in Chapter 3.

5.6.6 The Reference Case models already had the ability to apply tariffs to the CAZ area and therefore no further development of this aspect of the model was required at this stage.

5.6.7 The compliant and non-compliant vehicle splits have been adjusted to reflect the situation should a CAZ scheme be implemented. These adjustments have been based on information supplied by JAQU.

5.6.8 The tariff levels that have been applied are based on those provided by JAQU for the London Charging scheme. They include:

- Cars, Taxis, LGVs: £12.50 per day
- HGVs, Buses: £100 per day.

5.6.9 This benchmark test has been run through the full DATM model so that any driver demand responses, such as a choice to move to public transport or to change destination, that may occur as a result of the scheme are included in the predicted impacts of the scheme.

Benchmark CAZ Sensitivity Testing

5.6.10 A single sensitivity test has been requested by JAQU based around the Benchmark CAZ D test above. This test assumes that there is no changes to the compliant and non-compliant vehicle splits as a result of implementing the scheme, to replicated a worst case scenario that no one changes their vehicles to avoid paying a tariff under the Benchmark CAZ scheme. All other assumptions are the same as the core Benchmark test.

5.6.11 This benchmark test has been run through the full DATM model so that any driver demand responses, such as a choice to move to public transport or to change destination, that may occur as a result of the Preferred Scheme are included in the predicted impacts of the scheme.